STUDIES IN HEALTH TECHNOLOGY AND INFORMATICS 320

Universal Design 2024: Shaping a Sustainable, Equitable and Resilient Future for All

Proceedings of the Seventh International Conference on Universal Design (UD2024), Oslo, Norway, 20-22 November 2024



Editors: Kristin S. Fuglerud
Wolfgang V. Leister
Juan Carlos Torrado Vidal

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UNIVERSAL DESIGN 2024: SHAPING A SUSTAINABLE, EQUITABLE AND RESILIENT FUTURE FOR ALL

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Preface

This book is a collection of papers from the Seventh International Conference on Universal Design, UD2024, organized by the Norwegian Directorate for Children, Youth, and Family Affairs (Bufdir) on behalf of the Norwegian Ministry of Culture and Equality.

The UD conference series is one of the largest and most cross-disciplinary conferences on universal design. Past events have been held in a number of European countries: UD2012 (Oslo, Norway), UD2014 (Lund, Sweden), UD2016 (York, UK), UDHEIT2018 (Dublin, Ireland), UD2021 (Helsinki, Finland), and UD2022 (Brescia, Italy).

The United Nations Convention on the Rights of Persons with Disabilities (UNCRPD) emphasises the concept of "universal design". This concept is central to the convention's goal of ensuring social inclusion for persons with disabilities. Organisations, such as the European Disability Forum (EDF), advocate using the term universal design to align with the UNCRPD.

Universal design, inclusive design, design for all, innovation for all, and accessibility are concepts aimed at making products, environments, and services usable and accessible for diverse users, regardless of ability, age, or background. While these terms imply common goals, they each offer distinct approaches to creating inclusive solutions. Additional approaches, such as barrier-free design, user-sensitive inclusive design, countering design exclusion, ability-based design, and universal usability, provide further insights into designing for diverse user groups.

Although the conference uses the term universal design, it welcomes researchers and practitioners from the various disciplines designing for diverse user groups in the hope that this will result in a wider spectrum of viewpoints, and will help to unite our forces to advance the field.

Through keynotes, academic paper, practical project and poster presentations, workshops, field trips, panels, and knowledge exchange, the conference aims to highlight best practice, disseminate recent research, and foster collaboration across sectors, disciplines, and nations to further advance universal design. By integrating knowledge and perspectives from users, practitioners, researchers, experts and policy makers, the goal is to provide designers and innovators with insights which will help them to create products, environments, and services that are accessible, usable, and beneficial to all individuals, regardless of their abilities or backgrounds.

The papers in this collection have undergone a thorough review process, detailed below. Topics covered include product and service design, systems development within both the private and public sectors, and various disciplines. The collection illustrates a continuation of the development and research within areas like theory, policy approaches, standards, co-creation, user involvement, community engagement, design methods and tools. There are also papers about universal design in education, architecture, the built environment, urban planning, navigation, and transport. Key themes attracting more attention include: measuring the costs and benefits of universal design, universal design dilemmas, health and wellbeing, tourism and cultural heritage,

and emerging technologies like virtual and extended reality, as well as artificial intelligence.

The conference proceedings are accompanied by a conference compendium containing extended abstracts which describe practical presentations and work not selected for inclusion in these proceedings. We hope that both collections will serve as a valuable resource for users, disability and minority group advocates, policymakers, practitioners, and researchers, facilitating the exchange of ideas, best practice and knowledge, as well as identifying knowledge gaps.

Looking ahead, there are still many open issues within the field; areas needing further research, and emerging areas that require research. Society is facing important challenges that will require a combined effort and mutual understanding in the present and near future, such as climate change and pandemics. How can we address such societal issues in a way that includes everyone? What are the implications of the various solutions proposed for vulnerable groups? Rapid changes in society and the environment, the rise in certain health challenges and the proliferation of new technologies, highlight the need for ongoing dialogue and collaboration, the exchange of experiences, and continued research. We believe that this collection of papers reflects this development to some degree. Understanding people in all their diversity remains crucial, meaning that more research from the perspective of intersectionality is needed, as is addressing the needs of people with allergies, chronic diseases, invisible disabilities, and mental health conditions. As this collection demonstrates, co-design, community engagement, and user involvement continue to be foundational aspects of universal design and similar approaches.

There is also growing recognition of the fact that the concepts and knowledge within universal design are crucial for achieving the United Nations' Sustainable Development Goals (SDGs) outlined in Agenda 2030. Consideration of the knowledge already produced, and promoting more research within this field are both essential if we are to ensure good health and well-being and promote quality education, decent working conditions and economic growth, reducing inequalities, and enabling sustainable cities and communities.

Universal design must continue to be promoted within mainstream design and development, and approaches to facilitate this must be explored. We hope that this collection will inspire you, as we continue our work in this challenging and evolving field.

Kristin S. Fuglerud
Juan Carlos Torrado Vidal
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Details of the peer review process

The review process involved 108 dedicated reviewers, who collectively conducted 808 reviews in two rounds. In both rounds, almost all submissions were evaluated by three or more peer reviewers, ensuring a thorough assessment of each contribution. In the first round, abstracts were reviewed with the emphasis on quality and relevance to the conference theme, and constructive feedback was provided to authors. The primary goal of the second round was to identify the best papers for inclusion in the proceedings. The overall evaluation of submissions was conducted using a 7-point scale to ensure nuanced differentiation between papers. Reviewers rated each submission as follows: 3 for excellent quality, 2 for very good quality, 1 for good quality, 0 for average quality, -1 for below average quality, -2 for poor quality, and -3 for unacceptably poor quality. Reviewers were encouraged to consider several criteria, including originality and novelty, clarity and structure, methodology, data and analysis, results and conclusions, references, and ethical concerns. In cases where reviewers did not agree, discrepancies were addressed by conducting additional reviews and meta-reviews, thereby maintaining the integrity and quality of the evaluation process. In such situations, the self-reported reviewer-confidence scores, on a scale from 5 (expert) to 1 (none), allowed us to place greater weight on evaluations from experts. Additionally, reviewers were encouraged to provide constructive feedback to all authors, highlighting strengths and offering suggestions for improvement. The authors were then asked to improve their papers based on feedback before submitting a final version for publication.

Number of submitted papers

We received 97 scientific papers.

Number of accepted papers

60 scientific papers were accepted for publication.

Additional information

While the conference received submissions from 26 countries and reviewers were from 15 countries, the majority of submissions came from Norway, Denmark, and Sweden, followed by Ireland, Italy, India, the United States, Belgium, Australia, and Japan. Reviewers were predominantly from countries that had previously hosted the conference, including Norway, Ireland, Sweden, Italy, Denmark, and Finland. The acceptance rate was relatively evenly distributed across the different countries. The most frequently occurring topics of submitted papers, as well as accepted papers, were: built environment and digital accessibility, followed by best practice, user participation, community engagement and co-design, design thinking, innovation, and ICT.

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Universal Design 2024: Shaping a Sustainable, Equitable and Resilient Future for All
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Universal Design and Accessibility as an Act or a State – A Comparison of Policies in Norway, Sweden, and Denmark

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Abstract. 186 countries have ratified The Convention on Rights of People with Disabilities (CRPD) since 2006. Sweden ratified the CRPD in 2008, Denmark in 2009, and Norway in 2013. In the context of the United Nations, the concept of Universal Design (UD) introduced in the CRPD is new. Previously, accessibility was the dominant concept. By ratifying the CRPD, these three countries have agreed to initiate or advocate for research and development aimed at utilising UD when designing goods, services, equipment, and facilities. Additionally, they have committed to encouraging the integration of UD in the formulation of standards and guidelines. As a starting point for a future debate about the research part, this paper studies the uptake of UD in national policy in the three countries. The findings show that the approach in each country differs. Norway quickly developed their own version of UD (that has been critisised by scholars), thus choosing a top-down approach. By contrast, Denmark has been reluctant and is still using the concept of accessibility, waiting for the different sectors to adopt the concept of UD in their own way – as a kind of bottom-up strategy. While Sweden, has chosen another approach between these two strategies focusing on UD as a guiding principle, accessibility, and a third concept: usability. Finally, the paper discusses these approaches in relation to the built environment, using a framework that distinguishes between and act (like a process) and a state (as a result). All three counties are characterised by a dual focus on both act and state in line with the literature; however, the state dominates. The paper argues that we must acknowledge this duality but focus more on the process-related aspect to further develop UD as a human right concept.

Keywords. Accessibility, Convention on the Right of Persons with Disabilities, Scandinavia, Universal Design

1. Introduction

Universal design (UD) as a concept was originally coined by Ron Mace and presented as "a way of designing a build or facility, at little or no extra cost, so it is attractive and functional for all people, disabled or not." [1, p 147]. The concept is

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dynamic and has been adjusted over time. In 1998, UD was defined as "the design of products and environments to be usable to the greatest extent possible by people of all ages and abilities. Universal design respects human diversity and promotes inclusion of all people in all activities of life." [2]. Additionally, it has been emphasised that UD could be viewed as a process [2] highlighting Universal Designing [3].

Today, UD is a human rights concept, implemented in The Convention on the Rights of Persons with Disabilities (CRPD) [4] in 2006. Here "Universal design" means the design of products, environments, programmes and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design. "Universal design" shall not exclude assistive devices for particular groups of persons with disabilities where this is needed. "(4; Article 2). The CRPD builds on eight principles, one of them is accessibility [4]. Later, UD was reformulated as "a process that enables and empowers a diverse population by improving human performance, health and wellness and social participation." [5, p. 29] emphasing that UD is not an end state.

Until now, 186 countries have ratified CRPD. Sweden did it in 2008, Denmark in 2009, and Norway in 2013. In a United Nation context, the concept of UD introduced in the CRPD is new. Formerly, accessibility was the dominant concept, see e.g. (6). By ratifying the CRPD, these three countries have agreed to initiate or advocate for research and development aimed at utilising UD when designing goods, services, equipment, and facilities. Additionally, they have committed to encouraging the integration of UD in the development of standards and guidelines.

2. Method

The principle of sectoral responsibility is a fundamental pillar of Scandinavian society and the welfare model. The paper is based on desk research of official documents from the three countries Norway, Sweden, and Denmark. The languages are quite similar unlike e.g. Finnish, which made it possible for the authors to read the other countries documents without translation.

The selection and classification of the document is based on the macro, meso, and micro levels of an analytical model on implementation of UD [7]. The macro level characterises the policy level where UD appears as a value, while the meso level pertains to the instrumental level defined by legal requirements and standards. At the bottom of the model, we find the micro level, where people experience an environment that is accessible and usable.

Another aspect of the framework of the paper is the distinction between an act and a state. When implementing the general concept and political strategy of UD in specific national contexts, the states party to the convention are free to decide how to approach implementation in concrete terms. The three Scandinavian states are both sufficiently similar and different, making it interesting to evaluate whether UD is implemented as an act or as a state, or both. By "act" we refer to the act of universal design*ing* [3] like UD as an activity (a verb), and by "state" we refer to UD as a condition: to be universal designed. Thus, an act is related to a process and a state is present as a result or solution (a noun) that becomes defined and prescribed.

3. Status of UD in the Nordic countries

A summary of the status of the uptake of UD is structured in relation to three countries, followed by a discussion that spans across them.

3.1. Norway

The term Universal design was first mentioned in 1997 in a booklet published by the Council for Disabled Persons at state level [8]. In this rather thin booklet, UD was introduced by the Norwegian concept "universell utforming" [8]. Norway´s strategy for implementing UD across different contexts and political levels has involved governmental action plans, as well as its incorporation into law, technical specifications, and standards. The first Action Plan was introduced in 2004, whereas the most recent is covering the period 2021-2025. There are two definitions of UD in Norway, the CRPD definition and the definition used in the Equality and Anti-Discrimination Act [9], and in the Planning and Building Act [10].

The particular Norwegian definition was introduced in a legal report published as an attachment to the white paper 'Equal Status and Accessibility (Likeverd og tilgjengelighet)[11] which served as the preparatory work for the Discrimination and Accessibility Act [12]. This law was later repealed and integrated into the Equality and Anti-Discrimination Act in 2018 [9]. Accessibility and accommodation are viewed as a requisite for equality, as described in the purpose section of the Equality and Anti-Discrimination Act [9]. CRPD was ratified by Norway in 2013 and signed already in 2007, prior to the adoption of the Norwegian Discrimination and Disability Act [12]. Therefore, the particular Norwegian legal definition, which reads more like a minimum standard, is to be interpreted in light of the CRPD definition.

There are two issues with the Norwegian strategy we want to discuss here. The first relates to the use of action plans as a top-down strategy for implementation. The second is the focus on physical barriers in implementing UD through the specific Norwegian legal definition. We will use the thematic report Universal Design: Clarification of the concept [13] as an example of top-down strategy. This thematic report was translated into English and other languages. The report is the product of a dialogue with NGOs and governmental institutions. It was published in 2007 and refers to the CRPD, but the CRPD definition of UD is not used, although Norway signed the convention March 2007. However, the thematic report delimits UD to concern only physical and technical environments. In doing this, the Norwegian government, in a top-down process, changes the content of UD, simply stating that this is how the concept is to be understood. By ratifying the CRPD, Norway took on a responsibility to support research on UD as defined in the convention. Through the action plans and calls from national directorates, there has been funding for smaller projects, but few, if any, more comprehensive interdisciplinary research projects.

Fifteen years after the first Discrimination and Accessibility Act came into force, there have been some notable improvements, such as new ferries designed according to technical specifications for UD. However, there have been fewer comprehensive changes that strengthen the human right situation for persons with disabilities, particularly regarding access to education, paid work, public space, transportation, culture and services.

At the macro level, Norwegian national law interprets UD more narrowly than the CRPD. The technical specifications of the Planning and Building Act are national, representing the macro level. However, these specifications are implemented by local authorities, institutions and practitioners which corresponds to the meso level. At this level, the duties of these authorities and institutions in implementing UD need to be more predictable and grounded in research and knowledge. Some improvements at the meso level can be seen, such as enhanced access to buildings, public spaces, and transportation due to the implementation of law and standards. Nevertheless, much remains to be done, especially ensuring seamless access to resources and arenas. At the micro level there have been improvements with regards equal accessibility, but we lack knowledge about what works, why, and for whom.

3.2. Sweden

Sweden differs from Norway in its interpretation and implementation of UD. In 2019, UD was put forth as a guiding principle for the realisation of the Swedish disability policy, stated as "To do the right thing from the beginning" [14, p.97]. By planning and designing society based on the whole population, one can avoid having to make adaptations and special solutions later down the line. Overall, Swedish disability policy is closely aligned with the CRPD and how, e.g., the term UD is used there. The approach is more bottom-up than top-down, i.e. more governing than government.

In Swedish policy, UD is used alongside the terms accessibility and usability. On a macro level, this entails applying UD as a value-based concept in national policy and guidelines. UD is also used outside of disability policy. As an example, systematic work based on UD is highlighted in the national architecture and design policy, "Policy for Designed Living Environments" [15]. It is important to note that in Sweden, UD is not defined or used as a measurable concept. Instead, UD is used together with the terms accessibility and usability, which can be assessed or measured. Both these terms have been implemented in Swedish regulations and guidelines for many years. One example is the Swedish Planning and Building Act, where accessibility and usability are used, but not UD. Chapter 2, §3 states that planning according to the act should support "a social good living environment which is accessible and usable for all groups in society" (our translation) [16].

On a meso level, the Swedish municipalities are encouraged to base their work on UD. In 2017, the Swedish Association of Local Authorities and Regions, introduced UD as part of a positioning paper meant to guide the municipalities and regions work [17]. In Sweden, some barriers are called "Easily Eliminated Obstacles" ("enkelt avhjälpta hinder"), a definition that was introduced in Swedish legislation in 2003 [18]. In most cases, removing an easily remedied obstacle is the municipality's responsibility, but the legislation is national and was introduced to meet the national goal that public spaces and environments should be accessible for all [19]. The requirements concern both the elimination of existing obstacles [18] and the accessibility of new buildings, places, and environments [20].

The three terms UD, accessibility and usability are used together also on a micro level. While UD sets the direction and mindset, focusing on inclusion and non-stigmatisation, accessibility and usability make it possible to operationalise and realise UD in practice [21].

3.3. Denmark

In contrast to the other countries, Denmark has been cautious about implementing UD despite the ratification of the CRPD. UD was present in one of the visions in the National Disability Action Plan launched by the Government in 2013 [22]. It is interesting to note that even though Denmark has been criticized for not following up on this action plan [23] there are no current plans to create and implement a new action plan [24]. The focus of this summary is the built environment because of the deficiency of UD in other fields.

An expert group is working on a white paper for a new architectural policy. Lately, this group has identified several central societal challenges, where an architectural policy can and should play an active problem-solving role, and UD is mentioned as a future focus [25]. Concerning architecture at the macro level, the building act has been revised 24 times since 2008 without implementing UD. In 2010, a goal to promote accessibility (handicap-tilgængelighed) was included [26].

At the meso level, the building act results in the buildings regulations. Practitioners understand accessibility as the prescriptive requirements in the Building Regulations. This means special solutions for a specific group: tactile guidance paths for blind people, ramps, and spacious lavatories for wheelchair users [27]. The new version of the building regulations from 2018 has removed the word 'accessibility' but maintained the prescriptive requirements. UD is mentioned in a guideline about the users and is characterised as a methodology that acknowledges a wide view on the users meaning everybody, encouraging the building sector to think in architectural solutions that encompass a wide range of potential user needs [28]. Thus, a website about UD was launched in 2019 to support the building sector's shift in practice [29]. It was ordered by the agency behind the building regulations, however the report from 2020 stress that the website will promote "…education and information on the accessibility requirements of the Building Regulations [24, p. 9]. Besides an annual grant to Aalborg University for research and this website, the state does not fund any research about UD [24].

Related to this meso level, we find among frontrunners different understandings of UD e.g. 'not just about ramps' and as a design driver for social sustainability [30]. In addition, two organisations have recently embraced UD. The Danish Association of Construction Clients (DACC) integrated UD in their policy on social sustainability in May 2024 [31], and Disabled People´s Organisation Denmark (DPOD) launched their first policy on UD and accessibility in February 2024. DPOD understands UD as the sum of a palette of accessible solution [32]. The situation in Denmark is characterised by a buttom-up approach to UD.

4. Concluding discussion

The implementation of UD in the three countries differed in strategic approach and interpretation of UD. In this discussion of the implication of the different approaches, we focus on policies in relation to the built environment, and we use the distinction between an act and a state.

In both Norway and Sweden, the areas of planning and buildings are combined into a single act, while they are separated in Denmark. The situation on the macro level varies across the countries. Norway has developed its own legal definition of UD, implemented at the macro level. While Sweden and Denmark have not implemented the term UD at the macro level in their building acts, Sweden operates with UD as a guiding principle

in other policies on that level. In the concrete implementation of CRPD, Sweden focuses on accessibility and usability for all people, and Denmark focuses on accessibility for people with disabilities even though the word accessibility is not used.

There exist a kind of choice in Denmark because it is up to the individual actor in the building sector to define and engage in UD, which might create a kind of ownership different from when a concept is imposed from the top, and a dynamic understanding of UD. However, the result can also be different individual understandings and definitions, leading to confusion.

Regardless of approach, the meso level in the three countries is defined by technical specifications, e.g. maximum gradient of a ramp. The specifications are strikingly similar (33). Even though Norway claims to have a UD mindset, these technical specifications do not cover the diversity of the users' needs and situations in relation to equal accessibility and usability.

What Norway and Denmark have in common is an understanding of UD and accessibility as a state rather than an act, while in Sweden, UD on the contrary is a principle guiding the acts. This difference in focus has profound implications for how UD is understood and practiced on macro, meso, and micro levels. To focus on a state is not unique because, as the introduction has shown, the UD discourse is characterised by a certain confusion regarding UD as an act or a state, or both. There is a risk that practitioners working with UD find themselves torn between several competing interpretations and tendencies related to UD. Some of those in the “UD as a state camp”, have previously worked based on guidelines and technical specifications related to accessibility, as this has been the existing practice in the planning and building field. By contrast, those in the “UD as an act camp” are more interested in strategies and policies, striving to advance the implementation of the CRPD.

The understanding of UD as primarily a process concern can be traced back to Mace (1) in the mid 80’s and has repeatedly over the years been highlighted by Steinfeld and colleagues (2, 3, 5). In the Nordic context, several researchers have developed this aspect e.g. [34, 35]. It is problematic if UD is reduced to a state, as we can see in the findings where the state dominates. As a state it requires a certain precision. Telling a passenger that a station is UD is not usable information because the passenger does not know how UD has been interpreted in the design of the station.

We argue that UD in the future should be understood more as an act than as a state if we are to avoid a reproduction of measurable accessibility (prescriptive requirements) and instead ensure a conceptualisation of UD that embraces human diversity and contributes to the creation of a society grounded in citizenship for everybody. However, we cannot only focus on the act; we must acknowledge and explicitly highlight the duality of the concept as both an act and a state to avoid further confusion and ambivalence. Thus, we argue that we need this dynamic. Moreover, we recommend policymakers and practitioners to become aware of the dynamic between an act and a state and use this distinction in the continued development of UD as interdisciplinary and inclusive processes.

Looking at the future for UD, we aim to further research and develop the knowledge regarding UD as a human rights concept included in the CRPD. In 1985, Mace expressed that “Universal design is ultimately about changing attitudes throughout society, emphasizing democracy, equity, and citizenship. Universal design denotes a process more than a definite result.” (cited in 36). The CRPD calls for a shift in attitude emphasing the human right aspect of UD alongside accessibility as a guiding principle of the convention.

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Better Late Than Never – Universal Design in Disability Policies

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Abstract. In Denmark, the local disability councils are encouraged to develop municipal disability policies in alignment with the Convention on the Rights of Persons with Disabilities. These councils are often involved in public building and infrastructure projects. Inspired by Carol Bacchi's strategy for policy analysis, 'What's the problem represented to be? this paper studies and compares municipal disability policies and Disabled People's Organisations Denmark (DPOD)'s first policy on Universal design (UD) and accessibility. The findings reveal that the municipal disability policies predominantly focus on accessibility, with only a few addressing UD. Among those that do, there are varying interpretations of UD, such as a concept for housing. In contrast, the policy of DPOD embraces UD more comprehensively. The problem represented - 'the environment is not accessible for everyone, and everyone cannot participate' - and the use of UD as the solution indicate a paradigm shift towards inclusivity, focusing on everyone rather than just people with physical disabilities. The paper suggests that UD, as presented in the DOPD policy can be seen as an approach to spatial justice for all. This approach appears essential for the disability movement, though it is though-provoking that is has taken so long to be adopted. Better late than never.

Keywords. Accessibility, Disability movement, Disability Policy, Universal Design, WPR approach

1. Introduction

Policy is an instrument for driving change towards a more inclusive built environment [1]. The concept of Universal Design (UD) was originally developed in an architectural context by Ron Mace [2]. Later, UD was introduced in the CRPD [3], which has been ratified by 191 countries [4]. By doing so, these countries have recognised and accepted the responsibility of integrating the CRPD into policies, plans, and programmes. The characterisation of UD within the CRPD may be perceived as primarily technical. However, Lid argues that UD is also a concept of human rights [5]. She emphasises that UD has the potential to revitalise the notion of social justice by adressing the tangible aspects of the fundamental right to coexist harmoniously with others. Furthermore, UD recognizes the crucial role of human-environment interaction in promoting social justice, both in political discourse and everyday interactions [5]. In the spatiality of life, relations of power are inscribed. Spatial justice refers to a fair distribution of, and access to, space [6]. In relation to UD, it is meaningful to discuss spatial justice. Lid understand it as 'the socio-materiality of the planned and built environment' [5, p. 18], while Rieger [7]

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suggests it as "a guiding approach to understanding how to design for inclusion and DfA" [7, pp.113].

In the Danish context, accessibility - but not UD - has been a theme in both national architectural policies and in a few of the municipal architectural policies [8]. However, accessibility has been black boxed in the building sector [9], and the uptake of UD has been slow [10]. In contrast, different understandings of UD exist among frontrunners who are interested in UD [11]. Recently, Disabled People's Organisations Denmark (DPOD) recommended that UD should be the foundation of a new national architectural policy [12]. Local disability councils in all Danish municipalities are encouraged to develop a municipal disability policy (MDP). The MDP is seen as an important tool for implementing the convention's requirements and creating the framework for binding and coordinated cooperation on disability-related developments within municipalities [13]. This structure of local disability councils, comprising an equal number of representatives from the city council or municipal officials, alongside members of the local DPOD branch, has created an opportunity for DPOD to work with disability policy on a decentralised level [14]. The local municipality councils, often involved in public building projects or urban design projects, tend to focus on accessibility and do not use the concept of UD. Moreover, they do not interpret the notion of user as encompassing'all of us', and they fail to recognise UD as a driving force in collaborative design processes [15]. Therefore, it is relevant to explore how local disability councils and DPOD have adopted UD in relation to the built environment. This paper studies how UD is presented and understood in MDPs that incorporate the concept, as well as and DPODs new policy on UD and accessibility.

2. Theoretical framing

An approach or a tool for analysing and scrutinising public policies is Bacchi's 'WPR' approach, which examines 'What's the problem represented to be?' The 'WPR' approach operates under the premise that what a policy proposes as a solution, or as relevant initiatives, reflects what the policy perceives as problematic and aims to change. This means that in every policy, a problem is represented. Bacchi emphasises the importance of examining and critically scrutinizing these representations, rather than the 'problems' [16]. It is important to note that the result of a 'WPR'- approach is not a discourse analysis but an analysis of discourses [17].

3. Method

Empirically, the paper is based on desk study of all Danish MDP and DPOD's new policy for UD and accessibility. Each of the 86 MDPs have been mapped and coded according to the year, title, references, structure, and themes. For example, several MDPs were structured around four to nine themes, with accessibility being one of them. Subsequently, the five MDPs that referenced UD were selected and coded in relation to goals and UD, focusing on initiatives aligned with those outlined in DPOD's policy. These initiatives are presented later in Table 1. These five MDPs can be seen as paradigmatic cases, because they establish a kind of model or "school" for the domain [18]. The DPOD policy has been analysed using the WPR approach, answering the following questions. "1. What's the 'problem' represented to be in a specific policy or policy proposal? 2.

What presuppositions or assumptions underpin this representation of the 'problem'? 3. How has this representation of the 'problem' come about? 4. What is left unproblematic in this problem representation? Where are the silences? Can the 'problem' be thought about differently? 5. What effects are produced by this representation of the 'problem'? 6. How/where has this representation of the 'problem' been produced, disseminated and defended? How has it been (or could it be) questioned, disrupted and replaced?" [19 p. 21]. In this approach, it has been crucial to relate the policy to the surrounding discourse to fully benefit from the analysis.

All quotes from policies are translated from Danish by the author.

4. Findings

The findings are organised into three parts: first, an introduction to the MDPs and the DPOD policy; next, a presentation of the policies´ initiatives in relation to UD; and finally, an analysis of the DPOD policy using the 'WPR' approach.

Eighty-six out of 98 municipalities had formulated an MPD. The oldest MDP dates to 2007, while the most recent is from 2024. Most municipalities have revised their MDP every fourth year. The CRPD was cited as a foundational basis in 67 of the MDPs. Sustainability was addressed in seven MDPs, referencing the SDG2030 and the 17 Sustainability Development Goals. Seventy-nine MPDs mentioned accessibility issues, with 62 of these containing a theme focused on accessibility in relation to the built environment and digitalisation. Additionally, five (5,8 % of the MDPs) included references to UD.

4.1. UD in the five MDPs

Different understandings of UD existed across these five MDPs.

Gentofte municipality (75.033 citizens) emerged as a pioneer, integrating UD into its MDP in 2013. Initially, UD was seen as an accessibility principle, but by the time of 2019 MDP, it was regarded as means to achieve the best possible physical accessibility for everyone in Gentofte. The MDP delegated responsibility to the Accessibility Forum to disseminate knowledge about accessibility, including the principles behind universal design.

The 2019 MDP of Frederiksberg municipality (103.696 citizens) stated that future planning should, as far as possible, be based on a mindset where solutions must be usable by all people without the need for adaptation or special design, adhering to the principles of UD. In the newest version, effective from 2023, UD was presented in a simplified manner: "The aim is that the city and its services are accessible to all, and that future planning is based on the principles of universal design.".

Under the headline: 'Aarhus – a good city for everybody', the MDP of Aarhus Municipality (367.633 citizens) was presented in 2019. The concept of UD was linked to the goal of creating an inclusive and accessible housing market. Consequently, new municipal buildings were to be inspired by the principles of UD. In a fact box, UD was framed as an argument for designing for a lifespan, explaining that the mindset of UD is based on the idea that no one can predict if they will become disabled during their lifetime. Therefore, housing should not only accessible but also usable for everybody, ensuring no one is excluded. Thus, the design of housing and facilities should be flexible, accommodating that people are different needs at different stages of their lives.

The MDP of Hillerød Municipality (54.159 citizens), structured around a 2019 policy and a 2023 strategy, emphasised the concept of UD in creating inclusive environments, aiming for solutions that cater to all citizens' needs. This would ensure that everyone feels welcome and can participate.

The MPD of Copenhagen (653.648 citizens), Denmark's capital, in its third version effective from 2023, integrated UD as part of one of its goals. Copenhagen Municipality aims to incorporate UD to make the city more accessible to a wider range of people. It was emphasised that this approach will minimise the need for special equipment for people with disabilities, or, at most, only minor adjustments would be necessary.

Except for the MDP of Aarhus (the second largest city in Denmark), the other MDPs are from municipalities in the capital area. These municipalities are all characterised by being among the top 20 in terms of average net capital: Gentofte is number one and Copenhagen is number 19 [20]. It could be interesting for a future paper to study correlations between disability policy and prosperity.

February 2024 DPOD launched their first policy on accessibility and UD: 'Together Toward an Accessible Future - The Disability Movement's Proposal for a Society with Equal Opportunities for All´. The policy emphasised that implementating UD principles is the way forward in creating an equitable society, regardless of physical, mental, cognitive, and sensory abilities. The strategy includes 33 initiatives aimed at ensuring equal possibilities for all, clustered into four themes 1) Solutions Across – from Websites to Public Space, 2) Digitalisation Without Obstacles, 3) Good and Safe Transport for Everyone, 4) Buildings and Nature Must be for Everyone. UD is involved in eight of these initiatives, which will be presented in Table 1.

4.2. Initiatives about UD in the policies

This part of the paper presents the different initiatives from the policies but structured in relation to the levels of macro, meso, and micro, as shown in table 1. In contrast to [21], meso represents the level of professional practice and not only projects and standards.

Table 1. The different initiatives of the MDPs and the policy of DPOD in relation to UD.

Level	MDPs	DPOD Policy
Macro; Related to the overall structural level		National strategy based on UD principles UD as basis for the national architectural policy UD into policies and building regulations UD into curriculum (architect, construction manager, and landscape architect)
Meso; Related to professional practice	Gentofte: Dissemination of UD Frederiksberg: UD in planning	UD research + dissemination (common knowledge center) Free guidance and advice on UD e.g. for clients UD dissemination to clients (municipal level)
Micro; Related to users meeting the space	Gentofte: Increasingly consider and include universal design and inclusive architecture in municipal building and construction projects. Aarhus: Housing inspired by UD Hillerød: Design of environments that consider the diversity of the population and their different needs Copenhagen: UD and accessibility in the designed solutions	New facilities in public transport must comply with principles and objectives of UD Building and construction in nature must be built according to UD

The future initiatives of the MDPs involving UD were characterised by addressing initiatives on the meso level and micro level, whereas the DPOD policy also addressed initiatives at the macro level.

4.3. What´s the problem represented to be?

1_The DPOD policy about UD and accessibility viewed UD as a means to create an equal society where everyone can participate. The 'problem' represented was that 'the environment is not accessible for everyone, and everyone cannot participate'. Because if the environment was already accessible for everyone, there would be no need to focus on UD. Similar 'problem' was represented in the MDPs of Gentofte, Frederiksberg, and Hillerød, which aimed to create accessibility for everyone. Consequently, the different initiatives within these policies focused on UD in future planning and building project. A subordinate 'problem' identified in the DPOD policy was that the building sector - particularly clients, as well as educational institutions and legislation - have not shown interest in or prioritised accessibility and UD. As a result, accessible solutions for people with disabilities were often considered as special solutions that were not integrated into the project from the start but were instead added in the final phase of construction.

2_This representation of the 'problem' was underpinned by certain assumptions or processes contributing to the understanding of this 'problem'. The emphasis on 'equal possibilities for everyone' and a life span perspective supported this representation. These elements could be seen as an attempt not to classify people with disabilities as a special category. Therefore, the policy used self-reported data from a survey indicating that one in four people aged 16-64 self-assessed as having a disability or a long-term health problem, highlighting the human diversity within the general population. The life span perspective reinforces the focus on 'everyone', suggesting that even if you do not currently require an accessible environment, you may need it later - for example, when using a pram or experiencing difficulties with navigation as you age, and your senses weaken. The conclusion that '*accessibility is necessary for some and good for all*' [12, page 4] was an assumption that contributed to this representation of the 'problem'.

3_This understanding of the problem may have emerged due to the CRPD and its definition of disability, encompassing four groups of impairment (physical, mental, intellectual, or sensory), and its incorporation of UD. However, this explanation is incomplete because the CRPD has been in place almost 20 years, and neither the Danish Disability Council [13] nor DPOD have made significant strides in disseminating UD to the local disability councils during this time. For example, DPOD themselves recommends three examples of MDPs for inspiration [22]: Silkeborg (year unknown), Esbjerg (2010) and Brøndby (2015) – the two last mentioned had been replaced by a new version twice. None of these MDP focused on UD. Nevertheless, the notion of invisible impairments has been emphasised by various actors, such as disability organisations like the Danish association of Youth with Disabilities (SUMH) and the ADHD organisation. Furthermore, this issue has gained more attention generally due to an increase in diagnosing children [23]. A research environment at Aalborg University was mentioned in the policy in relation to research in UD and dissemination of knowledge about UD. It is also important not to overlook the zeitgeist's focus on diversity and sustainability. The representation of the 'problem' did not stem from a single factor but rather from a network of activities and interest groups in the building sector. This network has contributed to a shift in focus from wheelchair users to the inclusion of people of all ages, abilities, genders, and ethnicities.

4_A notable silence or absence in the DPOD policy was the economic aspect of the representation of the 'problem'. The policy did not provide information about how much a society could save if the environment were accessible for everyone and all could participate. This is a complex theme requiring data [23]. Another gap was related to the initiative proposing UD as basis for the new national architectural policy. Specially, the policy did not address the qualities of UD in relation to creativity and aesthetics, which could have made UD more acceptable and desirable for the architects. This opportunity was missed, despite the vice-chair of the DOPD in 2021 having co-written a contribution to a debate highlighting that UD could reconcile the perceived contradiction between architectural expression and inclusive designing [25]. Obvious advantages were not used to substantiate the policy. Additionally, the policy did not address UD as a process [26]. Furthermore, the SDG 2030 Agenda and its pledge: "Leave No One Behind" were not mentioned, Even though DPOD was a knowledge partner at the 2023 World Congress of Architecture hosted in Copenhagen, which had the theme: "Sustainable Futures – Leave No One Behind".

5_The representation of the problem 'the environment is not accessible for everyone' produced several effects. It defines and restricts the relevance of discussion, influences individuals' self-perceptions, and materially impacts people's lives. Firstly, this representation led to a focus on ensuring that everyone can participate equally in society. It also contributed to an understanding that everyone can experience or acquire a disability, thereby framing people as only temporarily able-bodied and shaping their self-perception. In relation to the physical environment, this understanding was evident in the MDP from Hillerød, which emphasised that it was no longer just about ramps but also about creating an environment where people feel welcomed, thereby addressing other aspect of accessibility.

Despite several attempts, the DPOD policy never fully clarified UD. On one hand, the policy and some of the MDPs contributed to a kind of black boxing of UD by repeatedly mentioning UD principles without providing a clear definition. One the other hand, examples of UD primarily focused on classic accessibility solutions like ramp and lifts, suggesting that combining these elements equates to a UD solution. However, the policy did attempt to demonstrate that UD encompass more than just ramps, as seen in the initiative offering free guidance on UD which covered "… everything from Buildings Regulations to lighting, acoustics, visual and sensory impressions, wayfinding, quiet rooms and the possibility of retreat." [12 p. 32].

6_The final step in the WPR approach involves examining any conflict or controversy behind the representation, a concept Bacchi refers to as contestation. In 2023, the Danish Minister for Finance, at a press conference blamed the specialised social sector (which includes services for people with disabilities) for budget cuts in other municipalities areas. This statement led to significant opposition from people with disabilities under the hashtag #Undskyldvierher (#sorrywearehere). The minster later withdrew his statement [27]. A possible conflict or contestation around the way the 'problem' is represented was related to his statement and view on people with disabilities as a financial burden. As a result, the representation of the 'problem' produced and disseminated was a narrative about an accessible future being good for everyone and at the same time being necessary for some. By doing that, the DPOD policy both defended people with disabilities and advocated for universal design for everyone.

5. Discussion

To sum up, many disability policies have been written and updated since Denmark ratified the CRPD. It is thought-provoking that so few have included UD, given that most are about accessibility. Accessibility has evidently been an acknowledged concept possibly because it has been emphasised by the UN for many years [e.g., 27], even before the CRPD. It may take time to initiate a shift towards UD, perhaps the abstract nature of UD and its focus on everybody contributes to its slower uptake. Nonetheless, accessibility remains a concept that clearly addresses people with disabilities.

Even through the DPOD policy did not directly address spatial justice by mentioning the term, I will argue that the 'represented problem' and the proposed solution in the policy demonstrate a spatial justice focus. In this case, UD is a strategy for spatial justice and not the opposite, as suggested by Rieger [7]. Such a paradigm shift from accessibility to UD could mark a new departure for the disability movement. However, given that very few MPDs have embraced UD so far, it might become a challenge to enroll the local level into this this direction. For years, the local disability councils have been advocating for people with disabilities, and now the DOPD policy highlights a fight for human rights for everyone. DOPD introduces an entirely new direction. Perhaps it was worth the wait. However, it also embraces complexity in a time when the understanding of disability has evolved to include invisible disabilities, while the Danish society is under pressure, and people with disabilities are often regarded as a 'cost problem' [29]. Thus, it may be a strategic move that is inevitable. The future focus will be on implementation at the local level, a mission that will be relevant and interesting to study to understand the resistance within the disability movement.

6. Conclusion

The findings show that accessibility is the dominant concept in the 86 Danish MPPs with five of them adopting UD as a concept. Among these, there are varying interpretations of UD, ranging from a concept of housing to ensuring the best possible physical accessibility for everyone, and even to creating a welcoming environment for all. Additionally, the DPOD policy utilises UD to foster an inclusive environment for everyone regardless of abilities, age, gender, or ethnicity. The analysis problem represented in DPOD's policy on UD and accessibility reveals that the problem is that 'the environment is not accessible for everyone, and everyone cannot participate'. Thus, the paper suggests that this policy can been understood as a contribution to a paradigm shift by emphasing UD and thereby advocating for spatial justice for everyone. However, it can also be seen as an inevitable move to ensure that people with disabilities are not overlooked.

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The Problem with "Inclusion"? It Is Done to Someone by Someone

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Abstract. In this paper, we aim to contribute to an enhanced theoretical ground for Universal Design (UD) by examining the concept of "inclusion", presenting a conceptual critique of it based on our research on categorisation and UD, and proposing a way forward. This study is based on a comprehensive analysis of a range of photographs related to inclusion and exclusion collected during five recent research projects. We employ theories on categorisation and UD to inform our critique and discussion of inclusion. The findings show that inclusion 1) entails categorisational ambivalence, 2) upholds patterns of norm and deviation, and 3) results in power being redone, rather than undone. Consequently, inclusion becomes paradoxical, where efforts to promote equity and empowerment simultaneously become another reification of existing power structures and marginalisation. To address this issue, we propose moving beyond "inclusion" to "nonclusion" and the corresponding "nonclusive design" as a foundation for UD. This entails a shift in categorisation towards design that resists categorisations of bodies, persons, and roles. We argue that such a shift can usher in a new paradigm regarding how the path towards a society where everyone belongs can be conceptualised and realised.

Keywords. Universal Design, Norms, Inclusion, Nonclusion, Inclusive Design, Nonclusive Design, Categorisation, Disability, Accessibility

1. Introduction

While there are certainly many reasons to identify, acknowledge, and remedy exclusion, current ways of thinking and working based on norms and deviations seem to uphold the exclusionary patterns that they seek to dismantle. Universal Design (UD) has always had all people as the intended target group, but in practice, it is still largely understood to be about disabled people [1,2]. Almost 40 years have passed since Ronald Mace famously said, "Universal design is a concept whose time has arrived." [1,p.152]. The concept is more well-known today, but its development is still impeded by the same misconceptions that Mace pointed out. First and foremost, the understanding that UD is primarily intended for disabled people.

"Inclusion" is both an act and a state [4]. It is a global phenomenon that underpins both policy and research. In this study, we focus on the performative side of the term.

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According to Dunne, the growth of inclusion has largely occurred uncriticised. Social inclusion has become a self-evident, taken-for-granted good, and a 'truth' [5]. Spandler notes, "the notion of social inclusion is difficult to critique because, like other concepts in the Government's 'modernisation' agenda (such as 'choice', 'user involvement' and 'recovery'), it is presented as self-evidently desirable and unquestionable" [8,p.3].

Inclusion comes with inherent power structures and presumed norms [7], where someone defines what it means to be included and then adds a person or a group to "the included". The one including is positioned as a fully able, normal person, i.e. what Garland Thompson has helpfully defined as "the normate" [8]. The asymmetrical relation between "includer" and "included" creates and upholds what we will here call a normate logic, with the normate positioned at the centre and the deviant at a distance from that centre. This asymmetry has largely remained tacit and escaped critical scrutiny in extant UD literature. In the words of Wexler, "The term inclusion, with its multiple underlying ideologies and meanings, often obscures historical and problematic power relations" [9,p.41]. Simply put, it is not innocent "to include" someone. Thompson argues that "[s]imple inclusion offers minimal to none lasting social change or ideological equality" [10,p.1489]. Maybe it is time to ask if inclusion delivers on its promises of a society for all.

In this paper, we aim to contribute to an enhanced theoretical ground for UD [3,11] by examining the concept of "inclusion", presenting a conceptual critique of it based on our research on categorisation and UD, and proposing a way forward that does not rely on normate logic. The study is based on extensive analyses of a range of photographs related to inclusion and exclusion collected in five recent research projects. In the study, we focus on the photographic features of the material.

2. Theory

In our critique and discussion of inclusion, we draw on theories from Universal Design and Categorisation.

2.1. Universal Design

At the heart of the paper is UD, a concept with a rich history and prominent position in current conventions and policies around the globe. A great deal of hope is tied to UD as a silver bullet solution to solve exclusion. UD is still tightly connected to disability, despite its origins, which focus on creating a society for all. However, the concept also has untapped potential in terms of the kind of change it can bring about regarding how *human differences* are understood and dealt with in society [12].

Ron Mace introduced the concept of 'Universal Design' in a widely referenced issue of Designers West, an interior design publication [3]. Mace described UD as a design approach that aims to move away from specialised, costly, and unattractive solutions for limited groups, instead focusing on designing for 'everyone'. Mace viewed individuals with disabilities not as a distinct group requiring separate solutions, but as a valuable source of knowledge. He characterised UD as design that can be used by all people. By deliberately focusing on mainstream solutions, Mace envisioned UD as tacitly providing accessibility and blending seamlessly into its environment. However, this approach also created a tension between utilising knowledge gained from disability experience in design and marketing these products without mentioning disability at all [13].

UD is a guiding approach to design processes and societal development, based on a view central to the argument we develop in this study: that there is only one population – not a normal population and a deviating one [14]. The understanding of UD as primarily a process concern can be traced back to Mace and the mid-80s and has repeatedly been highlighted by Steinfeld et al. [11,15,16]. In 1985, Ron Mace stated this as follows:

> "Universal design is ultimately about changing attitudes throughout society, emphasizing democracy, equity, and citizenship. Universal design denotes a process more than a definite result." (Mace 1985, cited in [17]).

2.2. Categorisation

Inclusion presupposes an inside and a corresponding outside. This division is created and upheld by categorisations, giving advantages to some and disadvantages to others [18]. The connection between inclusion and categorisation is important to note. With Foucault, we view the categorisation of people as inherently linked to power dynamics [19]. Thus, categorisations are not simply neutral descriptors but mechanisms through which power is exercised, shaping technology, design, norms, and social order. Categorising someone is always a choice, and multiple categorisations are always possible, including no categorisation [2].

Categorisations can be quite sticky, and it is easy to get stuck in a category. As Ahmed puts it: "we can be constrained even by the categories we love" [12, p.4]. To emphasise the active processes that are involved when someone, for instance, decides to put a number of pictograms of persons in a row on a toilet door, we use the term 'categorisations' rather than 'categories' in our research [21]. Categorisations are often performed invisibly or in a tacit manner. However, they involve power structures, as they value certain perspectives and silence others, and are always done to someone and by someone[18,21].

3. Method

In our studies on categorisation and UD during the last five years [12,22], we gathered a range of photographs related to inclusion and exclusion. Participants submitted 92 photographs as part of citizen science studies [23] on inclusion and exclusion [21], and we took some images ourselves as part of observational studies, all in all, more than 300 photographs. The underlying analysis has had a hermeneutic [24] character and included both formal analysis sessions using NVivo and informal activities such as discussions of denotations, connotations and categorisations present in the photographs [25] at project meetings, seminars and presentations. This has continuously advanced our understanding of what the photographs express, and over time, allowed us to identify and mature in our interpretation of patterns in the material. The findings in this paper should be seen as a conceptual discussion, rather than a systematic empirical investigation, of what inclusion creates in relation to categorisation [18,21] and power structures [7,20], based on selected photographs.

4. Findings

The findings comprise three sections showing how inclusion entails categorisational ambivalence, upholds patterns of norm and deviation, and leads to power being redone rather than undone.

4.1. Inclusion entails ambivalence – what, when and how to categorise

Inclusion involves choice. Multiple categorisations are always possible [18] and this appears in the photographic material as a number of ambivalences regarding 1) what and when to categorise and how to categorise 2) gender and 3) dis/ability.

Below are three photographs of toilet doors (Figure 1). To the left is a door with a large wheelchair pictogram where someone has put an all-gender sign on top of it, this way changing its categorisation. In the middle, is a door where someone has chosen to display an astronaut in a wheelchair instead of the traditional RI sign with a person in a wheelchair. To the right, is a door with a pictogram of a water closet with handrails, categorising and highlighting the functionality of the room instead of whom it is intended for.



Figure 1. Three photos in a row, displaying categorisational ambivalence.

The first ambivalence concerns what and when to categorise. A traditional method is to categorise bodies, people, and roles. While this is a prominent categorisation pattern in the material, there are also other ways to categorise that refrain from categorising bodies, people, and roles. One such example is categorising a function instead of a person (see our discussion regarding "nonclusion" later in this paper).

Second, the material exhibits ambivalence regarding traditional ways to categorise and new emergent ways to categorise gender. One example is the categorisation of gender on toilet door signs. Genders are sometimes kept separate (e.g., 'man, woman', 'man, woman, third gender'), sometimes combined (e.g. all-gender signs), and sometimes not categorised at all. These varying categorisations can be interpreted as ongoing hegemonic negotiations regarding how to understand gender [22], or, in other words, as ambivalence regarding how to display categories.

The third ambivalence involves how to categorise dis/ability. In the material, there are several examples of signs that do not use an RI sign with a person in a wheelchair, such as the photograph in the middle in Figure 1. In line with Williamson [13], we

interpret the many alternative pictograms to the RI symbol as an ambivalence related to stigma, leading to people trying to come up with less stigmatising pictograms. Sometimes these solutions are less successful, as can be seen in the middle photo, where the shift in signage, while presumably well-intended, does not change the stigma connected to dis/ability.

4.2. Inclusion upholds patterns of norm and deviation

Inclusion means that someone is positioned as the one to determine who is part of the norm and already included and who is to be included. An example is when people add long rows of pictograms to achieve inclusive signage. This strategy has the drawback of making assumptions about people. Additionally, no matter how many pictograms one puts in a row, for example, on a toilet door, there will still be some people who are outside or who do not identify with any pictogram.

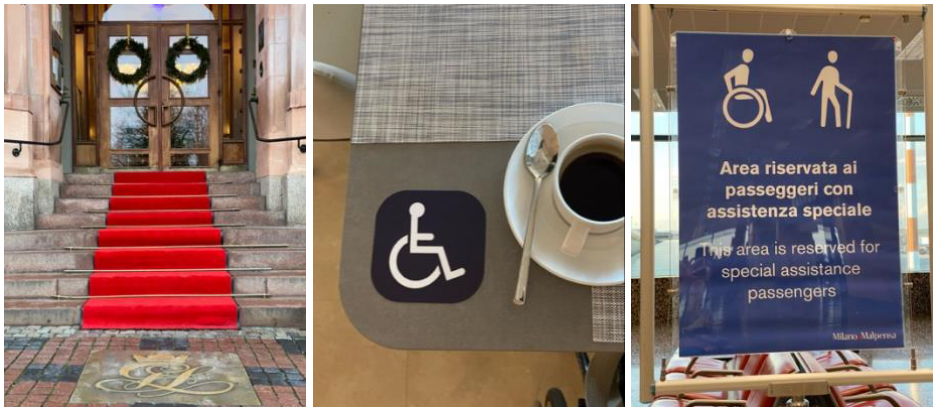


Figure 2. Three photos in a row show division in norms and deviations.

Above are three photographs (Figure 2): To the left, an entrance with a red carpet leading up eight steps into a hotel with a separate entrance for guests who do not use stairs (the latter is not shown in the photograph). In the middle, there is a table at a restaurant with a large wheelchair sign and other tables without this sign. To the right, a separate row of seats at an airport and a sign saying these are for "special assistance passengers".

The photographs show an environment, a product, and a sign, all relying on and exhibiting the distinction between norm and deviation. The leftmost photograph illustrates how the assumed norm is unmarked, whereas the other two photographs show how deviations are marked. Taken together, these photographs illustrate how inclusion is built on a normate logic whereby the norm is positioned as already included, and the deviation is positioned as what is to be included.

4.3. Inclusion leads to power being redone rather than undone

While often well-intended, strategies and practices based on inclusion always carry delimitations and demarcations, and thus, are always exclusive. In this way, inclusion leads to power being redone, rather than undone [20].

Importantly, the division into norm and deviation is not only visible in older constructions but also in new buildings and environments in the material. Below are two

photographs of newly built constructions (Figure 3). To the left is a recently finished university building, constructed around a "social staircase", which dominates the space. Students and teachers who do not use the stairs are left to use the elevators, which are tucked away in a darker area to the left of the staircase. The right image shows a photograph from the entrance to a new office block. When entering the building, there is a revolving door to the right and an ordinary door to the left. The space is categorised with a sign on the ordinary door saying "Only entrance for" and then a pictogram of a person in a wheelchair and a baby.

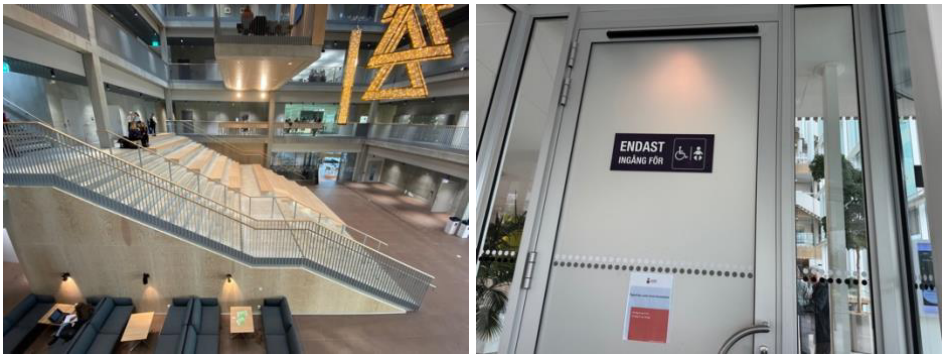


Figure 3. Two photographs showing how power structures are reified in new constructions.

These two environments are intended to be used by all people. However, the patterns of norm and deviation the environments exhibit are manifestations of the prevailing normate reasoning. Despite being finished just a year or two ago, they showcase yet another reification of the currently dominating power structures, in which some people are tacitly included as part of the norm and others are supposed to be included.

5. Concluding Discussion

We doubt that inclusion holds the key to creating the lasting social change that Thompson [10] asks for. Based on our findings, we argue that inclusion is something of a paradox, where genuine efforts to promote social equity and empowerment simultaneously become yet another reification of power structures and marginalisation. The main problem with inclusion is that it is done to someone by someone (Figure 4). All these long lines of debated icons depicting people, bodies, and roles, and all efforts to come up with less stigmatising ways to categorise, seem to obscure a vicious circle of includer and included going on.

Moving forward, understanding diversity will be just as important as ever before, demanding continued studies and use of lived experience, anthropometry, and other ways to identify and acknowledge human difference. There is a rich body of knowledge connected to accessibility and usability, which will play a crucial role in the future as well. However, understanding and acknowledging diversity does not necessitate putting categories of bodies, persons or roles on display or dividing visitors of environments and websites into separate groups.

It should be noted that categorising is human and that categories are essential cognitive features. When a child grows up, it learns what counts as "a lamp", "a dog", etc, and what does not. Here, it is important to note that we do not argue for avoiding

categorisation. This would not be possible. However, we *do* argue that the habits and practices resting on categorisation of bodies, people, and roles that have been established over the decades need to be challenged, and that purposeful use of categorisation can help change oppressive power structures.

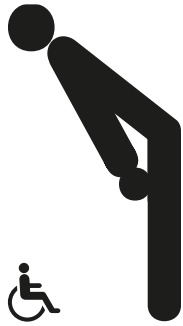


Figure 4. It is not innocent "to include" someone.

UD has a long history, but it seems to be stuck in old ways of thinking based on normate logic. In real life, these divisions into norms and deviations become narratives and choreographies, dictating who can go where, enjoy what, and contribute to what. The markers of not fully belonging are hidden in current terminology and practices. This creates what we might call a "band-aid diversity", where each act of inclusion becomes a new band-aid on the symptoms of a divided society but without changing it at its core. Thus, inclusion-based UD is an incomplete goal that cannot and will not act as a bridge to "a society where human difference would be *missed* if it were not present" [10,p.1491].

We propose the following: move beyond "inclusion" to "nonclusion" and the corresponding "nonclusive design" as a foundation for UD [26]. This entails a shift in categorisation: "Nonclusive design means design that resists categorisations of bodies/roles and that does not come with predefined or presupposed limits in terms of whom it is meant for" [12,p.85]. One concrete example of nonclusion can be seen in the rightmost photo of a toilet door in Figure 1, where the people and families that are often found on toilet doors are replaced with a water closet with handrails. By refraining from categorising "who" and instead describing the nature of the room and its features, one can establish a shift in narrative wherein the focus is redirected away from the individual towards the environment. This shift in categorisation "from person to function" represents one of the patterns identified as part of "Nonclusive Design" in [12] and further elaborated upon in [2,22,26,27].

We argue that such a shift in categorisation on a larger scale can usher in a new paradigm regarding how the path towards a society where everyone belongs can be conceptualised and realised. It is time to revisit the roots of UD, aiming for citizenship, democracy, and changes in attitudes in society. UD has always been nonclusive.

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Which Diversity? Expanding the Gap Model of Disability for Digital Information Systems

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Abstract. In this paper, we extend the gap model of disability that supports digital equipment and cyber-physical situational variations. We explore an alternative approach to visualizing and understanding disability that takes into account the diversity of personal abilities, the diversity of digital equipment and equally important, the situation (environmental, psychological, and digital) in which the information system is used. The most important implications of this work are twofold. First, this work will contribute to the need for Universal Design to take into account not only the diversity of abilities and impairments of the users that are tangible and recognizable in the physical environment, but also the diversity of digital equipment and usage situations. Second, as part of the systems development cycle, in user testing of digital services, this work highlights the essential need to not only involve a diverse set of users, but also to conduct testing in diverse digital environments (smartphones, tablets, laptops and desktop PCs), and in diverse realistic usage scenarios, including strong sunlight or low light situation, as well as tired, alert, stressed or distracted, and slow network. The proposed model attempts to give a more holistic view and promote a more comprehensive understanding of the disabilities that can occur during use of digital services or mediated communication in daily life.

Keywords. Gap Model, Models of Disability, Cyber-Physical Gap Model

1. Introduction

The Gap model [1-4] of disability [5], also sometimes referred to as the Nordic Gap model, has been used to visualize and place disability in everyday situations. This model highlights the fact that it is not only the abilities or impairments of the person, but the gap between the person's abilities and the affordances of the physical *environment* or a *system*, that creates the disability.

The environment or system in the Gap model is based on physicality or tangible elements such as a physical staircase or a parking automat. The common visualization of The Gap model shows the level of functioning in a situation, and the space or gap between individual abilities that need to be strengthened to meet the requirements from the environment, that in turn need to be reduced. The Gap model is appropriate when the

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environment as mostly static, However, it does not account for environmental variation over time, much like weather system patters such as the transition between sunshine and snow, the user's variation of attention between digital and physical environment. In addition, the Gap model was developed before the prevalence of mobile computing, internet of things and digital services. These digital environments add layers of complexity to common usage situations, thus, exposing some limitations to address digital accessibility.

Digital services, understood as fulfilling needs through digital processes, are increasingly important in our daily lives, as our lives have become intrinsically integrated and influenced by technology. Gone are the days were digital interactions meant only staying in front of the computer on our desk. Now digital services not only need to reach us, but also need to be reached by us, "in action", as an extension of us and our activities, as we go through all kinds of situations using smart phones, smart watches and tablets. A digital service, is used in relation to the environmental, organizational and situational conditions [6]. For example, when digital services can work perfectly fine on a big screen with adequate lighting in calm working conditions. However, they may be totally unusable in a more complex outdoors scenario, thus prompting so-called *situational disabilities* (see Section 2.2).

In the current *cyber-physical* situation where the digital and physical world interact in complex and dynamic ways, the Gap model may be too simplistic, thus calling for a more comprehensive understanding of disabilities to be able to continue designing barrier-free systems. One app or web page may offer completely different user experiences and experienced barriers depending on the equipment in use and the situation in which it is used.

Through extensive research on Universal Design and situational disabilities that may in particular occur during use of information systems in disaster situations [7-11], it is becoming more and more clear that the traditional Gap model has failed to withstand the test of time and fall short of adequately adapt to digital and cyber-physical environments of today. An extended cyber-physical Gap model that can explicitly demonstrate the above-mentioned factors and aspects of disability is therefore needed, and the development of such model is the primary goal of this study, that attempts to answer the following research question:

How can the Gap model of disability be adapted to meet the environmental demands of using digital services in ever evolving cyber-physical environments and thus contribute to reduce situational disabilities and other Universal Design challenges?

To achieve this, we first look into relevant theoretical concepts in Section 2, then we present and analyze a realistic scenario involving digital services, a dynamic environment and situational disabilities in Section 3, and develop an extended Gap model in Section 5. Finally in Section 6, we conclude and point out directions for future work.

2. Theoretical Concepts

In this section, relevant concepts from the literature on disability and related phenomena are introduced. We first conceptualize the meaning of disabilities, followed by situational disabilities.

2.1. Persons With Disabilities

Traditionally, following the Convention on the Rights of Persons with Disabilities, persons with disabilities refer to "… *those who have long-term physical, mental, intellectual or sensory impairments which in interaction with various barriers may hinder their full and effective participation in society on an equal basis with others*" [12]. The World Health Organization (WHO) has a broader scope and mentions that almost everyone will temporarily or permanently experience disability at some point of life. WHO's International Classification of Functioning, Disability and Health (ICF) framework classify disabilities as body and health functions, activities, and participation, that includes environmental factors and body structure [5]. *The body functions* encompass among other thing mental functions, sensory functions, voice, and speech functions. *Activities and participation* include, among other things, learning and applying knowledge, communication, and mobility. *Environmental factors* contain different technologies that support persons with disabilities, including technology for communication. *Body structures* incorporates structures of nervous system, eye-ears related structures, structures involved in voice and speech, structures related to movement and so on [13].

While the medical model of disability sees disability as abnormal bodily functions, the social model of disability recognizes disability as contextual, arising from the interaction between a person and their environment. The social model was promoted by disability movements as a response to the medical model, highlighting that a change in the environment or an improved design of a system removes the barrier, thereby empowering the individual [1]. This implies that society has the responsibility to remove barriers, rather than forcing the individuals to find ways to overcome their disabilities.

2.2. Situational Disabilities

Situational Disabilities can occur to people who are not usually considered to be in the category of "person with disabilities". Situational Disabilities are momentaneous impairments or disabilities experienced by a person in a given situation. A common situational disability can be illustrated when a tourist without knowledge of the local language in a foreign country can't find a way to read or interpret the signs in the road. This article is especially interested in situational disabilities occurring when using information systems and information and communication technology, environmental (physical, mental, and/or digital) factors disturb the interaction between the user and a digital service. The concept of Situational Disabilities has its roots in Situationally Induced Impairments and Disabilities (SIID) [14, 15], first introduced in 2003 by Sears, Jacko and Xiao [16], regarding issues occurring related to pervasive computing, where they suggest a model consisting of the human, the environment, and the application to understand and evaluate the effects of SIID. SIID are often referred to simply as situational impairments or Situational Disabilities [17-19], but Wobbrock points out that they are actually different, with impairments being features of the body itself, while disabilities are difficulties in performing a certain task [14]. For example, in a situation with cold weather, a Situational Impairment could be the inability to move fingers in an agile manner because of the cold weather, while the corresponding Situational Disability would relate the stiff fingers with the inability to use a smart phone app that requires agile finger movements, for example typing on a virtual keyboard.

We note that W3C recommends not using terms related to disability or impairment for these concepts, but instead using the term situational limitations[2] to distance the concept from disabilities and impairments that concern people's functional limitations. While this may seem reasonable from the perspective of the medical model of disability, the social model of disability highlights that disability occur in the gap between the person's abilities and the environment's requirements [20], and from this perspective, it makes sense to see SIID as legitimate types of disabilities.

Gjøsæter et al., [7, 11] discuss the differences between permanent, temporary and situational disabilities, and link these understanding in the emergency situations. "Disabilities" is taken as something that may occur to everyone who is unnecessarily a part of the vulnerable groups due to specific, situational, or temporary conditions. Moreover, the authors argue that effects of the situational disabilities may result in the same effects as those who have "traditional" disabilities. In the following, we will apply this understanding of disabilities.

2.3. The Gap Model of Disability

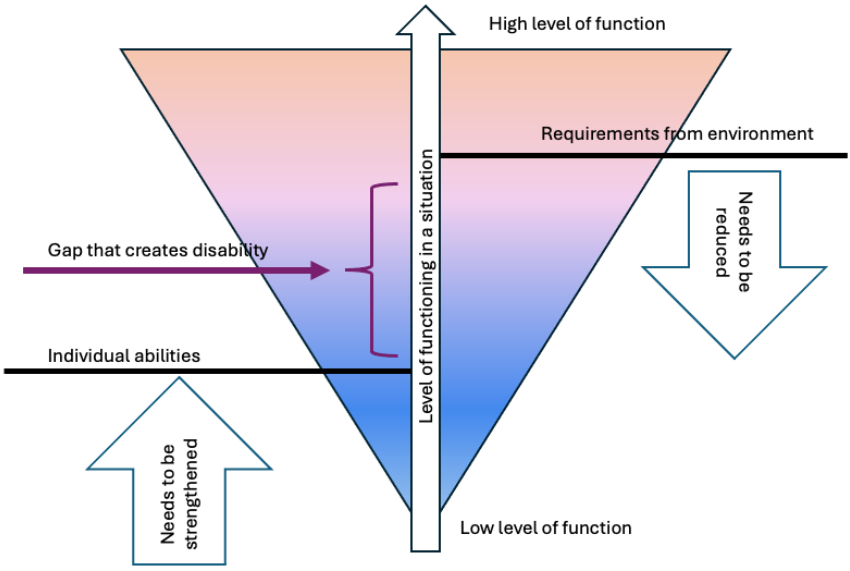


Figure 1. A common Gap model visualization inspired by visualizations in [2] and [21].

The Gap model of disability, sometimes referred to the Nordic gap or the relational model, is often visualized as shown in Figure 1, based on the visualizations in [2] and [21].The model builds on the social model of disability and presents disability as the gap between the individual abilities that needs to be strengthened, and the requirements from the environment or society, that needs to be reduced to close the gap and remove the disability. The model has been used in teaching for more than 40 years, and while the original publication is difficult to pinpoint, the gap model is frequently referred to later in Nordic scientific work on disability and Universal Design [1-4]. The gap model is also

[2] https://www.w3.org/WAI/EO/wiki/Situational_terminology

used in the definition of disability in the Norwegian Government White Paper nr. 40 on Dismantling of Disabling Barriers 2002-2003 [21].

We contrasted the literature on situational disabilities with the Gap model and a real-life scenario to formulate an extension of the Gap Model that could visually address the gaps emergent through the increasing use and dependence of digital services and cyber-physical environments.

3. Scenario Analysis

This section presents a scenario that highlights the limitations of the gap model in visualizing complex dynamic cyber-physical situations. The following scenario has been developed, discussed, elaborated and refined with university students in a bachelor level course on universal design of information systems, during special thematic discussions on situational disabilities and the presentation of the Gap Model.

Consider yourself in the scenario of needing to buy a bus ticket using a mobile app. You are in general able-bodied, but you overslept a bit and didn't have time for your morning coffee. And in addition, it is late autumn, so it is raining and there is a cold wind blowing. You are also late for the bus but hope to still catch it. Your fingers are wet, so the fingerprint reader of the phone fails to log you in to the app, and cold shaking fingers miss the buttons for the pin code three times. You are presented with a captcha, so need to select which ones of nine tiny pictures contain a traffic light. Your glasses are foggy, and you are now very stressed. You miss the bus, and you find yourself now clearly situationally disabled. Neither your abilities, the usually adequate mobile phone, nor the situation itself should be a problem, but the environment and surrounding factors combine to render you situationally disabled.

Analyzing this scenario from the perspective of the traditional gap model visualization, we find that the environment, and in the particular the weather has a strong impact on the ability to use the ticket ordering system. The combination of the too small pictures, shown on a small screen, the foggy glasses, and the stress, are however not easy to pinpoint exactly in the gap model. Is the smartphone part of the user or part of the system being interacted with? It can be argued that it is either or even totally distinct from both. While the smartphone clearly can enhance the abilities of the user, it can also introduce barriers, for instance by a lack of Universal Design of the app in use (too small pictures, maybe without descriptions), or through the impact of the environment and weather. Using the traditional gap model to analyze the scenario, factors affecting the user are displayed on the left side, while it is not clear if the inclement weather should be on the right side increasing the requirements from the system, or on the left side, reducing the abilities of the user, or perhaps both? It makes sense to consider environmental conditions in both places, since it makes the system harder to use but also reduces the capabilities of the user.

4. Towards a Cyber-Physical Gap Model

In this section, we take the previously described scenario as a starting point for developing an extended gap model visualization that better supports digital services and cyber-physical situations. First, we look at the requirements, then we propose a model and discuss its applicability to the scenarios.

4.1. Requirements for a Cyber-Physical Disability Gap Model Visualization

Based on the previous discussion as well as the theoretical background, we suggest that that the following aspects, that has a potential impact on the person's ability to achieve their purpose, should be included.

1. Diversity of user abilities and skills
2. Psychological status
3. Diversity of hardware and software affordances and limitations
4. Degree of control over different parts of the system
5. Dynamic and static elements of the environment
6. Time of day, time available to complete a task.

The Gap Model is a "gold standard" to interpret disabilities and possibilities to reduce gaps. Therefore, to avoid unnecessary competition and increase understandability we build on the existing model, and while this may lead to some compromises in expressiveness, we propose an intuitively understandable incrementally improved gap model that could potentially be a great benefit to the Universal Design community.

4.2. The Proposed Cyber-Physical Gap Model

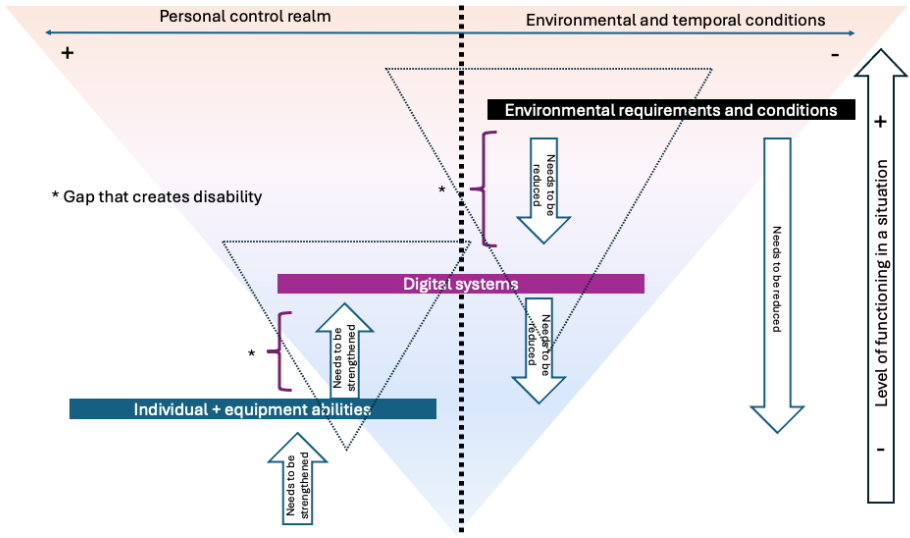


Figure 2. Proposed Cyber-Physical Gap Model. * denotes gap.

Figure 2 shows the proposed Cyber-Physical Gap model that introduces the Digital Systems as a third element sitting in between the individual realm, together with supporting equipment, (left side) and environmental and temporal conditions (right side). This extended model visually distinguishes the degree an element or issue is under (left side) or outside (right side) the control of the person or user of the system. The proposed model also maintains the areas that could need to strengthen abilities and reduce environmental requirements and conditions that can be addressed in a cascading manner. By highlighting the potential for multiple gap areas, these become possibilities for staggered interventions to address the gaps.

As shown in Figure 3, the user has control over their assistive devices (e.g. glasses), the configuration of user settings of their digital equipment (e.g. such as font size or

zoom), as well as protective gear against the environment (e.g. umbrella). However, on the middle can be perceived the limited control over the digital services (e.g. app) and the environment (e.g. inclement weather). The environmental conditions affect both the digital systems and the personal abilities of the user, who can meet them with digital and physical countermeasures, such as high contrast mode and easy captcha verification.

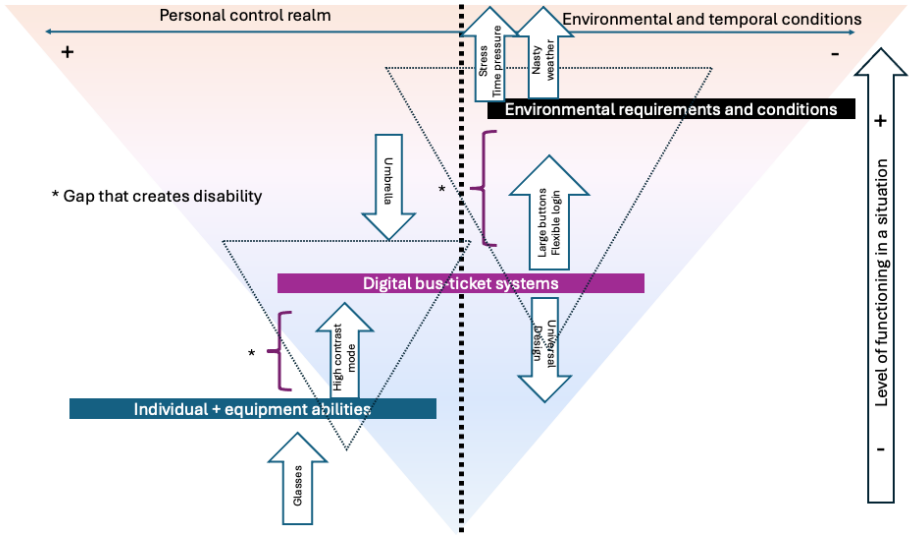


Figure 3. The bus ticket scenario visualization based on the proposed cyber-physical model.

5. Conclusions and Future Work

This study has examined the Gap Model and its applicability for Cyber-Physical situations, with a particular focus on complex situational disabilities. We find the current model to be inadequate to address the increasing digitalization of services and the subsequent disabilities and propose an extended version that explicitly distinguishes between physical and digital environmental factors, through a cascading approach for addressing disability gaps. The proposed model supports a thorough examination of digital as well as physical diversity of situations, which could support Universal Design of digital services and mediated communication platforms to be used in daily life by diverse users under diverse conditions as illustrated by the inclement weather scenario.

Future work includes a thorough examination of the proposed model with diverse users, UD-experts and -designers for validation and further evolution and elaboration, and in particular to examine and discuss more thoroughly situational disabilities potentially occurring while using digital services (for example for situational awareness or mediated communication) in crisis situations. A zoomed-in view of the cyber-physical gap model that shows individual cyber-physical equipment-enhanced abilities in detail as a stack (or rather a tree) of digital and physical (assistive) equipment use/affordances, as well as the situation broken up into cyber-physical requirements, and known as well as unknown environmental/situational conditions, is also in the works.

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Widening the Circle: Is There an Eighth Principle for Universal Design?

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Abstract. The advantage of Universal Design (UD) over mere barrier-free design is that it can benefit everyone, regardless of age or ability. The imperative to include design for personal safety even outranks accessibility as a design precept. Evolved almost four decades ago, Ron Mace's Seven Principles did not anticipate advanced standards of safety in today's world. Whilst Principle Five - *'Tolerance for Error',* states that *'the design minimizes hazards and the adverse consequences of accidental or unintended actions'*, this notion of 'error' implies that it is the user who is at fault, rather than the provider. This may lead to inhibition and fear, hampering one's lifestyle in a multitude of ways. Fear of falling, inhibition of being unable to find a public toilet, forgetting a password or simply being made to feel old and incapable can all have an adverse effect. A cross-disciplinary group of experts undertook a number of studies on design for age-friendly cities in Ireland, through empirical research, experiential exercises and dissemination into third-level design education. Studies on design and facilities that lead to an individual's lack of confidence are discussed, including a research programme undertaken for the National Disability Authority on the Universal Design of Fall Detection Technologies. The paper proposes that an additional Principle: "Reduction of Fear" should be a basic design parameter in all aspects of the built environment as well as IT and services. By broadening its scope and joining forces with health and safety issues, UD becomes more inclusive, desirable to client bodies and attractive to everyone. The paper identifies areas where improvement in design is urgently required, suggesting the breadth of benefits accruing from more inclusive design, particularly in reducing fear through safer home zone environments.

Keywords. UD Principles, Safety, Ageing

Introduction

In the time since Ron Mace forged the influential Principles of Universal Design (UD) [1] things have moved on significantly. The increase in global ageing underscores the importance of built environments that are designed to meet the needs of older people: accessibility, comfort, security and, most importantly, the safety of the individual. The 2015 "Shaping Ageing Cities" [2] emphasizes aspects of safety and security in optimizing living standards for the elderly. Health and safety standards, once seen only as necessary in the public realm, are now demanded in the home zone, especially for

vulnerable sectors of the population. Whilst ageing is not a disability in itself, some diminishing of physical and mental faculties will occur; added together these may significantly reduce a person's abilities overall, increasing over time. Although not limited to ageing, awareness of potential risks and hazards about the environments that one uses can cause anxiety or fear, affecting attitudes on living and engaging socially.

A better understanding of the nature and causes of such fears will inform design towards reducing aspects of anxiety and inhibition that limit independence and quality of life in diverse ways. A research programme undertaken for the National Disability Authority on Universal Design of fall detection technologies [3] set out to i) assess the impact of falls, both on people at risk of falling, their families and carers and the need for Fall Detection Technologies, ii) to investigate the design state of fall detection solutions and services through a UD lens and iii) to understand how this technology can support lifetime community initiatives. Further unpublished aspects of this research include results of interviews with various stakeholder groups regarding the causes, consequences and impact of falling on those at risk and their carers. Salient aspects of the built environment that present threats have been identified through this work and from multi-disciplinary research and observation. Through an understanding of a person's lifestyle, appropriate UD measures can significantly reduce barriers, both mental and physical. Design professions must inculcate awareness-raising in current practice and in education, in order to reduce fear for everyone. This paper proposes the need for an Eighth UD Principle, the Reduction of Causes of Fear and Inhibition.

1. Widening the Circle of Universal Design

While the necessity to improve the built environment through the application of UD principles is clear, it is important that this not just limited to providing access for people with disability, but that it also encompasses the widest range of ages and abilities As ageing populations increase the need for optimally designed built environment is imperative. While it is important to demonstrate the advantages of safety through inclusive design, it is also necessary to point out the high cost, both monetary and social, of not doing the right thing, at the right time. Encouraging greater attention to designing for safety into the UD remit will widen the circle of beneficiaries, with consequential reduction in fear, in all sectors of the population. The greater number of people who are seen to benefit from UD, the stronger the argument for its continuing promotion and the more value it will gain worldwide.

Accessibility and safety are not always synonymous. Whilst one of the most valuable outcomes of UD is that of providing accessibility, in practice the need for safety may override this. Principle 5 of the Seven UD Principles states "*The design minimizes hazards and the adverse consequences of accidental or unintended actions."* advising to *"arrange elements to minimize hazards and errors" and "provide fail safe features. Discourage unconscious action in tasks that require vigilance."* [1]. The notion of 'error' suggests that the fault lies with the user, rather than laying the real responsibility on the provider. Is it an 'error' for an individual to have chosen a route without handrails on a slippery ramp? Although Principle 3 advises *"provide warnings of hazards and errors",*

if we see a sign saying "*Mind Your Step"* where a change of floor level presents a hazard, we could justifiably respond: *"No; it's YOUR step - YOU are responsible for our safety - it should not be there at all".*

Universal Design seeks to include the widest spectrum of users, not just people with a disability or the ageing population. If we acknowledge that fear and anxiety can result from poor design, negatively impacting an individual's life choices, the challenge is how to design to reduce these fears, improving the quality of life for an individual of any age or ability. Experienced designers can identify elements in the built environment that exhibit poor design or have occurred by default, through ignorance or false economy. One hidden quality of UD is that where good design has been seamlessly integrated into the environment it is, to an untrained eye, not easily recognizable. Only a designer's informed eye is able to perceive the inclusive qualities, bearing out an old proverb that *"the good shoes are the ones you don't know you are wearing".* Achieving this level of expertise requires awareness through experiential exercises, directed observation and dissemination into professional education curricula.

An example of such awareness might be in the design of a balustrade One with bars arranged vertically would be seen by an experienced eye to be eminently safer than one with horizontal bars, even though both may comply with building codes. To a small child, horizontal bars afford an exciting climbing opportunity, which a parent may recognize with dread. Thus an element intended to prevent falling may be a deathtrap if designed without an appreciation of the perception of all users.

Older people may be the main beneficiaries of safer design, for various reasons. Ageing brings body changes and increasing limitations in different aspects of a person's ability. Though conditions such as Irritable Bowel Syndrome (IBS), incontinence or a sprained joint may not define a person as having a disability it may significantly reduce their ability to live as they did before. Decline in cognitive, physical, motor and sensory systems are also part of the ageing process [4]. Adaption to these changes may be a challenge, depending on how rapidly they occur [5]. Increased vulnerability through decreased vision, slower reaction times, lack of balance or reduction in limb sensation, all may increase the risk of falling.

A person's awareness of their vulnerability may increase to the extent that they may become inhibited about leaving the safety of their home or partaking in activities which they feel may endanger them, possibly as a result of a previous fall. Conversely, there will be independently-minded individuals who continue to go about their lives as they did when they were younger, unaware of the risks that changes to the body may present. Fear is a natural and necessary reaction to emotional, cognitive or physical threat, real or perceived. Such reaction may produce fear avoidance behaviors. Although not the only area, the most researched factor is the fear of falling, described as a negative experience, directly linked to perceived or real fall consequences, such as physical injury, loss of autonomy, fear of dependence or of humiliation, significantly impacting a person's physical, emotional and mental state.

The generation of fear may be due to the inability to cope with a physical, social or emotional challenge, particularly compounded by the environment's ability to conceal a

threat. Lesser inhibiting factors may range from a person with a weak bladder being unable to find toilet facilities, to a fear of being unable to read instructions on an ATM screen and losing one's credit card. Such fears stem from a perception that one's physical, mental or emotional abilities may be inadequate to manage these challenges, whether real or imagined. Additionally, fear of real danger, less definable fears, lack of security, loss of dignity or being aware of increasing personal limitations, being forgetful or appearing senile 'being a burden' to others, can inhibit someone from leading a full and active life.

Falls are common in adults aged 50 years and over. According to The Irish Longitudinal Study on Ageing (TILDA), 1 in 4 older people reported a recent fall, with 1 in 5 experiencing recurring falls. The rate of reported recurrent falls was highest in women aged 75 years and older [6]. During the study on the Universal Design of fall detection technologies [3], semi-structured interviews were carried out with 82 people from 4 different category groups (people at risk of falling, informal carers, formal carers and healthcare professionals). The analysis of data resulted in some interesting findings on the causes and consequences of falls, not previously published. Participants reported many factors that lead to a fall within and outside the home. Often the cause is influenced by health issues impacting on a person's life. These include vision, balance, frailty, weakness, low blood pressure and cognitive issues. Many participants highlighted the home environment as harboring diverse causes of falls, such as loose furnishings, rugs, cables or inadequate lighting. Daily activities such as dressing, using the bathroom, stairs and mobility aids, gardening and even domestic pets, are risk factors. The community environment, such as the condition of sidewalks, negotiating ramps and curbs or travelling on public transport were also noted as fall hazards.

Participants reported physical effects as a result of falls, such as direct bodily harm, cuts and bruises, broken limbs and more serious injuries requiring hospitalization, with long-term physical effects and an increased risk of further illness. The immediate consequence for many participants after falling was a change to their activities of daily living and general lifestyle. This may also impact the daily life of carers, particularly for informal carers, who must fit the care of a relative or friend around their career or other responsibilities. The emotional effect on both people at risk, their family and carers is evident, due largely to the perceived risks of falling in both the home and community environment.

According to a TILDA study 43% of those who report a fall report that they were afraid of falling. Such fears are also common even in those with no history of falls, with 29% of this group reported fear of falling [7]. However, the recent study on fall detection technologies [3] indicates that this fear may be even higher. Previously unpublished analysis of the interviews with 28 older people at risk of falling and 24 informal carers of those at risk indicated very high levels of fear. More than 4 in 5 people at risk reported this fear. One older person explained, *"We are all more aware of falling as we get older,"* with another mentioning that "*I'm very nervous of falling in the shower"*. Falls also impact on a person's ability to continue living at home. One participant who cares for her mother, reported: "*She's very nervous about falling again. She is afraid she will end up in a nursing home, if her family can't look after her anymore"*. Some participants felt their family member did not express their fears of falling to them. One informal carer explained about her elderly father, *"He is more afraid when he's alone… he could be*

worried but wouldn't tell you". Such fears also impact on those who care for people who have fallen or are at risk of falling, with 3 in 4 of informal carers interviewed having this concern. One participant described her worries about her parents *"I worry about both my parents falling again, especially as I don't live close to them."* Some carers worry more than the person at risk. One participant said when describing how he felt about his mother *"I was more worried about her falling than she was herself".*

Fear of falling can significantly impact how people live, leading to activity restriction, where people may isolate themselves. One participant described his fear of falling in bad weather: "*During the recent bad weather, I didn't move out of the house for three days, as I was afraid of falling".* Older people with fear of falling walk more slowly, cautiously and take shorter steps to increase stability. However such changes in how a person walks may be associated with an increased risk of falling [8]. Research demonstrates both the gait pattern and visual scanning patterns of people with a fear of falling is significantly different from people without this fear. A slower walking pattern can increase the risk of falling when combined with the focus on scanning visually for a nearer threat, as threats may be seen too late, and the size of the person's step could no longer be adequate to avoid the trip or slip hazard. Additionally, when people experience anxiety, their ability to process the threats cognitively is also reduced, decreasing their ability to identify, solve and avoid the problem. Research has identified that people experiencing fear of falling are more likely to miss a 'real' falls risk, due to the constant vigilance of identifying threats closer to them, which may not exist. Both in research and published literature, people with a fear of falling describe avoiding certain activities, particularly out of home. This both increases social isolation and decreases meaningful engagement with others, and also impacts their physical endurance and muscle strength. In the example cited above, "*not moving out of the house for three days"* due to the weather, can significantly affect muscle strength and endurance. The avoidance of outdoor activities is wide-ranging in its effect on health and wellbeing. A lack of nutrition and medication, due to avoiding shops during bad weather, or avoiding social gatherings in premises where stairs do not have a handrail, all impact on a person's overall wellbeing.

It is natural for people to wish to continue living in their own homes as they age. However, the fear of falling, for both the person and their families, often influences the longevity of home life. Recent developments in technology have started to change these concerns, such as the Smart Home, with inbuilt falls monitoring. Historically the drawback of technology has been the difficulties or perceived difficulties in its use, but Telecare's simple technology provides confidence and safety in the person's own home. Recent developments, such as personal fall sensors or smart home sensors, also provide confidence and security for people with a fear of falling [9]. Evidence shows that the implementation of assistive technology can play a significant role in the reduction in the fear of falls, where the design of the environment and technology can merge to make people feel safe, confident and well at home. UD Principle 5 says *"Provide fail safe features"*. For some time, alarm devices have been in common use by elderly people, particularly those living alone. However few existing fall detection technologies work well outdoors so, if a fall occurs, then serious consequences may follow. New sophisticated technologies offer great promise but are at a low maturity level, although advances in consumer electronics such as smartwatches have great potential.

Although much research has been done on fear of falls and its link with the increased risk of falls, there is limited research on how to address this as a specific intervention. Many publications, including 'Global Age-Friendly Cities: A Guide' [10] encourage barrier-free cities, green spaces, community, as well as mobility, but mention the advantages of safer environments only in a limited way, citing problems such as poor maintenance of pavements, danger from skateboarders, vehicles and other *"barriers to physical access, which can discourage older people from leaving their homes".*

A major aim of the World Health Organization's Sustainable Goals is to optimize health for all ages [13] with the concept of maintaining independence and increasing social and economic participation as fundamental to these goals for ageing populations. But social participation can be negatively impacted by poor design. 'Ageing-in-place" and personal independence are fundamental to UD but may bring their own problems, particularly following the death of one partner. Rowles cautions that: *"The elderly gradually become prisoners of space. Certainly some individuals remain active and mobile into their advanced old-age… For many older persons, physiological decline, economic deprivation and traumatizing effects of rapid social change, herald physical, psychological and social withdrawal. This withdrawal… is accompanied by progressive constriction of the individual's geographical life-space and associated intensification of attachment to the proximate environmental context"* [14]. Reviewing the design of the environment is imperative. Does it encourage community engagement or does it lead to the withdrawal of the person or avoidance due to stigma? Will I look disabled using this? These considerations will impact a person's independence, activity and socialization.

Causes of fear and inhibition may occur at both macro and micro level. Urban townscapes with picturesque alleys or luxurious landscaping may be desirable during daylight but, after dark, could suggest the menace of a dark downtown underpass, unless well-lit and overlooked. Places such as pedestrian short-cuts or bus shelters where youths may 'hang out' can be inhibiting for anyone to approach alone. The fault may be due to a lack of provision by city authorities of anywhere more suitable where young people can meet, just as much as the need for design for 'defensible space' [15].

Any element in the built environment should not only provide safety but also reassure users of this safety. Handrails are the most obvious example, having the advantage that, being commonplace, do not mark anyone who uses them as being old or incapable. Specifying materials for floor surfaces is also crucial; highly polished floors, where reflection can make even a dry surface appear wet and slippery, can be intimidating. Changes in floor material, where two different tones or degrees of reflectivity occur, can confuse even a person with good vision.

The Sixth UD Principle, 'Low physical effort', requires that "*the design can be used efficiently and comfortably and with a minimum of fatigue by all users"* [1]. Climbing stairs can be tiring. Landings with resting places are welcome for those with heart or weight problems. Users may feel that being seen to need to rest amounts to a loss of dignity; such elements might be more acceptable if there are other reasons to justify the pause, such as a notice board or pleasant view, thus removing the stigma that the resting place is only for the elderly.

In professional design education, it might be expected that principles of safety are emphasized as a matter of course, but this is not always so. Seductive views of minimalist design precedents lacking basic safety features may be presented to students as good exemplars, with staircases having open treads and no handrails. Good design, where the reduction of fear is imperceptible, is best taught with an interdisciplinary approach, working with real 'users', healthcare and design professionals, to allow different lenses to be applied to design learning.

Fear-avoidant behaviors can also be a result of fear of a loss of dignity or embarrassment. In ageing, changes to the body occur, such as the weakening of bladder control. People may avoid going out for fear of having an "accident" due to not being able to locate a toilet, or then finding it locked. Impassive and impersonal websites make no allowance for error. Dependence on IT continues to increase for many daily activities, reliant on systems actively designed to be disruptive. Poor design of IT hardware and software also engenders technophobia where problems range from difficulty in manipulating small controls or viewing miniature screens, forgetting passwords, running out of battery power to operate devices, or the fear of being controlled or spied on by unseen agencies.

2. Conclusion

From previous experience we learn to recognize potentially hazardous or embarrassing situations in our daily lives. This vital skill allows us to identify the cause, assess the potential risk and take appropriate evasive action. But one bad experience can turn this to overwhelming anxiety about real or imagined dangers, inhibiting a normal life course. Intervention by design or by management then becomes crucial. UD can not only effectively remove physical barriers in the built environment, but also reduce inhibiting mental barriers, particularly fear caused by the threat of danger, pain or loss of dignity. Many such causal factors are avoidable through intelligent, inclusive design, in both the built environment and in services to support independent living. Building codes and safety standards are only able to legislate for one element at a time, often leading to 'bolt-on' solutions that are both ugly and stigmatizing. The potential of UD lies in its capacity to integrate supportive elements without further modification.

Although people live longer, unless they have an adequate quality of life, they may become prisoners in their own homes, vulnerable, isolated and inhibited by dangers and fears, real or imagined. This may be due not only to a lack of awareness on the part of those responsible for realizing the physical world around us, but also to a lack of appreciation of how important the requisite measures are and, most significantly, how these may be achieved through informed design. Research findings on this may not be groundbreaking, but they do signal the urgent need for inter-professional design education and continuing professional development on this issue. The costs of not doing so now are surely unacceptable, in terms of an 'accident waiting to happen'.

For many people, even the home environment can seem to be a threatening place. Restoring personal confidence by providing safe environments will add to people's quality of life. UD is responsive to global trends so it is fitting that its scope might now be extended to make it ever more effective. The influence that Ron Mace has had on

attitudes to design continues to grow, through dissemination of best practice and through research and design education. With this in mind, the authors believe that it is timely to widen the circle of beneficiaries of UD and to propose that an addition be made to the Seven Principles, to further augment "Design for Tolerance for Error" by including a new Eighth Principle: "Design to Reduce Causes of Fear and Inhibition".

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Inclusive Public Toilets: A Universal Design Enquiry for Indian Context

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Abstract. Public toilets fulfil an essential need for all human beings. In the context of India, the diversity of population implies a diverse set of complex barriers in the public toilet experience. Inclusion and the contextual translation of universal design becomes crucial, considering the distinct socio-cultural dimensions. This study intends to enquire the above-mentioned perspective and contribute towards an understanding of inclusion and universal design in public toilets. The methodology is a three-part process including literature review, experiential case reflections and ethnographic field perspectives. The gathered data is mapped thematically and assessed qualitatively, based on the existing principles of universal design. The insights from the assessment highlight the need for contextualization of existing universal design principles, bringing out a multi-dimensional complexity of inclusion across human needs, behaviour, physical, planning and service aspects. This study paves a way forward for evolving design directions by raising further questions through fresh perspectives on inclusion & accessibility in public toilets. The raised questions contribute to a dilemma of standardisation versus contextual customisation around the understanding of inclusion and universal design, focusing on the scenario of Indian public toilets.

Keywords. Public Toilets, Inclusion, Universal Design, India

1. Research Background

Public toilets are a fundamental part of the urban realm, fulfilling an essential need for diverse populations. The global Sustainable Development Goals (SDGs) emphasise this through their Goal 6 stating 'clean water and sanitation for all' (United Nations, 2023). India in 21st century has initiated a sanitation revolution. The Government of India had constructed nearly 7 million toilets in cities, as of 2021 (Press Trust of India, 2021). However, inclusive toilet experiences remain challenging for diverse groups, intersecting across age, gender, ability/disability and socio-economic background (Purkayastha & Raheja, 2022).

As per World Bank, 15% of the Indian population does not have access to a toilet (Delfolie et al., 2022). The diversity of Indian population implies a diverse set of complex

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barriers, ranging across attitudinal barriers, environmental barriers and institutional barriers (Dawn, 2016). As per a survey conducted in the national capital of Delhi for 229 public toilets, 76% of toilets lacked provision of a ramp, making access difficult for persons with mobility difficulties, and two out of three public toilets did not have separate provisions for women (ActionAid India, 2018). Contextual translations of accessibility and inclusive design of public toilets, therefore, remain a subject of enquiry with distinct socio-cultural dimensions. The intent of this study is to work towards an understanding of inclusion and universal design in public toilets, situated in the Indian context.

2. Methodology

The methodology of the study involves three components – a) preliminary literature review around understanding existing interpretations of 'inclusion' and 'universal design' in public toilets, b) case reflections of the Indian context from the authors' field experiences, and c) ethnographic insights from specific locations of three different cities of Dehradun, Roorkee and Delhi.

The first component of the study was a preliminary narrative or traditional literature review involving a broad search in the databases of Google Scholar, Scopus and Web of Science using multiple keyword combinations of 'inclusion', 'universal design' and 'public toilets'. The insights were qualitatively categorized based on themes.

The second component identified primary case reflections of public toilets from the authors' perspectives, highlighting key accessibility concerns for public toilets. This component elaborates on existing interpretations of inclusion and universal design in public toilets, from an Indian lens. The insights are thematically assessed and refine the existing themes identified in the literature review.

The third component involved interpreting ethnographic insights / reflections from exploratory observations and informal conversations in the researcher's experience across the cities of Dehradun, Roorkee and Delhi National Capital Region (NCR). The locations were identified based on the site context with the following criteria: near a street market, near a notable public place and / or near a mobility / transit point like railway stations, bus terminals, etc. The studies were of an exploratory nature to build familiarity with the ground reality, spanning between multiple instances at different times. They were short-term, with an average time spent at each location being approximately 3 hours. The informal conversations were conducted with a total of 50 participants. These included on-site as well as off-site conversations, with representation of persons with physical disabilities, visual impairment, elderly and persons with illnesses like urinary incontinence. The conversations were unstructured and initiated with asking about their understanding and thoughts on contemporary Indian public toilets and accessibility / inclusion in the context of toilets. The questions were asked in both English and Hindi, the local language, based on respective participant's comfort and ease of understanding. The conversation was unstructured with some key questions including 'What comes to your mind while thinking of Indian public toilets?' and 'What are your thoughts on inclusion in Indian public toilets?'. Due verbal consent was taken from all the participants before carrying out the conversations, after explaining the intent of the study.

The gathered data from all three components was thematically mapped and assessed qualitatively based on the existing seven principles of universal design and the five universal design India principles or UDIP (Khare et al., 2011; Steinfeld & Maisel, 2012).

3. Results

The results have been elaborated in three parts – the insights from the literature review, the experiential case reflections and the ethnographic insights from Chandni Chowk, Delhi.

3.1. Literature Insights

The literature review revealed multiple interpretations around the meaning of inclusion in public toilets. Three scales of interpretations were observed – the 'urban' scale, the 'surrounding context' scale and the public toilet 'experience' scale.

3.1.1. Inclusion in Public Toilets at 'Urban Scale'

The first scale of an inclusive public toilet design is situated in how the public toilet fits into the larger urban realm. Based on the review, the location and availability of toilets emerge to be two crucial dimensions. Fu et al. (2022) highlight the importance of spatial equity in toilet provision at the urban scale, considering aspects of availability based on the population demand. Greed (2006) and Nega et al. (2021), amongst other authors, have highlighted the importance of locating toilets appropriately with respect to other urban elements, for example in marketplaces, connected to street / road junctions, and near transport points like bus stations.

Beyond location, information about the location of the toilet with its relevant details has been highlighted to be of importance (Bichard & Ramster, 2013). This is considering with disabilities or other diverse human conditions require to know the nearest accessible public toilet, especially tourists or new residents of the city.

3.1.2. Inclusion in Public Toilets at 'Surrounding Context Scale'

As we zoom in from the urban scale to the surrounding context scale, more aspects of public toilet design become relevant for being inclusive and universally accessible. Identification of the public toilet amidst other built forms and surrounding elements is essential, implying the importance of employing the principles of aesthetics and ease of visibility (Afacan & Gürel, 2015; Greed, 2006). Information about where to find the toilet (e.g., appropriate wayfinding signage) in the surrounding context is discussed to be of importance, which is often missing causing difficulties (Nielsen, 2023).

3.1.3. Inclusion in Public Toilets at 'Toilet Experience Scale'

The public toilet experience comprises of many different stages – from entering the toilet, moving around, using the WCs and other fixtures and elements, and finally exiting the toilet. For diverse user groups, the experience in using the toilet greatly varies with numerous barriers and challenges (Afacan & Gürel, 2015). Studies focusing on maneuverability, spatial considerations and usage experiences of fixtures inside the toilet environments were identified (Mamee & Sahachaisaeree, 2010; Mullick et al., 2012; Morales et al., 2017). However, empirical studies about public toilet experience from the 'human rights' lens are limited (Moreira et al., 2022). From a contextual lens, use of traditional types of fixtures, for example the Asian squat toilet, is a critical point for cultural inclusivity (Afacan & Gürel, 2015). Representation of gender and cultural

sensitivity in toilet information, for example through pictograms, is another crucial dimension that plays a role in an inclusive toilet experience.

3.2. Experiential Case Reflections

The diverse perspectives around inclusion are noted from case reflections across three cities of India – Ahmedabad, Dehradun and Noida. Each case reflects upon a perspective in a narrative manner.

3.2.1. Technology-enablement in Public Toilets

The first case highlights the advent of technology and its role in designing inclusive public toilets. During May 2022, the authors documented a Smart Toilet in the city of Ahmedabad. The toilet was hands-free, 'self-cleaning' and it had incorporated sensor-based fixtures, enabling inclusion for diverse user groups. There were no on-site maintenance personnel. It was a paid toilet, which required any user to insert cash, and the toilet would unlock automatically. The authors observed that a female user in her 20s who wanted to use the toilet inserted a coin without unlocking the toilet. The user attempted banging the door and employed other similar measures, eventually leaving the site.

This case highlights that technology, apart from being an enabler for inclusion, requires it to be supported by other aspects, especially appropriate services for it to be completely functional and incorporate tolerance for error. Technology, therefore, becomes a critical component to enhance inclusion at the 'toilet experience' scale.

3.2.2. Distribution of Public Toilets in the City

As part of a collaborative study with the National Institute of Urban Affairs (NIUA) in India, the authors documented public toilets in the city of Dehradun. A reflection during the study was the distribution of public toilet locations. There were toilets more frequently present in the city centre with lesser toilets present in the outskirts, with toilets often being sited near street junctions. This finding was in alignment with insights from the literature discussing location and availability of toilets as a crucial aspect. However, the toilets were often difficult to locate owing to challenges in visibility and built form aesthetics.

3.2.3. Inaccessible Approach and Entrance of Public Toilets

As part of an independent study, the toilets in the industrial city of Noida were documented. During this study, the status of accessibility of toilets was mapped. It was reflected that a primary challenge to having an inaccessible toilet is an inaccessible approach and entrance to the toilet (as shown in Fig. 1). Similar observations were recorded across multiple instances throughout the toilets of the city.



Figure 1. Infrastructural Accessibility Challenges at a Public Toilet entrance in Noida, Uttar Pradesh. Source: Authors

3.3. Ethnographic Insights

The following insights have emerged from field observations and informal conversations at a total of 12 toilet locations across Dehradun, Delhi NCR and Roorkee. The informal conversations were additionally conducted off-site, primarily to capture perspectives of people with physical disabilities, visual impairments and chronic illnesses. This was because there were limited instances of encountering persons with disabilities on-site during the field studies.

The observations and informal conversations led to emergence of numerous themes around the ethnographic understanding of inclusive public toilets of people. The first theme was that of people's understanding of inclusion. The term, known as 'samaveshi' (in Hindi), was not familiar with multiple respondents. It was 'never heard before'. It was observed that inclusion is discussed with respect to interpersonal behaviour. For example, one of the respondents shared that 'if everyone is allowed to use a public toilet so it is inclusive', implying that inclusion from his / her perspective is owing to whether he / she is allowed to use the toilet or not without any social barrier. Another commonality involved describing inclusion with respect to 'gender inclusion' – whether both males and females can use a public toilet – exemplified by a response which mentioned 'having separate provisions for both'.

The second broad theme was of typical barriers / challenges faced by diverse user population groups. Concerns of locating toilets were identified by persons with visual impairment along with challenges of identifying fixtures inside the toilets. Persons with disabilities highlighted how, despite locating toilets, they are often poor in terms of accessibility (with challenges like level differences, broken grab bars, etc.). Women highlighted safety and privacy concerns due to broken doors. Excessive crowding was observed outside female sections of toilets in multiple instances. Behavioural challenges like vandalism and conflicts between cleaners and users were also observed.

4. Discussion

4.1. Complexity of Inclusive Public Toilets

Based on the gathered insights, the complexity of an inclusive public toilet is evident. spread across scales, disciplines and for diverse human conditions, classified into six broad themes (as shown in Fig. 2).

Urban planning captures perspectives around location, availability and toileting demand at an urban scale. Information as a theme transcends across various scales - where the toilet is located, and accessibility status becomes crucial for any person with disability or diverse needs while using any nearby public place. The physical signage and wayfinding elements are a part of this theme. Infrastructure as a theme intersects with engineering, architecture and product / industrial design perspectives – capturing built-form accessibility, elements of lighting & ventilation and fixture ergonomics. Knitting all the categories together are the service and technology theme – operations & maintenance and safety & security being the prime components. The last theme is human needs & behaviour – one of the most essential components. The complexity of human behaviour has various dimensions including interpersonal behaviour between the diverse stakeholders, behaviour in the context of using toilets and sense of privacy and dignity.



Figure 2. Complexity Mapping of Inclusive Public Toilets. Source: Authors.

4.2. Reflecting the Principles of Universal Design

Taking forward the thematic complexity map of inclusive public toilets, the insights from the study are reflected in the existing seven principles of universal design and five

universal design India principles (UDIP) of equitable, usable, cultural, affordable and aesthetics (Khare et al., 2011). For each theme, the relevant principles are highlighted with the respective source of observations.

Table 1. Reflecting Universal Design Principles in the Identified Themes. Source: Authors

Theme	Sub-themes	Relevant Universal Design Principles	Observation Source
Urban Planning	Location Availability	Equitable, Flexibility in Use, Tolerance for Error, Low Physical Effort, Size and Space for Approach and Use	Ethnographic Insights, Experiential Case Studies, Literature Review
Information	Location & Wayfinding Amenities Representation Instruction Cautionary	Simple & Intuitive Use, Perceptible Information, Cultural (UDIP), Aesthetics (UDIP)	Experiential Case Studies, Literature Review
Infrastructure	Architecture Engineering Systems Fixture Design	Equitable, Flexibility in Use, Simple & Intuitive Use, Perceptible Information, Tolerance for Error, Low Physical Effort, Size and Space for Approach and Use, Cultural (UDIP), Economy (UDIP)	Ethnographic Insights, Experiential Case Studies, Literature Review
Services	Operations & Maintenance (Cleanliness) Safety & Security (Comfort)	Equitable, Tolerance for Error, Cultural (UDIP), Aesthetics (UDIP)	Ethnographic Insights, Experiential Case Studies
Human Needs & Behaviour	Interpersonal Behaviour Usage Behaviour Cultural Practices	Flexibility in Use, Tolerance for Error, Cultural (UDIP)	Ethnographic Insights, Experiential Case Studies, Literature Review
Technology	Service-enabling User-enabling (assistive)	Flexibility in Use, Tolerance for Error, Cultural (UDIP), Aesthetics (UDIP)	Experiential Case Studies, Literature Review

Based on the above discussion, it is evident that the universal design India principles of 'cultural' and 'aesthetics' are the most relevant to the identified themes. The principles of 'tolerance for error' and 'flexibility in use' are also quite relevant for 4 out of 6 themes. As the relevance mapping is subjective, the following questions are raised for taking this discourse ahead:

- Is the current interpretation of existing universal design principles appropriate and sufficient for examining the various aspects of inclusion in public toilets in India?
- Can the existing universal design principles be contextualized as opposed to standardized interpretations for the subject of public toilets and Indian complexity of inclusion?

5. Conclusion

Even though the study is limited in terms of capturing ethnographic insights from diverse user groups, it paves a way forward for evolving design directions by raising further questions through fresh perspectives on inclusion & accessibility in public toilets. It discusses an emerging complexity of inclusion in public toilets in Indian cities, though based on a subjective perspective, thus the generalizability needs to be validated in further studies. There is scope to carry out further investigations to establish interrelationships and evolve the complexity map around inclusion in public toilets, which can eventually contribute to the evolution of design frameworks for inclusive and accessible public toilets that are contextually relevant and significant. The raised questions contribute to a dilemma between standardized interpretations and contextual customisation around inclusion and universal design, focusing on the scenario of Indian public toilets.

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Universal Design Futures: Theoretical Insights and Paradigms from a Majority World

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Abstract. This paper intends to position the key theoretical understanding of universal design from a global lens to the contemporary times, especially with insights from India as a majority world perspective. Using a narrative-based approach, it combines theoretical insights with experiential insights through state-of-the-art literature and understanding. A seven-lens framework is proposed as a comprehensive approach towards UD viz. the human diversity and demographic lens, the socio-cultural lens, the environment and ecology lens, the economic lens, the technology lens, the policy lens and the philosophy lens. Each lens shares unique perspectives with Universal Design as a shared concept for application evolving a discourse for a human-centric and sustainable futures. It highlights various paradigms originating from the Indian context representing high population perspectives especially the context of economic inclusion through universal design with affordability as a key value. The discussion leads us into understanding contextual relevance of UD beyond its original intent of universal accessibility itself. It concludes to see and propose UD as an integral layer of sustainability with a common goal of sustenance and inclusion.

Keywords. Universal Design Theory, India, Human Centric, Future, Inclusion, Sustainability

1. Introduction

Universal Design (UD) as a theory, ideology, practice and philosophy has evolved over the years covering its expanse and relevance in global contexts. This paper positions a comprehensive understanding of UD through insights from India and from global orientations. Referring to Balaram's idea of majority world (2011) implying India as one of the highest population and diversity groups, the term "majority world" represents a

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metaphoric essence. It proposes a "Seven Lens Framework" to provide a unified and holistic understanding of UD envisioning a wider application (Fig. 1).

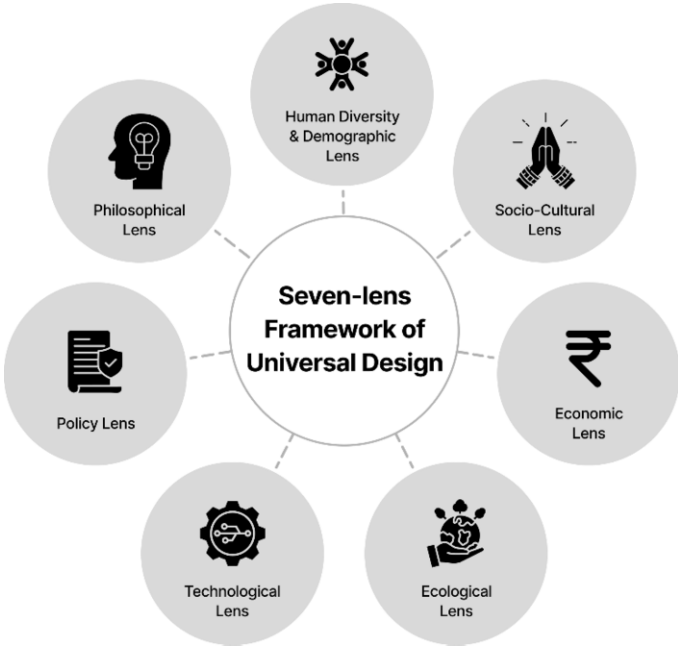


Fig.1 Seven Lens Framework of Universal Design for the Majority World. Source: Authors.

2. Theoretical Background & Methodology

UD has numerous interpretations evolving through times across the globe anchoring and unifying its key theme of design adaptations for a wider range of population groups. Initially conceived and coined by architect Ronald Mace in the 1990s, it was defined *as the design of products, services and environments, such that they remain accessible to a wider range of population groups* (Mace, 1990). The idea has since then evolved, carried forward and transformed with diverse contextual needs and interpretations. The Seven Principles of UD as originally created in 1997 were further extended to Five Universal Design India Principles (UDIP) in 2011 adding cultural appropriateness and affordability as key dimensions in UD contextualization from India (Khare et al., 2012). This followed a development of Eight Goals of UD by Steinfeld and Maisel in 2012 (Steinfeld & Maisel, 2012). It is acknowledged that a wide range of UD developments were carried out through foundational efforts at IDEA Center, University of Buffalo, Institute for Human Centered Design, Boston, Helen Hamlyn Centre for Design, UK, Centre for Excellence in Universal Design, Ireland, to name a few.

UD finds its nuances in diverse terminologies and phrases, ranging from Design for Disabled, Barrier Free Design, Accessible Design, Inclusive Design, Child Friendly Design, Age Friendly Design, Lifespan Design and others. UD as an idea intends to unify disciplines through its approach to address human intersections with applied outcomes.

Laboratory of Inclusive Design (LID) at IIT Roorkee (India) anchors and steers a guiding and leadership role in the narrative of inclusion and sustainability. Few researches under UD as a domain focusing on low resource settings in India suggest a need for greater contextualization of universal accessibility and culturally adaptive designs for inclusivity in Indian scenarios (LID, 2024).

This paper evolves on a research methodology of experiential reflections gained through a careful review of state-of-the-art literature, contextual field studies along with interactions and experiences with diverse stakeholders.

3. Universal Design on a Human-centric Axis

The human-centric axis offers UD a perspective to include diverse human aspects. Three distinct lenses – demographics & diversity, socio-cultural aspects and economics need to be sensitively understood using an empathy-driven approach.

3.1. The Demographics and Diversity Lens

Demographic spread of population suggests an existence of many and wide ranges of human intersections. UD provides an enabling framework to design systems, policies, products, technologies, etc. through a human-centric approach. The challenge, however, remains in the furthering of this delicate balance between human diversity and its co-existence with socio-cultural and economic contexts.

Indian demographic scenarios suggest that the current 1.4 billion population is expected to be 1.7 billion by 2050 (Press Trust of India, 2023). On the other hand, global scenarios such as an increase in ageing populations, high prevalence of disabilities, challenges of low birth rates, etc., continue to create dynamic human contexts for different regions.

UD, therefore, requires evolving wide-ranging strategies of interventions for the inclusion of diversity. Fig. 2 represents a range of human lifespan and diversity, implying a careful understanding of diverse needs for accommodation. UD exerts the possibility of exploring solutions for addressing the widest possible range of human existence. UD guides an empathy-driven approach to respond to dynamic human needs at an intersection of physical, cognitive, and sensory attributes.

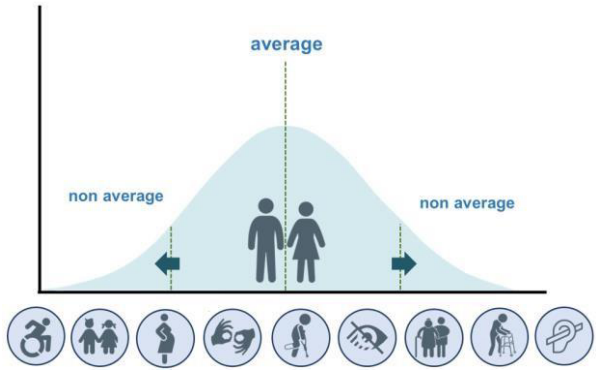


Fig.2 Range of Human Lifespan and Diversity. Source: Authors.

3.2. The Socio-Cultural Lens

This lens orients us towards socio-cultural backgrounds, collective behaviour, and various other attributes of social existence. It is imperative to understand how invisible lines define social boundaries and, in few contexts, how these boundaries dissolve. UD India advocates the principle of cultural appropriateness to achieve social inclusion. As a melting pot of plural cultures, through its languages, food, faith and ethnic origins, India provides opportunities for advancing UD explorations with these intersections.

For cultural co-existence, UD needs to respond with greater choice mechanisms. Socio-cultural practices bring unique perspectives to UD (Balaram, 2011), as demonstrated in an Indian scenario through examples of culturally sustainable products like 'dhoti' or 'saree' which can be worn in a multitude of ways by people of all age groups and body types. The same piece of clothing is, therefore, passed down across generations. 'Dhotis' and 'Sarees' as traditional Indian clothing reflect the ethos of UD with affordability, cultural appropriateness and flexibility in use for a wide range of population groups.

3.3. The Economics and Affordability Lens

Economic lens offers a unique position on the human-centric axis. It spans between A, B and C, i.e., Affordability, Budgets and Costs, in most decision-making systems. It orients the domain of UD towards an important aspect of global south, i.e. poverty and low-resource contexts. Goal 1 of UN SDGs positions poverty as the foremost goal. This implies the development of scalable solutions with affordability as a key guiding principle. UDIP and Eight Goals of UD, both highlight the economic aspect (Khare et al., 2012; Steinfeld & Maisel, 2012). Direct implications of economic affordability can be seen in sectors like assistive technologies, education, healthcare, built environment, mobility systems, information design and employment opportunities.

The built works of architects like Laurie Baker and Hassan Fathy have guided the world towards designing spaces keeping an inclusive dimension of affordability in context (Ali, 2015). Their work is often categorized as "architecture for the poor", but it is encouraged to view their lessons in material and spatial innovation as efforts toward human inclusion, especially in terms of economic diversity. The key challenge for low-resource contexts is to provide universal accessibility through affordable means and for greater adaptability.

An overarching relationship between disability and poverty is well established (Fig. 3) and remains the foundation for many national development programs for inclusivity. India has several national missions, schemes and programmes that provide immense scope for UD as a progressive concept. Missions like 'Swachh Bharat Mission' (mission to provide equitable sanitation) and 'Pradhan Mantri Awas Yojana' (mission to provide affordable housing), etc. reflect an inclusive intent.

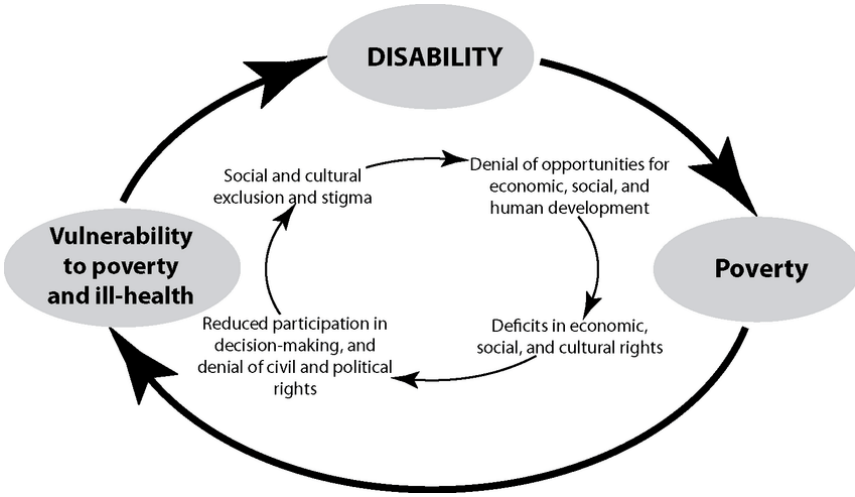


Fig.3 Poverty and Disability Cycle.
Source: Adapted from U.K. Department for International Development, 2000.

As a less-pursued domain of UD, the economic lens provides an orientation of human-responsive design to be pursued at greater scales. UD has proven possibilities of turning design systems and strategies into marketable ventures thereby enhancing economic benefits.

4. Universal Design on an Environmental Axis

Environment refers to a larger world embracing totality. To help understand the distinctions of diverse environmental views through its axis, three critical perspectives for UD are shared viz. the ecological lens, the technology lens and the policy lens. It is possible to have overlapping zones of mutual influence while interpreting wider impacts.

4.1. The Ecology Lens

The lens of nature and universal sustenance rests on human interactions with ecology. However, with growing population this interaction has strained more so in the past century and intensely in the past two decades. The key idea of an ecology lens is to view symbiosis of natural elements like air, water, vegetation, land etc. as a diverse yet unified existence. Amidst growing strains of climate change and a disturbed human – nature interaction, there is an emerging crisis in almost all spheres of human existence viz. water, agriculture, thermal comfort, air and many others.

An inclusive and equitable human existence remains an aspiration requiring urgent effort towards restoring ecological balances. UD originates from the narrative of equity and, therefore, becomes vital in its understanding through the ecological lens. Adverse health impacts and disasters require UD to be incorporated into the mitigation measures during implementation.

Goal 13 of SDG (take urgent action to combat climate change and its impacts) and their interrelationship with other goals is already showing an impact. Persons with disabilities, children, elderly and others with temporary conditions continue to remain

under this impact. Frugal innovations from India like "Mitti Cool" and "Hippo Roller" are examples of responsive and progressive design to an ecological condition with huge environmental impacts. Such examples pave the way for an equitable and environmentally friendly approach to the larger human good.

4.2. The Technology Lens

Technology lens defines a unique position globally. Technology remains an agile enabler for globalization and universality. UD as an approach provides immense scope for achieving inclusivity through this lens.

Technologies and their innovations span all sectors. From health to mobility, education to mass manufacturing, from information to infrastructure – the entire spectrum of technologies needs a human interface. UD principles can guide technological innovations towards long-term sustenance while responding to diverse and special needs. Assistive technology has emerged as a unique domain for UD applications. Technologies for sensory enhancements (such as speech-to-text and real-time language translation), mobility aids (like climbing wheelchairs and rollators), and several others reflect the potential expanse and impact of these technological breakthroughs. Notable frugal innovations from India, such as the *Jaipur Foot*, ground mobility devices for rural women with disabilities, exemplify how low-tech solutions can effectively promote inclusivity and affordability in the Indian context (Bhargava, 2019; Nandini et al., 2019).

This shows the need for appropriate technologies catering to diversity with a sensitivity towards the needs of persons with disabilities in low-resource contexts, offering immense potential for UD applications. Digital interface, information communication, manufacturing & mobility, robotics & artificial intelligence (AI) all provide unique possibilities to enhance human potential and access.

4.3. The Policy Lens

Policy provides a canvas for holistic implementation of rights-based frameworks for various population groups. It is vital to understand the role of UD in shaping policy with inclusive impacts. Through a range of policy frameworks, nations independently and collectively impact social good. UD with all its foundations of emergence pursues a position of inclusivity and equity. Policy evolution from Disability Discrimination Act (DDA), 1995 to the Equality Act, 2010 in UK (Hepple, 2010), and the Persons with Disabilities Act (PwD), 1995 to Rights of Persons with Disabilities Act (RPwD), 2016 in India, reflect a giant leap in enforcement of rights of diverse population groups.

Orientation of UD towards greater awareness of these policies, and their enforcement remains a strategic task involving the political, bureaucratic, business, and social world. The development of 'Harmonised Guidelines and Standards for Universal Accessibility in India, 2021' along with 'Accessibility Guidelines and Standards for Higher Education Institutions and Universities' reflect the long-term strategies for creating accessible environments and inclusivity in built environment and higher education as key sectors. UD remains integral to such policy documents, guiding greater awareness and professional approach towards accessibility and inclusion.

5. The Philosophy Lens

The philosophic lens of UD provides deep insights into its origin as a movement. UD as a concept has traversed a range between stigma & diversity, disability & diversity and accessibility & inclusion. As a philosophy, it has practical connotations in domains of assistive technology and accessibility design, built environment to industrial products, and cultural identity to inclusive policies as larger spheres of application.

The evolution of UD continues, reflecting transformations and paradigm shifts in policies, practices, and exemplars worldwide (Ostroff, 2011). Therefore, it's crucial for the world to recognize UD as an inseparable strand from the philosophy of sustainability. It needs continuity, collective understanding of the past and the present towards further evolving a meaningful orientation to the future. UD unites the above-mentioned six lenses through an umbilical cord of its philosophy. UD provides the foundations for a non-stigmatizing and a constructive discourse,

Over the past decades, philosophical existence of UD and need for its existence has only grown. On one side, UD as a philosophy finds its trajectory towards a process for social well-being (Steinfeld & Maisel, 2012), and on the other side from the Indian school of thought, its narrative extends to affordability and cultural sensitivities. It is crucial for the world to recognize UD as an inseparable strand from the philosophy of sustainability. It needs continuity, collective understanding of the past and the present towards further evolving a meaningful orientation to the future. It is crucial to debunk the myth of associating / interpreting UD as a "one size fits all" approach. UD has the potential to extend its philosophical approach across the globe. It is a philosophy with an ever-increasing relevance to mankind.

6. Concluding Remarks

This paper brings forward the need for a holistic vision to steer UD in this century while acknowledging its journey and origin so far. The discourse must intertwine the understanding of sustainability not as exclusive to climate change but as a change for better life-centric dimensions.

It shares a seven-lens framework towards enhancing the macro and the micro levels of applications for UD. UD provides a multi-dimensional and multi-disciplinary outlook, spanning across all age groups, genders, abilities, and human ranges of existence. Built on the core principles of equity and access, UD finds an extensive possibility towards plural human cultures and low-resource contexts in Indian and similar scenarios. It is crucial to understand the delicate intersectionality between human-environment interfaces for reasonable accommodations. The journey of the evolution of UD must continue with evidence-based practices and research to achieve inclusion as a unified goal.

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Co-Design, Community Engagement, Design Methods and Tools

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Visual Impairment and Lighting: Comparing Guidelines and Illumination in Homes

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Abstract. Universal Design aims to ensure that as many people as possible can participate equally in society, with equal access to housing, education, workplaces, institutions, and public spaces. In the construction field, many of our existing guidelines still need to catch up regarding the diversity of user needs and preferences. Recent developments in low vision rehabilitation have underscored the pivotal role of domestic lighting in fostering independent living and enhancing the quality of life for people with visual impairments. Moreover, several stakeholder organizations and associations in the field of low-vision rehabilitation have published lighting guidelines for this target group. A direct comparison of the different guidelines is difficult, as their focus, vocabulary, and level of abstraction differ: the rehabilitation process focuses on optimizing lighting to support and aid the individual's abilities in the existing environment. It is not directly related to the design- or construction process. Yet, how do the guidelines for lighting fit the actual settings and conditions in Danish homes of people with incipient vision loss or visual impairment today?

In this paper, a selection of these guidelines is assessed and analyzed in relation to three lighting categories: illuminance, luminance, and the visual system. The guidelines are also compared to the initial findings of an ongoing field study. This field study, a crucial component of the research, investigates the role of lighting for individuals experiencing incipient vision loss. This comprehensive approach, which includes both theoretical guidelines and real-world observations, ensures the reliability and relevance of the research, providing a solid foundation for the findings. The practical implications of this research are significant, as it provides valuable insights for architects, researchers, and individuals with visual impairment. Through observations and walk-along interviews in their home environment, we get their personal narratives and observe their lived everyday environments. 37 walk-along interviews were conducted from October 2023 - March 2024 during dark hours. The preliminary findings of the field observations, including observations and measurements, are compared to the guidelines of both the context of building design and -construction and the context of low-vision rehabilitation and stakeholder organizations.

Keywords. Universal design, visual impairment, regulation and guideline, lighting design, domestic lighting, illuminance, luminance

1. Introduction

Vision informs us of the world we live in. The eye is the essential human sensory organ that, through stimuli from light, extracts information about our surroundings [1]. The eye depends on light to function; when there is light, we can see; when there is no light, we

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cannot see. Light supports our everyday life and well-being. However, if the lighting scenario is inappropriate, the light is no longer the solution but the reason for failure to thrive. This points towards optimal lighting scenarios to increase the quality of life for people in general, especially for fragile people with visual impairments [2, 3]. Recent findings in low vision rehabilitation have also recognized domestic lighting as a key to independent living and quality of life for people with visual impairments [4]. This highlights that being able to see is also being able to understand and take an active part in society. Therefore, it is interesting to look into the Convention on the Rights of People with Disabilities, which defines Universal Design as a tool that ensures that as many people as possible can participate equally in society [5]. This regards equal access to housing, education, workplaces, institutions, and public spaces.

Guidelines are essential when discussing and designing the visual environment. They provide inspiration and concrete recommendations suggesting which aspects of light to be aware of and how to create lightscapes that promote good illumination and, thereby, well-being. The Danish Building Regulation specifies guidelines concerning daylight and electrical light [6]. Historically, the concern for light has been overshadowed by other themes such as fire, energy consumption, and sustainability [7]. Thus, the qualities of light have been overruled by other concerns. In a Danish context, the built environment is governed by legislation for specific building typologies and specific functions for shared environments like office space, common access areas, and public buildings. Privat homes are likewise governed by legislation, though they have less regulation.

The legislation provides general recommendations for people but none for those challenged by low vision. To have good advice and suggestions for people with low vision, one has to approach user- and stakeholder organizations' guidelines. Therefore, one of the intentions of the research project "The role of light when the vision changes—Enabling and disabling aspects of lighting in and around the home" is to expand this knowledge based on users' experiences of light and well-functioning lightscapes, applicable in design. Older adults with low vision were interviewed in their homes. The interviews concerned their experiences of challenges with low vision and preferences regarding artificial light in their homes combined with the layout and design of the lighting. This paper draws on the preliminary findings from the interviews and compares them with seven guidelines. It addresses the following research questions: *what are the recommendations for lighting in the guidelines provided by legislation, user – and stakeholder organizations? And how do the project's preliminary findings match these recommendations?*

2. Theoretical framework: illuminance, luminance, and the visual system

The relation between illuminance, luminance, and the processing of the electrical impulses of light in the brain creates a visual impression [8]. Light is described through the laws of physics by its luminous intensity, where the unit of measurement is candela [9]. Only when electrical light became widespread did a definition of daylight and electrical light become necessary. Using well-defined light units in lighting research allows for the traceability of measurements [10].

Illuminance is the luminous intensity or flux falling on a unit area of a surface, measured in lux, used to quantify light distribution from a light source [8]. Lux is the most well-known and widespread unit for communicating light intensity and is used in

lighting design. Traditionally, it is measured on a horizontal plane 0,80-0,85 above the ground.

Luminance is the luminous intensity emitted per unit projected area of a source in a given direction measured in cd/m2. When the luminous flux interacts with a surface, the surface becomes essential, where "the luminance of a surface is a correlate to its brightness*"* [8 p.7]. This means that illuminance is what you measure, and luminance is what the human eye perceives. This distinction is crucial as it can also entail misunderstandings of lighting designs communicated through light units.

The *visual system* is an image-processing system developed through a complex interaction between reflected light (luminance), the eye, and the brain [11, 12]. This means that the luminous flux falling on or emitted from a surface does not alone create the visual impression humans perceive.

With increasing age, the eye becomes less efficient. From around 60 onwards, the eye is a fixed-focal optical system [8], and glasses are needed to help the visual system function. The ability to adjust the pupil size becomes less operational, which causes older people to be less able to compensate for too much or too little light than younger people. Boyce points out that other elements of the eye also change. The photoreceptors decrease, likewise with both neurons in the visual cortex and ganglion cells in the retina [8]. This is all part of the normal process of aging.

Damage to one or more elements that make the visual system function can impair or lower the visual function. The malfunction will be perceived differently depending on where and how the eye is damaged, and psychological processes will impact how people cope with and handle the impairment. For people experiencing visual impairment, the quality or character of light can be crucial for the functioning of the residual vision, where elements like increased light levels, variation in light level to enhance specific areas or a characteristic shadow pattern can be pivotal for creating a supportive visual environment. This is not least because suggestions on supportive light focus on the central vision, which is extremely sensitive to light intensity, and do not consider the peripheral vision, which is less sensitive to light intensity [13].

Altogether, the complex relation between light and the eye's capability results in the human visual system informing us about our surroundings. Together, the well-defined units of light and the knowledge of the human visual system form the theoretical base of this paper.

3. Methodology: a thematic comparison

Seven guidelines have been reviewed and compared. Three of the seven guidelines provide general legislation recommendations, and four specifically target people with visual impairments. All the guidelines that have been studied are generally used and referred to in a Danish context.

Based on the theoretical definitions of light [8], themes on lightning properties from the seven guidelines have been extracted and organized into four main themes and more subthemes: *illuminance* (suggestions for lux levels, uniformity of illuminances), *luminance* (adaptation, glare, contrast) *visual system* (modelling and form-enhancing shadow pattern, uniform/non-uniform light distribution, directionality of light, ambient/focused light) and *light source* (correlated color temperature/K, color rendering Ra/CRI, flicker). Of the four themes, the first three are discussed. Aspects of electrical light sources are left out, as the guidelines mostly inform about their properties rather

than suggest recommendations about the spatial perception of light. The seven guidelines studied are:

On general recommendations

- *Accessible homes. SBi-anvisning 222*, BUILD, Aalborg University, DK [14]
- DS/EN 12464, *Light and lighting - Lighting of workplaces - Part 1: Indoor workplaces*, Danish Standards Association, EU/DK [15]
- JIS Z 9119, *General rules of recommended lighting levels*, JIS Japan Industrial Standard, JP [16]

On specific recommendation for visually impaired people

- TIBS, *Accessibility for blind people and people with low vision*, Danish Association of blind people, DK [17]
- IBOS, *Lighting in everyday life*, Institute for Blind and Low Vision, DK [18]
- DTHS, *Guideline – light, and lighting*, Danish speak, hear- and vision institutions, DK [19]
- TPT *Lighting in and around the home*, Thomas Pocklington Trust, GB [20]

The guidelines' recommendations extracted from the survey are compared with the preliminary findings observed in the homes of visually impaired people. As part of the research project "The role of light when the vision changes - Enabling and disabling aspects of lighting in and around the home," 37 walk-along interviews in peoples' private homes were conducted during the winter season (October 2023 - March 2024). The participants are 55+ years old; 27 live with visual impairments, and 10 without and act as a reference group. The interviews were conducted at their homes during dark hours to avoid additional light from daylight and to study only the effect of the electrical light. The interview guide included questions on how the participant uses the electrical light, how it supports various daily activities, where it is perceived as optimal in the home, and where it is less supportive. Furthermore, based on the informants' narratives, light measurements were conducted as spot measurements on a horizontal plane 0.85m above the floor or at the work surface.

The themes of the guidelines are compared to observations of the lighting scenarios of the visually impaired people's homes to see if the exact instructions of the guidelines are relevant to them and the needs they highlight.

4. Findings: illuminance, luminance, and the visual system capability of modelling

The findings are organized into three themes: illuminance, luminance, and visual system, as introduced above. They all include elements essential to humans perceiving the visual environment. Likewise, each theme relates to basic knowledge of light and vision, as introduced in the methodology chapter.

4.1. Illuminance

The guidelines' illumination recommendations can be a valuable tool for indicating light levels in lighting design projects, as the lux level can be an abstract number. The general guideline DS/EN 12464 recommends illuminance (lux) for many activities, but recommendations for private homes are not included. In a Danish context, though,

DS/EN 12464 is important as it is the guideline that legislation refers to. Also, some of the guidelines for visually impaired people (TIBS, DTHS) refer to this standard for suggestions of light levels.

The general guidelines do not have particular specifications for visually impaired people but emphasize older people as a specific group to pay attention to. JIS Z 9110 recommends higher illuminances when designing for older people. DS/EN 12464 suggests increasing the light levels on the worksurface in offices from 500 lux to 750 lux, and the guideline for Accessible homes suggests the lux level be times three of what DS/EN 12464 suggests.

Of the guidelines that specifically target visually impaired people, TIBS questions the many different suggestions for illuminance levels by saying: "In Sweden, they recommend 350 lux on task area and in Denmark 200 lux, while in the USA they require 1000 lux for the same, without therefore assuming that American eyes are constructed differently than Swedish and Danish ones" [17 p.227]. A research paper by Mills and Borg compares recommendations for office lighting in different countries. It concludes that the recommendations vary not only from country to country but also throughout time [21]. Going through the guidelines illustrates no unanimous agreement on an appropriate illuminance, as the recommendations differ significantly.

Looking physiologically at the eye, increasing illuminances on target areas makes sense to the older eye. As part of natural aging, the visual system becomes less effective. The central vision needs more light to see details and color than the peripheral vision. Therefore, an increase in illuminance compensates for the older eye not being capable of letting in as much light as the young eye. An increase in light level can help many elderly people, but as Boyce states: "There is no reason to suppose that aging is limited to only the optical elements of the visual system." He continues: "The fact that the neural elements of the visual system also show changes with age is important because it implies that the compensation for visual system aging that can be provided by lighting is inevitably limited" [8 p.432]. Therefore, eye malfunctions of people with visual impairment can be caused by many circumstances that are not necessarily related to the amount of light. This supports the preliminary findings from the interviews of visually impaired people where extra light on task areas can be helpful to some, but to others, it creates discomfort. Therefore, it also makes sense that all four guidelines for visually impaired people underline that it is highly individual how much light they need to feel comfortable, and thus has vague recommendations or ultimately leaves out any recommendations for concrete lux level.

4.2. Luminance

Luminance is defined as the emitted light from a surface. The human eye does not see the light itself but the reflection of light from a surface, e.g., the surface of an object [22]. This complicates the work with luminance, as it always relates to the surrounding surfaces and objects to reflect light. DS/EN 12464 highlights the importance of a well-balanced luminance distribution, and to create that, one must ensure that all surfaces' luminance is considered and explains: "They [the luminance] are determined by the reflectance of and the illuminance on the surfaces" [15 p.9], which highlights the relationship between more components of a room than just the light emitted from a light source. The guideline continues: "Although luminance requirements would be a representative way of describing the visual environment, this document lists illuminance requirements as luminance requirements are more complex due to their dependence on

exact material characteristics and viewing position" [15 p.9]. Thereby stating that it does not include recommendations for luminance but only illuminances.

The nature of luminance is complex and correlated with adaptation and contrast, as well as glare. These topics relate to the interplay between illuminance, luminance, surface reflectance, and the human eye perceiving the luminance pattern. The guidelines for visually impaired people all pay attention to the occasion of glare and state that it is essential to avoid it. Likewise, challenges with adaptation are underlined, and the guidelines recommend a balanced luminance pattern. DTHS and TPT emphasize that having a manageable amount of variation between the light levels in one room next to another is essential, as it can cause problems with adaptation and potentially cause glare. Only TIBS indicates concrete guidelines for luminance patterns by proposing a ratio between the task area, the intermediate surrounding area, and the background area.

Extracting precise luminance patterns throughout a space is difficult when visiting visually impaired people. While visiting the respondents, it is interesting to observe that enhanced contrast to help or as a reason for discomfort is not always consistently recognized. The preliminary findings illustrate that many respondents often preferred a luminance pattern with a large ratio from the highest to the lowest luminance. These luminance patterns resembled patterns that people with normal vision prefer, where the private home has isles of light with high luminance to enhance a specific functionality like the dining table, reading area, etc.

4.3. Visual system

High illuminance and a large ratio of the luminance pattern do not support the visual system alone. Creating visual surroundings that support vision is also a matter of making space and objects stand out, revealing their form clearly. To enhance form, it is essential to be aware of the combination of direct and diffuse light and the shadow pattern it produces [23, 24, 25]. DS/EN 12464 also reflects this point of view: "The general appearance of an interior is enhanced when its structural features, the people and objects within it are lit so that form and texture are revealed clearly and pleasingly" [15 p.19]. All these considerations are made concerning people with normal vision. However, what is important to people with normal vision can be essential to people with low vision. That is reflected in the guidelines for people with visual impairments, as they all comment on the importance of combining general ambient light with focused, task-specific light. Furthermore, they highlight how a balanced shadow pattern can enhance and make objects stand out. However, TPT is more concerned with not enhancing contrast or different levels of light to challenge adaptation and glare. Unlike the others, the uniform light is pinpointed as very useful. TPT states: "There should ideally be a high and even level of ambient light throughout the home to allow people to move around safely, and sufficient light for specific tasks" [20 p.10]. This point of view TPT repeats when summing up good advice and stating that supportive lighting should "offer an even level of light" [20 p.12].

Looking at the respondents' lighting scenarios, task lights with clear directionality prove that a clear shadow pattern on target areas is frequently applied and supports their ability to see details, read, knit, or sew. However, the diffuse light between the task areas is often shallow. This illustrates that the respondents have needs or preferences other than those TPT recommends. None of the guidelines provides a precise ratio apart from describing the shadow pattern as balanced. This also comes down to the fact that knowledge of the shadow pattern is complex and not widely known. Many of the

preferred lighting scenarios of the respondents' private homes would probably be characterized as non-uniform because of the significant difference in luminance combined with a strong directionality of light, creating a precise shadow pattern.

5. Discussion and concluding remarks: the ratio of human vision

The guidelines are welcome tools to help people design suitable visual environments. Also, introducing light units and explaining terms are valuable. The study presented in this paper focused first on comparing the guidelines and second on observing how people with visual impairment organize their visual environment and whether they resemble the guidelines' recommendations. The comparison of the guidelines is challenged by having different focuses. The general guidelines target design- and construction processes unfolding units and terms often related to describing minimum light levels concerning people with normal vision and work-related situations. The guidelines targeting visually impaired people focus on giving prescriptions relating to creating a stimulating visual environment that supports vision as best as possible. The guidelines targeted visually impaired people have many valuable recommendations to inspire and exemplify more concretely how to organize a visual environment ideal for people with low vision and thereby include more people in everyday activities.

Several guidelines recommend that extra high illuminance will benefit both elderly and visually impaired people. However, as Boyce states, extra light only targets a few specific eye problems, which can be an argument for looking broader at solutions supporting visually impaired people. Different preferences and needs were seen within the individual homes and across the participants, both in the group of visually impaired participants and control groups.

The four guidelines for visually impaired people are, in general, less specific when it comes to numbers and ratios. This reflects that they know their target group, as visually impaired people often have very individual needs when it comes to light. To some, it can be of decisive importance to have extra light, especially in target areas. But to others, it can create discomfort and even more problems. Our preliminary results from the summation of the interviews also illustrate this. Some have incredibly high illuminance in target areas, while others live in dimly lit homes.

TPT stresses uniform light distribution as one of the recommendations. However, we observed the opposite. Often, the ratio of light level spans very high illuminance at the target area and shallow light level in between. A lighting scheme character that is useful for people, in general, but can be essential for people with visual impairment. Furthermore, we observed that non-uniform lighting is often supplemented by directionality in light, producing clear shadow patterns that enhance space attributes and object form. In a sense, resembling a UD approach to lighting, ensuring a greater palette of possibilities, both due to the different activities and the different needs and preferences of the users. As the study was conducted in Denmark, one can argue that this non-uniform lighting pattern reflects a lighting culture that the visually impaired might adopt as preferable without considering whether it suits them. To answer this question, the preferences of non-uniform light distribution need to be studied more closely to investigate whether there is a relation between light preferences and eye disease.

The initial findings indicate that the mindset of Universal Design could be beneficial to implement in the guidelines. TPT guidelines are the only guidelines to refer to the seven goals of Universal Design [21 p.18]. As a tool, Universal Design implies

that one solution does not fit all, and the survey of the visually impaired people illustrates this. By broadening the range of solutions and viewing the lighting scenarios targeted to visually impaired people as manifold, new approaches to lighting design could emerge, creating safe, functional, and aesthetic light for more people.

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A Workshop for Accessible Crisis Information

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Abstract. Libraries have been pinpointed as a possible hub for information and safety during a crisis. We present a workshop design to contribute to the education of librarians with the goal to make them more able to provide inclusive and accessible information in a crisis. The workshop was carried out during a conference for librarians. The results from the workshop indicate that there is a need for further knowledge about methods and tools to make information accessible, as well as practical information about crisis preparedness. The workshop presented here could furthermore be improved upon by creating tailored personas and spending more time on the activity.

Keywords. Workshop, crisis preparedness, personas, universal design, variation cards

1. Introduction

People with disabilities are disproportionately at risk during crises or disasters due to different barriers they face when receiving critical information and other resources [1][2]. In such situations, accessible and timely information is crucial in maintaining the safety and well-being of all individuals.

During a crisis like, for example covid-19, inclusive and accessible crisis information is crucial [3]. Public libraries are well known for their community trust and play an important role in distributing information in times of crisis. They are also places of access to technology and information [4]. Research has highlighted that access to reliable, actionable information in accessible formats is critical for community resilience, especially for individuals with disabilities [5]. Public libraries, as community spaces and information hubs, are well positioned to bridge this gap by ensuring their facilities and services are designed with universal accessibility in mind [3].

In this article, we describe a workshop design aimed at improving the way librarians understand the diversity among their library patrons during times of emergency or crisis.

2. Background

A crisis (or disaster, we use these terms interchangeably) is an extraordinary event that potentially is harmful for humans and society [6], for example a severe snowstorm with infrastructural damage, a flooding or technological failure. Crisis management is usually

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described as having three phases with different activities connected to them [7]: pre-crisis (preparedness and planning), crisis (response and mitigation) and post-crisis (re-building and learning).

Workshops are meetings with structured tasks designed to create specialized results, new ideas or learning. According to [8], workshops can have three perspectives: workshops as *a means*, *as practice* or *as research methodology*. As the project in which the workshop was carried out has components of action research, it means that the workshop in question can be said to encompass all those perspectives to some degree.

In Sweden, the public library is listed as one of the primary places to open so called "safety points" during a crisis [9]. Public libraries have previously been identified as a possible inclusive information hub working to ensure that crisis information and emergency preparedness resources are available in a variety of accessible formats, such as large print, braille, audio recordings, and easy-to-read versions [3]. Furthermore, several municipalities in Sweden have created "information points" [2,3] as a variant of the "safety point", which are also often placed in libraries.

The workshop reported about here is aimed to be a pre-crisis exercise and tailored for the professional role of the librarian and the library as an information hub. It was held at a conference for librarians, in the context of a national project aimed at developing methods for co-design of crisis planning and mitigation based on universal design principles. It was one in a series of activities within the project, others being for example inclusive crisis exercises, workshops for planning personal crisis kits and scenario-based crisis planning.

3. Method and material

Participants voluntarily signed up for the workshop which was part of the regular conference program, and the 26 spaces were quickly filled. The majority were librarians, but there were also municipality officials. Participants were from different parts of Sweden and 18 different municipalities. The participants were asked to self-organize in 5 groups of 4-6 persons. The available time for the workshop was 1.5 hours and was facilitated by two of the authors.

3.1. Scenario and tasks

To prepare participants for the workshop tasks, a short introduction to crisis management and Universal Design was held. This was followed by a short group-wise warm-up exercise with discussion topics such as:

- What is your current experience and knowledge of accessible information?
- Have you experienced a crisis or disruption while at work? (preferably something not related to the recent pandemic)

The main task for the workshop revolved around a flooding scenario with escalating severeness (figure 1). The discussion topics covered per scenario step were:

- What information could citizens need during a societal crisis?
- How do you provide this information?

[2] https://herrljunga.se/kommun-och-politik/civil-beredskap/informationspunkter.html

[3] https://lund.se/kommun-och-politik/samhallsskydd-och-beredskap/om-nagot-hander---hemberedskap

- How are you receiving your information in turn?
- Draw a card from either the persona set or the variation card deck (figure 2).
    - Do you need to do any adaptions of information for the person?
    - What needs to be adapted and how?
    - Do you have enough knowledge to be able to inform all your patrons?

Each group was given printouts with the tasks, a scenario with short texts and images, official crisis preparedness material from the Swedish Civil Contingencies Agency, the personas and variation cards (below), a big sheet of paper and post-it notes. The scenario was a series of images with text describing a flooding scenario, from slowly rising water to an electricity fall-out (Figure 1). The scenario was intended to be started by showing a rain-fall simulation-video, a method used in previous workshops, but it had to be scrapped due to time constraints.

The groups were asked to document their discussions. All material was also published on a learning web platform in accessible formats, to be possible to read digitally. After the group-wise discussions, a short presentation was made by each group to the other groups.



Figure 1 Images for scenario step 1 (rainy, windy, some train lines stop operating, water is slowly rising) and step 4 (electricity is falling out and eventually cut off to hinder more damage).

3.2. Personas and variation cards

Personas are descriptions of fictional persons extensively used in marketing and interaction design. There are multiple aims of using personas [10], in this context the most prominent are:

- Make user needs more explicit
- Build empathy for users
- Facilitate effective communication about users

The word “user” above, commonly used for the “stakeholder” or “customer” who will use a product or design, can be exchanged for “citizen” or “library visitor”. The personas chosen were a set from the Auckland Design Manual [11], that features 12 personas with various characteristics that highlight diversity in society, for example: an

adult with young children, an older person, a delivery person, a person in a wheelchair, a tourist etc.

The personas had little practical and specific information about user requirements, thus, the variation cards [12] were added to the material. The 9 cards are intended to visualize population diversity. The deck of cards was developed in a project aimed at including universal design for public procurement. The current main themes are 7: mobility, vision, cognition and perception, hearing, language and allergy. Each card contains general information, as well as more concrete points to consider. Additionally, there is an introduction card explaining universal design, as well as one "joker" card intending to remind the card user of the risk of using yourself as an implicit reference. The basic design of the card is flexible, allowing the addition of more cards to get an even better visualization of human diversity.



Figure 2 Back and front of the vision and mobility variation cards. English version.

3.3. Data collection

The data collection from the workshop consists of the collective documentation from the groups, on-the-fly observations and notes. The documentation from the groups (post-it-notes with issues, questions and solutions) were clustered in six categories.

4. Results

The concrete result of the workshop was a very mixed bag of observations and results, both about what can be concluded about crisis preparedness at the libraries, but also about the method used. In general, participants had heard about universal design, but were not familiar with definitions or details. The conference theme was targeted to accessibility and inclusion, and the interest for the risk workshop was good as it was filled quickly.

It was observed that participants were eager to discuss many aspects of crisis preparedness, and that different groups focused on different parts of the exercises. 4 of 5 groups carried out the tasks and used the material as intended, and one group got "stuck" on the preparation questions, but also shared practical tips about crisis preparedness among group members. Figure 3 shows an example of a group documentation. Notes from the 4 groups were collected and clustered in 6 categories: *Information need*, *information spreading*, *practical issues*, *organizational issues*, *collaboration with surrounding society*, and *other*.

Participants generally felt that they lacked preparedness, information and knowledge to contribute to crisis situations. For example, they did not feel informed what their role was during a crisis ("*Are we even a part of the municipality crisis organization?*"), and they didn't know when and by whom they would be informed of a crisis and what was expected of them. However, being librarians, they were confident that their role was to actively search for information and help citizens. They also expressed that it was difficult to know the boundary between being a librarian in the crisis organization and being a conscientious citizen.

The use of the personas and variation cards highlighted the need for flexible information in different languages ("*We actually had tourists come to our library asking for information, like last week, but still we don't have anything prepared for those occasions.*"). Other adapted types of information, like visual support images were also mentioned. There was also discussion about information needing to be "analog" (not digital) in case electricity falls out, but also that information boards etc. should be placed in such a way that it was easy to access and read in different heights.

Although the Auckland Design personas were seen to work in some cases, and encouraged discussion about information accessibility, the results showed that the texts on them steered the discussion to physical accessibility, which in many cases was already in place due to regulations. It was also noted that the persona cards were used more than the variation cards, despite there being more context regarding the information needs in the variation cards.



Figure 3 Two personas from the Auckland Design Manual with numerous notes for the four scenario stages.

5. Discussion

The results from the workshop can be relevant in different ways, but we will here focus on the ones anchored in Universal Design and methods, and less on the ones that solely have to do with general crisis preparedness. If libraries are indeed to be able to contribute to inclusive information spreading in crises, it is very important that they feel able to do so also in their everyday work (when there is not a crisis). As it is now, the success of inclusive information spreading relies heavily on the knowledge and initiative of individual librarians. Providing targeted training and resources to empower librarians

(like this workshop) is one way to start. This could equip them with the skills and confidence to integrate accessibility considerations into their library's policies, programs, and, eventually, their emergency response plans. Additionally, appropriate resources, such as equipment for creating accessible materials are needed. Potentially libraries could be a place that has equipment like braille printers, materials and machines for swell paper, 3D printers etc., and where you can go also in a non-crisis situation to create accessible materials, something which would then allow the creation of better information materials also during a crisis. In the long run, public libraries could leverage their position as trusted community spaces to provide essential services during crisis events [3]. By ensuring both their facilities and services are designed with universal accessibility in mind, libraries can furthermore serve individuals with disabilities to access resources, shelter, and support, that happened during the Katrina hurricane i southern USA [13].

The need for "analog" (non-digital) information in a crisis could be an interesting universal design challenge. Many information- and communication needs today are solved with digital equipment which will be rendered useless without electricity. Batteries could be used short-term but charging possibilities and/or analog equivalents need to be considered if libraries should maintain their information services during a crisis.

As noted above, the personas and variation cards worked to some extent, but not as well as we had hoped. Re-using personas can be risky [14], and in hindsight we should have realized that the Auckland Design personas were skewed too much toward physical design, and that the workshop participants did not have the appropriate experience to extrapolate information needs from those descriptions. Moreover, the personas (as also the variation cards) were both missing a narrative component, which is brought forward as an important characteristic for personas [15 pp. 229]. Furthermore, for personas to be effective to build empathy and make needs explicit, they need to have enough detail (for example a name, a demographic, skills, feelings and attitudes) and be targeted to the specific context [14, 15 pp. 229]. The Auckland Design personas were in this regard very minimalistic. We don't have a clear explanation for why the variation cards were not used more, but perhaps participants were drawn to the images of the personas (simple but clear line drawings) and the clean design. It could also be that personas are a more compelling tool than checklists of variations, even if the personas were not optimal for the task.

The time frame of the workshop was an issue. During the session, the tasks felt a bit rushed, however, when analyzing the results, the main goals of the workshop were indeed fulfilled by 4 of 5 groups, as seen in Figure 3. With more time, a more in-depth introduction could have been made, and it would have been easier for the facilitators to ensure that groups were working with the intended tasks. However, a workshop with many tasks is not a problem in itself, provided that facilitators can handle different knowledge levels and focus. There is no question that all participants in the workshop learned new things, being it about universal information design or crisis preparedness, or both.

6. Conclusion

The workshop served as an eye-opener to crisis preparedness, crisis information spreading and accessible information in general. Ideally, seeing as the knowledge among

the participating librarians of how to work with accessible information was lower than expected, this workshop could be followed up by courses in universal design, accessible information design and crisis preparedness. It also highlighted that municipalities might need to work more actively and openly with incorporating their libraries in the crisis management process.

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Universal Crisis Information Design: A Multi-Case Study

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Abstract. This paper presents a multi-case study on universal crisis information design, focusing on individuals with communication disorders, the elderly, and immigrants. Using a research-through-design approach and various qualitative data collection methods, the study explores accessible information solutions by examining the accessibility of crisis information design and developing universal crisis information design guidelines based on the findings. The findings highlight the necessity for simplified crisis messages, multimodal communication, and the involvement of community facilitators. This leads to a set of guidelines for universal crisis information design, including integrating adaptive technologies and multiple communication channels to enhance trust and inclusivity in crisis management. The study underscores the importance of community-based strategies and the role of personalized, clear, and trustworthy information in improving crisis preparedness and response among vulnerable groups.

Keywords. Crisis Information Design, Design for All, Research Through Design

1. Introduction

Due to emerging political conflicts and the climate change crisis, preparedness is gaining more importance than ever before. Effectively communicating vital information to all segments of society is crucial for crisis mitigation. Without a universal design approach, certain groups risk exclusion from crisis communication, which affects both their well-being and overall societal resilience [1]. While well-established universal design guidelines exist, applying them to crisis information design presents challenges. One reason for this is the hierarchical nature of crisis management and the complexity of evaluating designs during actual crises. Current literature primarily focuses on high-level strategies and training instructions for decision-makers and communicators [2, 3]. However, limited exploration remains in universal crisis information design guidelines. This multi-case study, using a research-through-design approach, conducts three case studies to understand the problems vulnerable groups and stakeholders face with crisis information. The three case studies involve individuals with communication disorders, the elderly, and immigrants. The research questions are: RQ1: How can crisis information be designed to ensure accessibility and understandability for individuals

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with communication disorders, the elderly, and immigrants within the context of Swedish society? RQ2: What lessons can be learned from these groups to develop universal crisis information? Each study includes qualitative research and participatory design workshops aimed at developing information design solutions. Through the studies, diverse data types, such as interview transcripts, reflection notes, survey results, and conceptual ideas, were collected. Although the cases had similarities, they differed in terms of event sequences, data collection methods, and participant numbers.

2. Background

Current literature on crisis information and communication emphasizes a few key approaches to ensuring accessibility including developing macro-level communication strategies [4], such as identifying audience segments and crisis contexts to improve planning for vulnerable groups [5]. This helps select effective communication channels for specific groups and situations. An additional approach is embedding crisis communication within local authorities and organizations, which better understand vulnerable groups and can more flexibly address their needs [6]. Another approach is focusing on the preparedness of crisis communicators, mainly by improving the psychological and interpersonal skills necessary for coping with and communicating during a crisis [7,8]. Using various communication tools, including those that utilize technology, is an approach that focuses on instruments of communication to make crisis information universally accessible. Examples include universally understandable visual codes and icons [9], as well as coordinating and quality assurance solutions for spreading understandable and relevant crisis information [10, 11]. Finally, there are studies that address specific groups and contexts with higher vulnerability during a crisis. Such studies often suggest tailored communication solutions and strategies for specific crisis situations and vulnerable groups [12,13,14]. Although the existing approaches towards universal crisis communication and information are diverse, they often do not provide comprehensive design guidelines or strategies for universal information design. In current literature, the term design, within the context of crisis information, is usually used for describing the development of technology, specifically digital communication [15,16,17]. However, information design involves the practice of arranging and presenting information by considering clarity, effectiveness, and usability and requires combining various media such as text, audio, and visuals to communicate information effectively to its intended audience [18]. Given the general gap in crisis information design, it follows that universal crisis information design is also underexplored.

3. Method

Considering the gap in the literature, this multiple case study attempts to develop a set of universal crisis information design guidelines based on findings from three vulnerable groups: individuals with communication disorders, the elderly, and immigrants, within the context of Swedish society. To develop these guidelines, we applied a 'research through design' approach, meaning that activities during the design process, such as user studies and co-design workshops, as well as the design solutions generated, were used as the main sources of data for research [19]. Research through design is a promising approach for developing well-integrated solutions to complex and

uncertain challenges involving multiple stakeholders [20]. This is particularly relevant in the challenging field of universal crisis information design. Collected data from cases were analysed using thematic coding to identify common themes and ensure robustness through triangulation of various methods such as interview, survey, and workshop data.

3.1. Case one: individuals with communication disorder

The first case study investigates crisis communication for individuals with complex communication needs, including people with aphasia and users of Blissymbolics. Aphasia is a communication disorder that impairs understanding and expressing spoken and written language, often due to brain damage. Blissymbolics is a visual language of symbols, each representing a unique concept. Symbols can be combined to represent new concepts, aiding communication for those with severe speech and physical impairments. As shown in Table 1, data collection involved semi-structured interviews, group workshops, and questionnaires. To facilitate communication a Supported Conversation for Adults with Aphasia (SCA) approach was used. The SCA approach trains communication partners to facilitate conversations with individuals with aphasia, using strategies like acknowledging competence, multimodal communication, and focusing on one idea at a time. In the workshops, the Talking Mats tool was utilized. Talking Mats is a visual tool that helps people with communication difficulties express their thoughts using pictures and symbols on a mat, enabling participation in discussions. Data collection was conducted by a speech and language pathologist.

Table 1. Summary of case one data collection methods

Data Collection	Scope	Participants	Specification
Semi-structured Interviews	Investigate personal experiences and pre-understanding of crisis scenarios	3 participants with aphasia	30-minute interviews using the SCA approach discussed participants' backgrounds, external support, COVID-19 information evaluation, trust in societal crisis care, and their capacity to assist others.
Codesign Workshops	Crisis-specific problems	3 participants with aphasia (first workshop), 4 Blissymbolics users (second workshop)	Two 90-minute workshops demonstrated crisis scenarios. Participants used Talking Mats to rate nine problems, with pictures and symbols aiding understanding.
Questionnaires	Evaluate current support, crisis handling, and trust in authorities	16 participants with aphasia	A 10-question survey, aided by a pathologist, addressed participants' support, crisis management, trust in authorities, and crisis help preferences.
Expert Interview	Provide expert insight into participant functionality and reliability	1 speech and language pathologist	A 60-minute expert interview, audio-recorded and semi-structured, provided insights into participants' functionality and reliability from a pathologist's view.
Individual Interview	Personalized input from a Blissymbolics user	1 Blissymbolics user	A 60-minute interview, semi-structured and assisted, ensured accurate understanding of participant's input.

3.2. Case two: elderly

The second case addressed crisis communication for elderly individuals, focusing on climate related crises such as flooding, storms, and wildfires. The study employed participatory design methods to engage the elderly in developing inclusive communication strategies. Data collection methods included unstructured group interviews, web surveys, focus groups, and workshops (Table 2). The unstructured group interviews were conducted at senior meeting places to gather initial insights. A web survey distributed through senior associations provided quantitative data on how seniors currently receive and prefer to receive crisis information. Focus groups with seniors living on islands explored specific needs and preferences, while various workshops and activities facilitated the co-design and evaluation of communication solutions.

Table 2. Summary of case two data collection methods

Data Collection	Scope	Participants	Specification
Unstructured Group Interview	Initial exploration of information sources and preferences	5 seniors	Informal discussion at senior meeting places to understand general information behaviours and preferences.
Web Survey	Broad assessment of information needs and trust	693 seniors	Survey distributed via senior associations, exploring preferred channels, trust in information sources, and specific information needs during crises.
Focus Groups	In-depth exploration of crisis communication preferences	9 seniors living in an archipelago	Two focus groups discussing crisis communication preferences, focusing on the differences between city and island living seniors.
Emotion Workshop	Creative exploration of crisis communication strategies	5 participants representing Multiple stakeholders	Workshop with seniors and crisis management authorities to co-design communication solutions.
Telephone Interviews	In-depth exploration of trust issues and preferences	5 seniors	Conducted via telephone to gain deeper insights into trust issues and communication preferences.
Co-design Workshops	Co-design and evaluation of communication solutions	5 seniors	Conducted in two parts: scenario-based board game and idea generation. Participants empathized with personas to develop crisis communication strategies.
Post-it Evaluation	Gathering feedback on proposed solutions	Workshop participants	Participants provided feedback and suggestions on proposed solutions using post it notes during workshops.

3.3. Case three: immigrants

The third case study explores crisis communication within Swedish metropolitan suburbs, specifically focusing on individuals with foreign cultural backgrounds and

lower socio-economic status. Emphasis was placed on trust. As shown in Table 3, the study began with an exploratory literature review, followed by multiple user studies, including cultural probes and interviews with communicators, other experts, and the target group. This phase was summarized using six different personas. Subsequently, individual idea generation activities and idea-generating workshops were carried out, resulting in a conceptual design with four variations. The final design proposals were evaluated through a survey, with the responses qualitatively analysed.

Table 3. Summary of case three data collection methods

Data Collection	Scope	Participants	Specification
Cultura Probes	Understanding daily lives and communication habits	14 participants from the target group	Digital format over five days, capturing routines, neighbourhood views, media habits, crisis information opinions.
Interviews	In-depth exploration of target group needs	5 participants from the target group	Gathering detailed insights on crisis information needs and behaviours.
Design Workshops	Translating research outcomes into communication solutions	6 designers	Scenario-based board game and idea generation. Participants empathized with personas to develop crisis communication strategies.

4. Results

4.1. Results of case one, individuals with communication disorder

Participants with aphasia could manage crisis information if they stayed at home but struggled with complex instructions and had not considered stocking up on essentials. Blissymbolics users relied heavily on personal assistants and faced life-threatening risks without them. Both groups expressed low trust in societal support but had strong personal networks. Based on a qualitative synthesis of data from different methods, the most common themes related to the research questions include simplifying crisis messages, ensuring multi-modal communication, and involving these individuals in crisis planning to enhance their preparedness and trust in crisis management systems.

Table 4. Summary of case one results

Data Collection	Findings
Semi-structured Interviews	Participants with aphasia could manage crisis information at home but struggled with complex instructions and lacked plans for essentials.
Codesign Workshops	Blissymbolics users heavily relied on personal assistants; without them, they faced life-threatening risks. Both groups emphasized the need for simplified crisis messages and multi-modal communication tools.
Questionnaires	Participants expressed low trust in societal support but had strong personal networks. They preferred personalized and clear crisis information.
Expert Interview	Confirmed that participants had varying abilities to manage crisis situations independently, highlighting the importance of tailored communication strategies.

Individual Interview	The Blissymbolics user indicated complete reliance on personal assistants for effective crisis management, stressing the need for assistant-inclusive plans.

4.2. Results of case two, elderly

The elderly prefer concise, clear, and reliable information delivered through familiar channels such as TV, radio, and text messages. There is a need for personalized communication strategies that account for the cognitive and sensory impairments common among the elderly. Trust in information sources varies, with authorities and rescue services being the most trusted. Both the web survey and focus groups revealed a reliance on neighbourly cooperation and social networks, especially among those living in the archipelago. This emphasizes the importance of community-based communication strategies. The workshops facilitated the development of several innovative communication concepts, including automatic voice SMS, updated outdoor signals like Hesa Fredrik using drones, and neighbourhood chat groups.

Table 5. Summary of case two results

Data Collection	Findings
Unstructured Group Interview	Seniors rely heavily on TV and radio for information and social interactions at meeting places enhance information dissemination.
Web Survey	Trust in authorities and rescue services is high; seniors prefer concise and clear information. Personalized messages and updates on the situation and expected duration are crucial.
Focus Groups	Neighbourly cooperation is vital, especially on islands. Information should be clear, concise, and adapted to local contexts.
Emotion Workshop	Developed concepts include automatic voice SMS, drone-delivered outdoor signals, and neighbourhood chat groups for crisis communication.
Telephone Interviews	Revealed specific trust issues and communication preferences unique to the target group.
Co-design and Evaluation Workshops	Seniors actively contributed to the creation and assessment of crisis communication concepts, emphasizing the need for clear and direct messaging.
Post-it Evaluation	Participants provided constructive feedback on proposed solutions, emphasizing the need for localized and trusted communication channels.

4.3. Results of case three, immigrants

Trust in authorities and crisis information is generally lower in these areas, primarily due to socioeconomic factors, previous experiences, and perceived inequities. The study found that two-way interpersonal communication significantly increases trust and effectiveness in reaching the target group. Community facilitators, multilingual and multicultural individuals from the given areas, emerged as a crucial element in bridging the information gap. The design proposals focused on creating processes to reduce this gap by involving these facilitators, who would collect and relay information to crisis communicators to tailor messages better suited to the target group.

Table 6. Summary of case three results

Data Collection	Findings
Cultural Probes	The importance of familiar communication channels and the need for trust-building through everyday interactions.
Interviews	Challenges in reaching the target group due to low trust in authorities, socioeconomic disparities, and cultural differences. Importance of clear, concise information and the role of community facilitators.
Workshops	Concepts including multilingual facilitators, community-based information sessions, and digital tools for real-time updates.

5. Discussion and conclusions

Qualitative synthesis of results from cases revealed common themes in target group challenges, stakeholders' challenges, and design requirements. All participants encountered communication challenges related to accessibility, trust, and inclusivity during crises. These findings directly address RQ1 by demonstrating the necessity for simplified, multi-modal communication strategies tailored to the needs of individuals with communication disorders, the elderly, and immigrants. A recurring theme in all three studies emphasized the importance of flexible communication strategies tailored to the diverse needs of participants [21, 22]. These strategies aim to ensure that everyone receives timely, clear, and trustworthy information during crises. The stakeholders faced challenges related to effective reach and trust-building with diverse community groups. The studies highlighted the importance of stakeholders developing adaptable communication strategies to build trust between authorities and the communities. Design requirements from all three cases emphasized accessible, adaptable, and inclusive crisis communication systems. The messages needed to be relevant, timely, credible, transparent, and actionable. Examples of solutions included automatic voice SMS, drone outdoor alarms for remote areas, and multicultural facilitators bridging gaps between authorities and communities. It is unsurprising that achieving universal crisis information design necessitates participation. However, facilitating such participation is not easy due to limitations of some target groups and difficulties in evaluating designs in crisis situations. Moreover, security concerns sometimes dictate a waterfall decision-making approach. Therefore, there is always a chance that crisis information design is being partially developed using a top-down approach. Design guidelines for overcoming these challenges include the use of adaptive technologies, communication through multiple channels and media, facilitators who can bridge the communities and policymakers, and constructing universal design solutions around common communication challenges such as mistrust, need for iteration, exhaustion, confusion, delusions, and processing delays. A key limitation is the small sample sizes and focus on Swedish society, which may affect the generalizability of the findings. Future research should test these findings in diverse cultural contexts with larger populations to validate the guidelines.

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Filmmaking as a Tool for Investigating the Positive Spatial Experiences of Disabled People

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Abstract. Current studies at the intersection between architecture and disability focus on addressing the immediate needs of disabled individuals and often overlook the potential of built environments to create positive experiences. Additionally, conventional approaches for investigating disabled people's spatial experiences often fail to capture the inherent nuanced sensory and emotional aspects. This paper describes the process of filmmaking and the use of film to explore its contributions and limitations in the understanding on how personal and contextual factors influence individuals' positive spatial experiences. The film *Places and Small Pleasures,* produced by the Cluster for Spatial Inclusion at the Royal Danish Academy in collaboration with Nossell & Co, serves as a case study for a reflective inquiry. The filmmaking process involved participant interviews, transcript analysis, storyboarding, shooting, editing, and final screening. The analysis of the interviews with four selected participants revealed key spatial attributes and contextual phenomena contributing to their described positive experiences. Four distinct narratives emerged, highlighting the participants' diverse bodily conditions, emotions and feelings in their favorite places. Representations of their experiences through the film incorporated verbal and non-verbal cues, their bodily reactions, and contextual phenomena, offering an immersive sensory richness for the viewers. By capturing the embodied experiences of the four participants within their personal and spatial contexts, the filmmaking process enhanced understanding and empathy, enriching disability studies and fostering academic discourse in this domain through positive stories.

Keywords. Filmmaking, spatial design, disabled people, positive spatial experience, pleasure

1. Introduction

Existing research at the intersection of architecture and disability predominantly addresses the challenges faced by disabled individuals in built environments, targeting immediate needs such as access and usability [1]. While these aspects are essential, their focusing solely on the immediate and practical needs of disabled people excludes the important potential of the built environment to contribute to positive spatial experiences [2]. This gap in the literature points to an unexplored area concerning the study of the positive spatial experiences of disabled people, highlighting the need for a more comprehensive understanding that includes sensory and emotional dimensions. Traditional design approaches and research methodologies frequently fall short in

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capturing these nuanced aspects of spatial experiences [3]. To address these limitations, this paper explores the use of filmmaking as a qualitative research method to investigate how personal and contextual factors influence the positive spatial experiences of disabled people, with a particular focus on the feeling of pleasure within architectural spaces.

Film is increasingly being recognized as a valuable qualitative research method, due to its ability to capture and convey complex narratives and experiences [4]. In qualitative research, filming is an established method used for collecting and recording data [5], moreover, it has become a valuable medium not only for knowledge production but also for dissemination [6] [7] [8]. The process of filmmaking often requires immersion in human interactions, emotions, and social dynamics, making it a rich source of valuable data and insights [9]. Furthermore, through film screening and discussions, film can be used as a tool for facilitating critical reflection on prejudices and understanding of social issues [10], while supporting audiences' identification with, and empathy towards the represented subject and emotions [11].

Starting from these premises, this paper employs the short film *Places and Small Pleasures* as a case study to examine the extent to which film can be a valuable tool for exploring, representing, and discussing the positive body-space interactions of disabled people in the built environment. By detailing the filmmaking process and reflecting on each step, this study highlights the strengths and limitations of the filmmaking process in unfolding the spatial mechanics that underpin disabled people's everyday experiences.

2. Methodology

To examine how film can be an effective medium for producing and disseminating research-based knowledge, a reflective inquiry was conducted after the project's completion. This approach allowed for a critical examination of how each step of the filmmaking process contributed to collecting, understanding, and representing the positive experiences of disabled individuals in the built environment. Reflective inquiry, as a methodological approach, involves a qualitative examination of one's own work through a critical lens. It allows for a deeper understanding of how the project-related decisions and applied methods shaped the interpretation and representation of the participants' experiences of pleasure [12] [13]. Additionally, reflective inquiry helps to identify the strengths and limitations of film [14], providing insights into the ways the film, as a medium of representation and communication, captures the more subtle, yet significant, positive interactions between bodies and spaces.

The film *Places and Small Pleasures*, used here as a case study, is the result of a project conducted by the Cluster for Spatial Inclusion at the Royal Danish Academy in collaboration with Nossell & Co. The filmmaking process involved various stages, including interviews with the four participants, transcript analysis, storyboarding, on-site shooting, final editing, and film screening. The film presents the experiences of four individuals: William, Belinda, Christian, and Vibeke. In this paper, each step of the filmmaking process is described and discussed through the narrative of William, as a representative case, to reflect on how the filmmaking process contributed to depicting unique relations between personal and contextual factors forming a positive spatial experience.

3. Places and Small Pleasures: the filmmaking process

In what follows, the process of making *Places and Small Pleasures* is presented. Each step describes the research approach, and the modalities employed for generating and representing knowledge about the experiences of the four participants, exemplified through the case of William.

3.1. Participant recruitment

Our main challenge in recruiting participants was to ensure diversity in bodily conditions, gender, and age range. Furthermore, the project required that the participants be willing to share their experiences, sometimes leading them to describe highly personal reflections and feelings. Nossell & co. were responsible for establishing contact with potential participants and selecting relevant interviewees after an initial round of contacting 15 individuals with various disabilities across five different disability organizations.

Accordingly, the final four participants who took part in the short film not only have varied profiles: age:(early 20's to late 50's) gender (man/woman) and type of disability (Cerebral Palsy, Stoma, Muscular Atrophy and visual impairment), but also different preferences, coping style and so forth. All four participants gave consent to share their verbal and visual information. William, one of the participants, is in his early twenties and uses an electric wheelchair due to muscular atrophy. He is the chairman of The Association of Young People with Disabilities (Sammenslutningen af Unge Med Handicap, SUMH), which aims to strengthen the resources of young people with different bodily abilities. William, like the other participants, showed full availability and commitment to participate in this project.

3.2. Interviews

The aim of the interviews was to gather detailed accounts of the participants' experiences and their reflections on how the environment contributed to their feeling of pleasure. Semi-structured interviews [15] were employed to ask focused questions on moments of pleasure experienced in space, while allowing for deviations based on the descriptions provided by the interviewees. The questions centered around understanding of: *who* the participants are, *what* kind of pleasurable experiences they recall, *where* they had these experiences, *how* the physical context influenced them, *when* these experiences occurred, and *with whom* they shared these moments. During the interviews, the participants were asked to close their eyes and imagine being in their mentioned favorite place. This exercise was not planned beforehand, and yet it became essential; as the questions required participants to articulate beyond purely cognitive-intellectual responses, this exercise was used to encourage the participants to recall and reflect on past bodily situated events.

William was first asked to describe himself. Then, he was asked about the specific places where he most enjoys being. He answered that he likes "walking", as he said, with his dog Arthur at Vestre Kirkegård, a cemetery in the west side of Copenhagen. Subsequently, he was asked to take a deep breath, close his eyes, and imagine himself *walking* around the cemetery. After he took a long deep breath, the tone of his voice changed, and he started to speak slowly. Then, he began to describe, in detail, the nature

in the cemetery and how he was surrounded by. This was followed by a description of how he felt calm in his body, and how this experience influenced his mind and thoughts.

3.3. Transcript analysis

The audio-video recordings of the conducted interviews were transcribed using automatic transcription software (Sonix). By following an iterative grounded theory research approach [16], the transcribed interviews were analyzed to extrapolate the key themes in relation to the positive experiences shared by the participants. The analysis focused on identifying words and descriptions related to pleasurable experiences and feelings (such as calmness, peace, enjoyment, and fun), as well as the types of pleasure and the associated narratives. For each narrative, the influential attributes of the built environment, natural phenomena, contextual and social dynamics, sounds, smells, and their related bodily sensations and reactions, were examined.

William conveyed his idea of Vestre Kirkegård as a place of "respect" and "peace" emphasizing the positive feeling of "walking" around the cemetery while reflecting on death and gaining a new perspective on life. He described the "beautiful" trees around the lake as well as the "magical" old trees that made him think about how much he liked "fantasy" when he was a child. William also highlighted how the "soundscape in a forest" differs from the one in urban environments. This ambiance nurtured the sense of peace and developed the feeling of relief from the daily "clutter" of his life. In recalling this sense of peace, William began describing his physical sensations of internal calm, like the relaxation of his shoulders, neck, and cheeks, which brought him in a deeper state of presence.

3.4. Storyboard for filming

Based on the interview analysis, storyboards were created to plan the visual and auditory representation of the participants' narratives. Storyboarding involved mapping out the sequences of scenes, the details of specific locations and actions, as well as contextual elements to be captured. These were extrapolated from the interviews by identifying and connecting relevant references in the described experiences. This process was essential in transposing the interviewees' accounts into a visual format that could effectively communicate each participant's experiences. The storyboards served as blueprints for the filming process, helping a cinematographer to visualize the sequences of scenes to shoot, and ensuring that the essence of the participants' experiences was faithfully captured.

In the case of William, the storyboard was centered around three main moments of pleasure experienced. The first moment was the feeling of calm, in which William felt a release from tension by admiring the beauty of the cemetery's nature. This put him into a sensorially pleasant bodily state. The second moment was more introspective, capturing William's increased awareness of his body and thoughts, through which he experienced a strong sense of presence. The final moment aimed to capture William's feeling of liberation, which he experienced while looking at the articulated crowns of a specific tree-lined footpath in the cemetery, allowing his mind to wander freely.

3.5. Film shooting

By filming participants in their favorite places, the study sought to visually and audibly capture the essence of the pleasurable experiences previously described in the interviews and synthesized in the storyboards. The filming process aimed to document not only the physical aspects of the described places but also the subtle interplay of verbal and non-verbal expressions, as well as other bodily reactions, of the participants while they are in these places. Each scene was designed to record and convey the sensory richness and emotional depth inherent in each participant's experience – including both the physical and contextual elements of their favorite place. This process was facilitated not only by the use of a story board but also by on-site discussions between researchers, the cinematographer and the participant, to set a direction and ensure that the participant's experience was represented authentically.

After deciding the camera grip points to capture the best perspective of the lake and its surrounding context, the cinematographer recorded scenes of William arriving along the gravel path, where the sound of his wheelchair was also recorded. Other scenes focused on William's bodily reactions, using close-ups of his face, hands, and breath. While moving to the second location, the cinematographer followed William and recorded him as he moved with familiarity around the cemetery. Once reaching the tree-lined footpath, William was filmed guiding his wheelchair along the path. Scenes were captured of William observing the regular sequence of tree trunks, occasionally shifting his gaze to admire the intertwining branches.

3.6. Storyboard for film editing

After the filming was completed, the storyboards for each participant were produced in detail based on the filmed material. This process helped to realign the collected visual and auditory material with the participants' narratives in consideration of any contextual factors encountered during planning and filming processes. These factors include availability of specific locations, the weather conditions, or other contextual variations diverging from the initial plan. Furthermore, in these storyboards, specific quotations of participants were selected from their interviews and suggested for the film editor to couple with the sequences which visually presented the feelings initially described by the participants during their interviews.

The storyboard for William's segment was structured to emphasize the relationship between the natural environment and his perceived feelings of bodily and mental relaxation and presence. In the storyboard, the feeling of calm is associated with images and sounds of nature in Vestre Kirkegård, accompanied by key quotes from William describing the "beautiful" trees and the pulse in his hands as the sign of a reached state of relaxation. To convey his sense of mental presence and imaginative desire, the storyboard links images of the "troll trees" with William's reflections on the real and fantasy worlds.

3.7. Film editing

The film editing process was crucial in ensuring that the key themes identified in the participants' narratives were represented in the film. The film editor (who is also the cinematographer of the film) reviewed the recorded material, selecting the visual and

auditory elements relevant to the key themes and the selected quotations from the participants. This stage involved a collaboration between the film editor, Nossell & Co., and the researchers to align the visual storytelling with the intended messages and feelings described during the interviews.

For William's segment, the film begins with emphasizing the serene and contemplative atmosphere of Vestre Kirkegård, contrasting the natural landscape with the hectic urban context while William describes his bodily feelings (Fig 1). Scenes of the lake and surrounding nature are interwoven with close-ups of William's expressions, capturing his sense of peace and inner calm. The ambient sounds, including the distinct noise of William's wheelchair on the gravel path, are incorporated to enhance the sensory depth of his narrative. William's segment concludes with scenes of him *walking* along the tree-lined footpath, accompanied by his voice, as he reflects on how the trees evoke childhood memories of fantasy and adventure, and how being in this place is always a pleasurable experience for him.

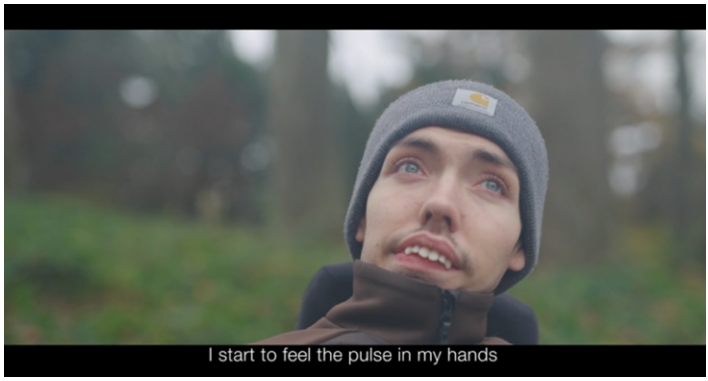


Figure 1. Screenshot of William's segment, *Places and Small Pleasures*

3.8. Screening

The film *Places and Small Pleasures* was screened at the Social Cinema in Charlottenborg, Copenhagen during the Copenhagen Documentary Film Festival, CPH:DOX. As part of the event's theme *Body Politics*, the film was screened in a unique projection cube where images were displayed on all four side walls. The event's program was designed to focus on the human body and celebrate bodily diversities, attracting not only the usual CPH:DOX festival audience but also directors, filmmakers, researchers, sociologists, architects, and any other persons or representatives interested in the theme of inclusion.

The film, which lasts only nine minutes, was shown on a loop for about an hour. This allowed the audience arriving at different times to watch all four stories. However, in the official film sequence, William's segment is placed first to welcome the audience with an immersion in nature and a sense of calmness. Especially during the screening of William's section, which features many images and sounds related to nature, the structure of the projection cube contributed to creating a sensorily-rich representation of his experience of pleasure.

4. Discussion

This reflective inquiry revealed the following points of discussion: the use of filmmaking to generate research-based knowledge, and the use of film as a medium to represent and disseminate knowledge.

4.1. The use of filmmaking to generate research-based knowledge

The making of Places and Small Pleasures contributed to understanding the participants' positive experiences by: a) stimulating the participants to recall these moments; b) collecting first-person descriptions of the places experienced and the related bodily perception and reactions; c) collecting both verbal and non-verbal expressions, providing richer and more comprehensive data on the sensory and emotional dimensions; d) developing narratives for representing the collected and analyzed data. However, emotions and bodily sensations, which are central to the experience of pleasure explored, can be abstract and challenging both for the participant to describe and for the researcher to fully comprehend and thus to represent.

The interview analysis involved a level of narrative construction and interpretation based on the extrapolated data. Even though the analysis was conducted by two researchers, decisions regarding what to include, emphasize, or omit could have been influenced by bias, potentially skewing the representation of participants' experiences. Furthermore, the storyboards used in the filming and the editing process could lead to the simplification or alteration of complex experiences to fit the film's structure and time limitations. However, both the narrative construction and the storyboard played an actively mediating role in synthesizing the different elements of the participants' spatial experiences, which, in turn, allowed for an authentic representation of these complex spatial experiences.

4.2. The use of film as a medium to represent and disseminate knowledge

One of the film's notable strengths lies in its ability to foster empathy and understanding toward the people and experiences depicted. The use of audio-visual stimuli, such as the ambient sounds of nature or the noise of William's wheelchair on the gravel path, created an immersive experience for viewers, allowing them to empathize more vividly with what would otherwise be a private experience. However, while film can convey visual and auditory information effectively, it is limited in representing other sensory experiences such as touch, smell, and proprioception, which are crucial for a comprehensive understanding of spatial experience.

The screening, part of the CPH:DOX festival, attracted a diverse audience, facilitating broader dissemination of the research related to *Places and Small Pleasures*. Additionally, film, as a commonly preferred medium over textual formats, offers a more engaging and accessible way to present research findings. Public screenings also provide opportunities to trigger audience reflection and foster further discussions on the positive experiences presented, thereby enhancing the impact of the research. It is important, however, to consider participants' willingness to share their intimate moments with a broader audience and to ensure their consent throughout the filmmaking process.

5. Conclusion

This reflective inquiry illustrates the effectiveness of filmmaking in capturing and conveying the positive spatial experiences of disabled individuals. By examining each phase of the filmmaking process – from interviews and transcript analysis to storyboarding, filming, and screening – the study identified both the contributions and limitations of this method in representing pleasurable experiences. By identifying and integrating detailed visual and auditory narratives throughout each step, the film provided deeper insights into the embodied experiences of pleasure in specific physical environments.

Visually and sensorially representing the participants' experiences helped to foster a more profound understanding of their perspectives and experiences. Finally, the use of film for dissemination means enhanced empathy and critical reflections among viewers. In this way, the film played a crucial role in taking the first step toward redefining the discourse around disability and architecture by highlighting positive experiences and fostering more positive connotations within disability studies.

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Eudaemonia-Focused Design as Intentional Praxis: An Inclusive Approach to Realising Flourishing

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Abstract. In this paper, the authors consider a novel eudaemonic approach to spatial design, proposed by Mikus et al., and examine how researchers and practitioners can co-design with participants to achieve a flourishing interpretation of Aristotle's concept of eudaemonia (i.e., being one's best self). The approach was tested in doctoral research conducted during 2021 at a time when many areas were under lockdown, necessitating a virtual approach. The research engaged nine older adults, aged 65-80 and living alone in Australia, and nine design professionals via creative methods including interviews, cultural probes, and co-design workshops. Combining these methods in concert with respectful engagement was found to produce not only the aimed-for principles to guide eudaemonic home design but also unintended yet beneficial consequences resulting from meaningful inclusive praxis. Here, the authors reflect on the importance of recognising eudaemonic design as a means of careful methodological praxis to precipitate promising participant outcomes, ranging from individual intrinsic motivation to collective mutual inspiration, to enhance the research experience, and to promote flourishing.

Keywords. Built Environment, Design Praxis, Universal Design, Design for All, Inclusive Environments, Older Adults, Flourishing, Eudaemonia, Salutogenesis

1. Introduction

Health and wellbeing-focused design has accelerated as a topic of interest since the COVID-19 pandemic began in 2020, whether considering such design in the context of combatting disease (pathogenesis) or supporting health and wellbeing (salutogenesis). The latter perspective has been expanded by human flourishing scholarship, which "[includes] mental and physical health, but also [encompasses] happiness and life satisfaction, meaning and purpose, character and virtue, and close social relationships" [1]. Consequently, a flourishing-focused design approach is likely to result in products, places, or processes that surpass health and wellbeing niceties and contribute to the five aforementioned determinants of human flourishing, for all humans.

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Developing a flourishing-based approach is vital when seeking to address the needs and aspirations of vulnerable demographics. One such example is the rapidly growing older adult population who desire to age in place but do not have the infrastructure, knowledge, and support required to do so [2]. As a collective and individually, they are often overlooked in the design process, thus diminishing any chance for meaningful engagement, voiced perspectives, or impactful design. To tackle this challenge, an inclusive design approach[2] built on respectful co-design conducted with older adults to understand their past and present connections with home and to conceptualise their desires for a flourishing home in the future was hypothesised as proving helpful in understanding how residential environments could be curated to impact this demographic's quality of life and ageing process-related needs that change over time.

This paper examines this idea, considering it in the context of doctoral research [4] conducted during the height of the pandemic in Australia—a time when doing in-person tactile work was especially difficult and required an outside-the-box tactic—to conceptualise spatial eudaemonia. The authors present findings and underscore eudaemonic design as an inclusive approach to flourishing, based on praxis intentionality.

2. Researching and Designing for Flourishing

Eudaemonic design, a proposed means of design centred on the neo-Aristotelian concept of eudaemonia, aims to facilitate flourishing health and wellbeing to support individuals to be(come) their best selves [5]. Such an approach moves beyond simplistic notions of hedonic happiness [6] to embrace a more holistic notion of eudaemonic wellbeing as living well [7,8] and to encompass elements of happiness, self-realisation and flourishing [9]. By definition, flourishing exploration is best if eudaemonic in intent and rooted in respectful design praxis.

2.1 Research through Co-design for Reflexive Consideration and Collaboration

Collaboratively exploring and creating a design approach based on human flourishing is well suited to designing *with* vulnerable people. The need to design better for older adults has become urgent due to population ageing [10], which is resulting in a larger percentage of older adults who can and should demand better quality designs that suit their needs and wants [11]. However, despite possessing unique requirements and the capacity for and interest in contributing, older people are often overlooked in the design process, experiencing diminishing opportunities for meaningful engagement. The outcomes of this can include loss of voice and agency; feelings of diminished motivation, self-worth, and mental health [12,13]; and a lowered likelihood that designs created without their involvement will support eudaemonic wellbeing. By meaningfully co-designing with and for this population and by reflecting on those efforts with a reflexive Research through Co-design approach [14], participant opinions can be captured and lived experience designed for, enabling the demographic to feel heard, experience agency, and connect with others while contributing to better design futures [15].

[2] Although universal design, design for all, and inclusive design are often considered to be interchangeable terms, the authors position the discussion in the frame of inclusive design, as "the more commonly used and accepted Inclusive Design term is less about designing for empathy, charity, or diversity and more about having a respectful, human-centred approach" [3]

Applying a co-design approach that seeks to understand older adults' past and present connections with home and to conceptualise their desires for a flourishing home in the future is essential to understanding how environments could be curated to positively impact quality of life and address evolving needs. One suggestion on how co-design could be transformed from "a branch of design for disability into an exciting gateway to product innovation and a more user-friendly future for all" comes from Coleman [16], the founder of inclusive design. Coleman [16] posits that "fresh approaches" involving "storytelling and scenario building techniques" have the potential to capture equitable accounts in research and health-focused design and to draw forth individual experiences innovatively while maintaining intention.

2.2 Creative Methods to Excite, Engage and Discover

Gerontological scholarship advocates for older adult involvement in design relating to their lives and spaces [13]. Doing so not only elevates their viewpoints as older adult design experts [17] but also provides insight into this demographic's wishes and needs [18] if accompanied by lived experience data [19]. Arts-based methods offer a compelling means of accessing experience [20], evoking emotion [21] and exploring complex topics [22]. However, because multimodal and multisensorial data can lose meaning in translation, carefully interwoven [23] creative methods enable intention to be incorporated into research design, innovation into methodology, and novelty into qualitative inquiry [24] to achieve a more accurate depiction of lived experience for designer (or co-designer) comprehension and impactful life enhancement by design.

Combining creative methods with the collaborative exploration that co-design affords ensures the nuanced sensory-based aspects of an experience, including the "physical, sensual, cognitive, emotional, kinetic, and aesthetic" [25], are co-identified and satisfied. The eudaemonic design for older adult home doctoral research presented as a case study in this paper explores how co-design involving creative methods can provide meaningful opportunities for self-exploration, reflection, and dialogue to create critical shared understandings about older adult lived experience and their objective and subjective relationship to home in the context of eudaemonic health and wellbeing, thereby uncovering it as a means toward better home design and more.

3. An Applied Example of Eudaemonic Design for Older Adults at Home

A doctoral research project, based in Australia and begun at the onset of the COVID-19 pandemic [4], aimed to explore how best to involve older adults to incorporate their needs and desires in creating flourishing environments. The challenge was to engage participants meaningfully in the process, despite the need for physical distancing. Nine older adults (and one advisor) were recruited from throughout Australia. Each was 65-80 years old, tech-familiar and wishing to age in place. This group was later joined by nine designers who were required to have a design qualification, five or more years of work experience, and interest in considering their own flourishing older adult future. The participants, depicted in Figure 1, were brought together to co-consider older adult perspectives based on lived experience garnered from virtually-conducted creative methods and to co-identify characteristics of a eudaemonic wellbeing (EWB) supportive home. Driven by a eudaemonic worldview, this research design and analysis was guided by self-determination theory [8,26]. It was important that the data captured include a

variety of communication modes and methods to improve the likelihood that the content would resonate with co-designers, contribute to a co-designed outcome to meet the needs of those being designed for, and uphold the intentionality of the design.



Figure 1: A visual depicting cartoon-like representations and pseudonyms of the nine older adult participants, older adult advisor, and nine designer participants of the study.

3.1 Research Design

The research design was architected to apply a mix of creative methods that gradually built in intensity and complexity via a scaffolding approach to "support and serve peoples' need for creative expression at the 'making' level" [27] and to effectively engage, connect, and inspire participants to precipitate more thoughtful design. Both visual and verbal data were captured, considered, and valued in this research, thereby embedding the research in qualitative exploration conducted from home, conveniently and flexibly, while considering the subject of home in-situ.

3.2 The Three Phased Approach

This doctoral study adopted a three-phased design approach (see Figure 2) that incorporated methods for intentional knowledge depth access and temporality consideration, examining past, present, and future perspectives of home.

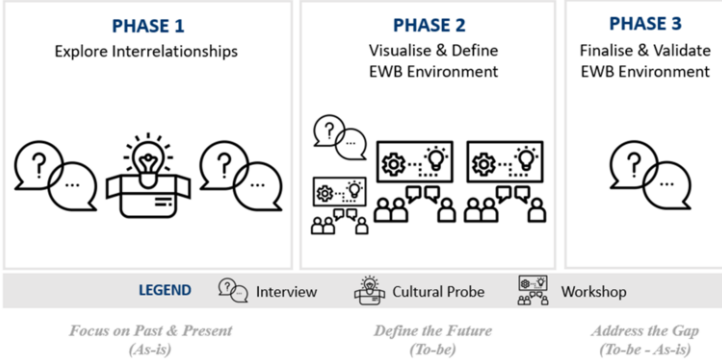


Figure 2: An overview of the doctoral research three-phased approach, focused on conceptualising a eudaemonic wellbeing (EWB) environment.

Phase One explored past interrelationships between older adults and their homes using intro interviews, cultural probes, and follow-up interviews. Phase Two focused on the future through two back-to-back co-design workshops that focused on visualising and defining a eudaemonic design environment as a large group. Phase Three applied what had been learned about a desired eudaemonic future and applied it to the present, bringing together both participant groups to formalise a final eudaemonic design model.

To transition this collaborative and creative methods-heavy work to the virtual realm, a combination of digital and analogue design decisions were made. Although the remote research proved challenging for front-end design planning, it resulted in wider range of Australian participants and was unaffected when unexpected lockdowns occurred. More importantly, this transition supported autonomy, enabling home participation without interruption, maintaining group connection and study involvement.

The research occurred on time and resulted in rich lived experience data that addressed objective health needs and subjective experiential desires. Group participation was maintained by both older adults and designers from beginning to end, with rapport developed between the primary researcher and participants, and among participants. By confronting what Sanders considered "the most difficult challenge" [28] head-on, namely co-designing with mutual respect, the research approach promoted trust and credibility, which were mirrored by participants beginning at recruitment and concluding after study end. Upholding self-determination theory's tenets of autonomy, competence, and relatedness was fundamental to the study aim and therefore pivotal in achieving inclusion—providing opportunities for all participants to communicate what and how they wished while maintaining personal comfort and dignity.

3.3 Study Results

A eudaemonic design set of principles and model were developed as a result of the doctoral research [in press]. However, what became noteworthy was the overall research experience of or impact of the design process on the participants, both older adult and designer, throughout the process as stories were shared and possibilities ideated. When considered on a group basis, older adult and designer cohort takeaways varied slightly. That said, as a collective, their excitement for the study's subject matter and creative methods usage grew as their feelings of gratitude, empowerment, and curiosity mutually flourished.

3.3.1 Older Adults' Experience: Appreciating Ageing-in-Place Potential

To document older adult interpreted emotions or moods throughout the process, a mood map based on Plutchik's emotion wheel model [29] was kept. Across the older adult cohort, the dominant emotions *before* completing the probe package balanced anticipation and apprehension, while emotions *during* ranged from interest to serenity. The most variety was seen in the emotions *after* completing the probe package, which spanned interest, serenity, joy, acceptance, and trust. Except for Dana who was unhappy in her living situation, experiencing annoyance and disgust with her living arrangements, there was a high level of consistency in positive emotional tenor and tone across the cohort. Interview feedback confirmed that engagement with the cultural probe had enhanced the connection between the occupants and their homes, and resulted in a favourable association for eight of nine participants.

Terry expressed the feelings of many in the group, finding the process "*genuinely interesting…made me think about where I live and how I live…I am a fairly visual person when it comes down to it…I found looking at things helped.*" While no formal interviews or polls were conducted after the research ended, verbal feedback at the end of the Phase 2 and 3 sessions was openly positive and, for those who took time to email after, even more complimentary and personal, noting how they had enjoyed the session (June), learned something (Terry), and look forward to seeing the research output (Stella). June

wrote a special note saying, "*I found the research we did very beneficial, especially as one person said, for those of us living alone*." Julie mentioned how "*rewarding*" and "*therapeutic*" the experience was. Terry, who had become motivated to make positive life changes after completing the Cultural Probe activity, was especially happy, stating how he had tidied up additional areas of his home and begun gardening—something he never had an interest in before but now relished. Harriet who had been preparing to sell her home, felt more confident putting her house on the market, knowing its worth and having clarity about what she wanted in a future, more supportive home.

3.3.2 Designers' Experience: Reigniting Passion for Design and Co-design

When asked about their feelings about participating in the study, many saw it as a "*fun way to virtually get out of the office and rediscover why I do design*" (Dante) while others considered the co-design approach to offer a perspective desperately needed in spatial design—a notion especially emphasised by the female participants (Kathy, Mandy, and Veronica). While no mood maps were applied formally for this group, a balance of interest and acceptance became the theme, and their attendance in the 150-minute sessions spoke to their research commitment. All designer participants maintained connection throughout the process, sincerely listening and co-designing, whether in small or large groups. By the end, many matured as designers, transitioning from simple solutionist tendencies to deep deliberation and unknown-embracing discomfort. It appeared that the collaborative co-consideration involving drawing, listening, and discussing in the context of past, present, and future selves had decreased essentialism and encouraged empathy as suggested by Loi and Lodato [30] and had promoted "mutual [designer and user] inspiration"—something Newell et al. [31] believed possible.

3.4 Reflecting on the Process

Early in the research process, both older adult and designer participants began identifying tendencies to improve themselves or their homes—citing those actions as direct results of the study. While some designers, like Veronica, were inspired to pursue postgraduate programs in health-based design, others like Aaron identified hobby or passion project zones at home. Of the groups, the older adults appeared to experience the greatest change, perhaps because of their longer period of project engagement (i.e., all three phases). Shared feedback ranged from early motivational comments of "*I'm not sure what my flourishing self is at the moment, but [this process] provides me with the opportunities to find that out*" underscoring one participant's desire to explore this subject further to another's more actioned "*Working through the assignment was good…it made me see things differently, move things…pick up some boxes of stuff and chuck it out.*"

Participant feedback also emphasised their experience of the process as "*enlightening—good for all people*", "*interesting*", and "*provocative*" noting how supported participants to "*look at things in a different way*", "*articulate likes and dislikes*", and "*illuminate the sorts of things I really value*." This enhanced experience and introspection, while noteworthy, were accompanied by deepened connections to home, gratitude ("*looking at things with an improved eye, I realised that I am living very well and very comfortably*"), and most surprisingly motivation. Some older adults, like Terry and Harriet, discussed doing chores they had procrastinated for years, while others, like Gigi, took note of home spaces they thought could benefit from biophilic influence, shared those stories with their families and received a gifted plant for improved ambiance, simultaneously strengthening their connection with their family members and their home. Months after

the study concluded, one participant reached out to the researcher to highlight how they were traveling and enjoying life post-retirement while also sharing an update on the plant that had been gifted as part of the Cultural Probes: "*I've kept the little plant alive. It's quite an achievement.*" These were unintended consequences of the research and may have been a result of the guiding self-determination theory, known for its relationship to intrinsic motivation [32]. Attribution could also be afforded to the underlying inclusive design-valued approach cultivated on careful planning, collaboration, and respect.

4. Conclusion

This work set out to examine how a study aimed for exploring eudaemonic design of older adult homes via creative methods and respectful co-design resulted in a contribution to knowledge relating less to spatial design guidance and more to design research praxis. Showcasing the experiences of a doctoral research project that sought to test utility of such as approach demonstrated that eudaemonic design can create the conditions for intentional, respectful design praxis through which older adults and other vulnerable people might be empowered and actively supported to create home environments that allow them to live well and be(come) their best selves.

Though the authors believe that health-based spatial design that can prompt flourishing in the future is still a worthy subject of exploration and one that the doctoral research exhibited might be addressable by implementing the derived model, the observed process or praxis that resulted has the potential to augment eudaemonic design approach efficacy and enhance likelihood of health and wellbeing facilitation. It is this perspective that has the potential to inform inclusive design scholarship and to induce designers (to involve older adults in design decisions), researchers (to learn about older adults' needs and desires using creative methods), and participants (to feel motivated to share and enact design desires) to collaborate and realise flourishing or eudaemonic wellbeing, by design.

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Universal Design as Co-Creation: Experiences and Visions from Urban Development Projects in Sweden

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Abstract. In Swedish policy, Universal design (UD) is implemented as a guiding principle. This paper explores the conditions for co-creation when authorities and civil society collaborate. The empirical basis comes from qualitative analysis of interviews, go-alongs, group discussions, and change-oriented workshops in three urban development projects concerning the re-design of public spaces and buildings in three Swedish cities. Collaboration between municipalities and local disability organisations was formal and established but different expectations of organisations' capacity and opportunities for influence, caused misunderstandings and mistrust. Interpretation of personal disability experience entailed ambiguity concerning roles and legitimacy. Hence, this paper considers UD a collaborative process, operating beyond regulatory compliance, transcending conventional categorisations, and inspiring and fostering commitment of a diverse population. It concludes that disability experience should be integrated into design processes in an intersectional way, as one of many experiences. That is in line with the CRPD, regarding persons with disabilities as equals and as contributors to cohesion and community building. Such a process requires co-creation where equals contribute to the common process but also reflection on the goals of community participation, and recognizing the needs of personal support and interaction. Since co-creation is a multifaceted, sometimes confusing, and idealistic concept, this paper suggests clarity, distinguished roles, and training of visualization abilities. Constraints of organisational asymmetry and challenges of engaging participants must be considered for developing a realistic view of co-creation. However, openness for learning between and beyond specific projects may develop equitable collaboration. For mutual and sustainable learning, the future usage phase must inform the design process. This positions UD in relation to co-creation as both a space of design possibilities and a human rights concept for an ethically reflected practice.

Keywords. Universal Design, Accessibility, Urban development, Participation, Co-creation

1. Introduction

Urban design reflects societal inequality and injustice, determining opportunities and identities on individual and social levels. Design that suits only some people simplifies and promotes their lives while others feel uncomfortable and excluded, avoiding these places. Besides emotional exclusion, there is physical exclusion, such as offering only stairs for movement.

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Universal Design (UD) originated in the 1980s when disability activists and architects in the USA launched a value-based design for all people and situations. They reacted against an accessibility discourse focused on regulations and group separation [1]. UD is also traced to the normalization movement in the Nordic countries [2]. With the adoption and definition of UD in the UN Convention on the Rights of Persons with Disabilities (CRPD) the concept has evolved into policy. Article 4 of the CRPD encourages ratifying states to apply UD in research and development. According to Article 9, standards and guidelines shall be developed for access to public environments, e.g. buildings, roads, transportation, information, facilities, services, and workplaces [3].

Article 19 of the CRPD claims the right to be independent and included in the community, i.e. participation without isolation or segregation. Services and facilities for the general population shall be available to persons with disabilities equally. Authorities (like municipalities) shall according to Article 4:3 of the CRPD involve persons with disabilities, through their representative organisations, in decisions concerning issues related to their lives. The General comment about Active involvement describes a "universal design process" regarding accessibility requirements and planning [4], indicating a collaborative process of co-creation.

The implementation of the CRPD in Sweden has made UD a guiding principle for societal development. According to decisions from the Swedish Parliament and Government, UD shall be applied as a guiding principle for the disability policy. UD is also found in policies for standardisation, procurement, and designed living environments [5]. However, despite decades of discussion in design and architecture, UD remains to be fully implemented in urban development. According to the Swedish Institute for Human Rights, UD is a key principle but "not used by actors at the heart of the implementation of disability policy" [6].

1.1. Co-creation as one aspect of Universal Design

UD has been coupled with the participation of people with disabilities in design processes [7]. The concepts of Participatory design and co-creation are akin. Here, participation and collaboration are considered neutral while co-creation denotes collaboration with certain qualities. According to Zamenopoulos and Alexiou, co-creation originally represented a loose kind of customer participation for framing and testing ideas and prototypes while they regard co-design as a closer way of collaborating with known persons [8]. Lindberg and Nahnfeldt regard co-creation as collaboration with shared and open processes based on common exploration of problems and solutions [9]. Sanders and Stappers see co-creation as participatory design related to co-design which is collective creativity for identifying, planning, and realising change [10]. They see the need to bridge gaps between professionals and stakeholders in the fuzzy front end of processes.

At the policy-level, UD is mentioned in the global development goals of Agenda 2030. People need "universal access" to green areas and public places according to goal 11:7, and "nobody shall be left behind" [11]. Co-creation is developed further in the European Commission's New European Bauhaus programme, where complex problems are addressed through co-creation and participation at all levels, ensuring accessibility and affordability. The future environment shall be beautiful for "eyes, minds, and souls" – "a quality of experience and style beyond functionality" [12].

This paper aims to explore and elaborate on one aspect of UD dealt with in my dissertation [13]: co-creation. Besides exploring how UD is understood, especially in relation to accessibility, and how urban development, guided by UD, is implemented, the

conditions for co-creation in the collaboration between municipalities and local disability organisations were investigated. Co-creation is used to analyse one type of collaboration and how it can be developed.

2. Method

Given the need for research about the local practice of UD, qualitative research methods were employed to explore user-oriented everyday perspectives on the realisation of UD in Swedish urban development. Eight persons who were professionally engaged with UD were interviewed for an hour in 2019. 14 participants from UD projects about education, working life, and housing were gathered for two digital group sessions of two hours in 2020. Three urban development projects in three municipalities were studied from 2021 to 2022. The cities were mid-sized in the Swedish context. The projects concerned the re-design of a square, a street, and a new library adjacent to a suburban square under re-design. The policy goal of all projects was urban revitalization. They were guided by UD through procurement requirements, a collaboration between a municipality and the university, or committed officials advocating UD.

Go-along and sitting interviews in city centres involved eight persons with different social backgrounds and approaches to UD. Participant observation was made at regular meetings of municipal disability councils, and internal municipal meetings regarding procurement requirements, purchasing, and planning. Two arranged workshops designed together with co-authors, officials, and local disability organisations in 2022, involved 22 municipal officials, members and employees at disability organisations, and some entrepreneurs. In one city two change-oriented workshops were organised by the municipality and the university in collaboration. The researcher had the role of lecturer, workshop leader, and counsellor.

To confirm and discuss some upcoming interpretations, three Member check interviews were conducted during the analysis phase in 2023. Besides 55 participants in qualitative interviews and group conversations or workshops, approximately 100 additional people were affected by participant observation and change-oriented workshops. Transcribed recordings of conversations and field notes from observations were analysed with qualitative content analysis [14], yielding themes that provide an overall picture of how UD is talked about, perceived and realised.

3. Result

The participants' understanding of UD was multifaceted, expanding the Swedish official line of a guiding principle. UD was an enriching but unclear concept, described as 1) a guiding ethical principle that provides direction, challenge, inspiration, and provocation in design processes, 2) a future-oriented vision and pursuit of an inclusive society for all beyond special solutions and target group thinking, and 3) a unifying of policy perspectives, an alternative to fragmentation and "silos" of separated administrations [5].

In the group sessions, the participants emphasized flexibility, predictability, and personalized support. Their experiences and ideals of UD covered adapting environments and services flexibly to individual needs and rejecting solutions based on categorisations of impairments. They used UD tactically as one of several, partly interchangeable, terms for the inclusion of human diversity. Influencing and initiating

critical discussions were more important than battles about words [15]. This means not getting stuck in fixed definitions but letting everyone present their understanding.

UD inspired new methods but faced resistance entrenched within municipal planning practices and bureaucratic inertia. Changing municipal practice and dislodging routines of rational negotiation between interests by means of a design concept with aspects of inspiration and provocation takes time and effort. The dominant focus on regulatory details was far from the overarching vision of UD. Simultaneously, UD was coupled with accessibility as a separate and target group-oriented interest among other negotiable interests. Accessibility focused on regulatory compliance of measurable rules for certain physical objects that affect limited groups, conveying risks of neglecting needs outside this frame. This association of UD with accessibility risks dragging UD into a rationalistic and merely result-oriented planning model.

The participants recognized the need for clear and sometimes measurable accessibility rules. UD was only connected to disability despite intersectional ambitions in municipal policies. Thus, a conceptualization of accessibility and UD as complementary was developed. In this model, accessibility is place-bound and rule-oriented, indicating planning and control of compliance for existing places in the present. To not lose sight of innovative creativity, UD stands for a future-oriented, and visionary space of opportunities for change. Accessibility compliance is not the goal but the baseline. UD goes beyond rules, denoting a higher ambition and inspiring innovations.

3.1. Collaborative tension and conditions for co-creation

The word co-creation (*samskapande*) was not used spontaneously. Participant observation and workshops revealed that consultation (*samråd*) and dialogue (*dialog*) were more common. Two of the three municipalities collaborated with umbrellas of local disability organisations. All had municipal disability councils which are municipally controlled advisory boards stemming from a democracy reform in the 1970s. The collaboration regarding urban development was formal and established. Collaboration with disability organisations occurred separately from dialogues e.g. with the elderly or youth. Groups were involved as different target groups in separate tracks. A municipal workshop with disability organisations treated edge heights and tactile lines, not how to create conditions for social inclusion and relevant activities. It was an issue not getting stuck with the white cane in restaurant furniture but not how to meet people to dine with.

Two ways of collaboration – or participation styles – were discerned and developed from the rungs Consultation and Partnership at Arnstein's ladder of participation [16]. The municipal officials were demanded to quickly move forward and wanted ready-made proposals confirmed. In the midst of experiencing junctions of policies and problems of handling them at the local level, e.g. in procurement processes, they consulted personal narratives. Disability experience informed their decision-making and clarified the reasons for accessibility rules. Though these stories offered information that facilitates processes, the officials experienced ambiguity toward personal stories due to issues with interpretations of the user perspectives and the legitimacy and representativity of participants. The same reservation was expressed by the employees at disability organisations who collaborated with officials as partners in the administration of and recruitment for workshops. As partners, they wanted feedback and opportunities to negotiate tangible outcomes but doubted the conditions for influencing the process.

Different expectations on organisations' capacity, and opportunities for influence, conveyed disappointment, resignation, and mistrust. Participants with impairments and

their allies were recognized as experts – an ideal of Partnership – but when asked about the exact height of curbs they referred to what they felt was good and to overarching principles, like the importance of complying with the CRPD. The ambition of a creative process of collaboration between equals was hindered by tensions due to misunderstanding. The disability organisations were used to an oppositional role, employed in e.g. monitoring the CRPD. No community of practice in Lave and Wenger's sense was found [17]. Rather than sharing engagement and learning together, information and opinions were shared, resembling communities of interest. However, based on trust gained from earlier collaboration, conditions for co-creation existed.

4. Discussion

In the practice of UD, one finds a diversity of interpretations and expressions with adaption to current resources and conditions. Knowledge as locally developed and situated – as Pragmatism portrays it – elicits a continuous, flexible, and iterative contextualization of UD based on local needs and circumstances. Along the way, possibilities of improvement that are anchored in local contexts will be discovered. This may develop and enrich the relevance of UD as a concept for integrating diverse user experiences, beyond minimum compliance with accessibility rules.

Moreover, UD challenges conventional intersectionality – where categories are crossed but still retained – with a unifying aspect. However, disability remained a driving force and testing tool for design in the studied cases. Disability experience was valuable knowledge but categorising humans into target groups conveyed limiting consequences. Thus, restricting accessibility to an interest for just people with impairments risks omitting invisible needs outside these categories and restricts the room for manoeuvre. Involving a target group like the current residents, might confirm and solidify exclusion.

Co-creation is understood in various ways. In Hong Kong, co-creation is regarded as a knowledge exchange between organisations and professions [18]. That reveals a group-oriented idea far from Swedish assessment of individual opinions as more genuine than those of organisational representatives [19]. According to Voorberg, Bekkers, and Tummers, co-creation is mostly used about processes [20]. Hence, it has a symbolic function as a value in itself, without certainty whether citizens' needs are met. However, self-esteem and empowerment may be sufficient outcomes. Sandin argues for knowledge about other actors as a valuable outcome of participatory processes [21].

While civil society often criticises and opposes authorities in policy processes, design processes aim to accessible and usable urban spaces, using co-creation. The studied processes had familiarity with citizen dialogues, ideally an arena for exchange and discussion but in reality, troublesome and conflictive [22]. That is far from the ideal of dialogues as open for continuous revision, through contributions based on other participants' contributions. According to Bohm, dialogues do not encompass persuasion or the giving and taking of negotiations. Some needs and rights are not negotiable [23].

Co-creation occurs in processes that are constrained by a lack of time, commitment, and resources. In Barcelona, researchers, a transportation operator, and disability advocacy associations used co-creation to ensure safe journeys during COVID-19, a circumstance entailing quick response, e.g. by means of digital occupancy information. Since this was visual it was not accessible for those who may need it most. Despite improvements, the transportation services "are far from universal" [24].

Chiscano and Darcy found that digital services should be complemented with trained staff since real-time assistance makes people feel safer – even during a pandemic. That resembles my participants' stress on personal support. Also Bigby found that not everyone likes or is able to perform activities on their own. Certainly, persons with intellectual disability may need backstage support in planning, engagement monitoring, or supported decision-making and frontstage support during activities [25].

Article 19 in the CRPD, is often overlooked in creating accessible environments. It couples with UD by aiming to create communities where persons with disabilities are recognized as regular members or participants of the neighbourhood, or community of interest. Bigby mentions art, yoga, walking, swimming, gardening or cooking as activities all can perform together [25]. Yet, it is not just about adapting mainstream activities, but also to open activities originally designed for disabled people to others. That creates belonging and opportunities for social interactions across social categorisations and along similar interests.

Both articles 9 and 19 of the CRPD mention social interaction [3]. Egard [26] notes that the CRPD depicts accessibility as actor-oriented with requirements of guides, readers and interpreters. Support comes, according to Bigby, from paid staff, volunteers, peers, friends, or strangers. Her concept "community participation" [25] elicits the official goal of the studied processes: social participation in urban life. However, despite the participants' hesitancy to visit public places – thus risking social exclusion – their experiences were reduced to one-dimensional explanations based on impairment.

Generalizations based on impairments ignore intersectional aspects as well as vital differences and needs. When Chiscano and Darcy conclude that separated seats "proved to be positive for all PwD" [24], they overlook how all of us sometimes use prams or bicycles or want to mingle with friends. However, Bigby considers the idea of "firm relationships with people without disabilities and using mainstream or non-segregated places that were open to everyone" as part of the normalization ideology of the 70s [25]. Such "dogmatic certainty" is contradicted by experiences of unwelcoming places – and people. She mentions poor design of digital devices as a reason why people with intellectual disabilities prefer familiarity before mainstream.

Moreover, it is unrealistic to view, like Chiscano and Darcy do, accessibility as ensured by merely including and listening to persons with disabilities in all stages of the planning process [24]. Such ambitions were in the Swedish cases hindered by the asymmetry between the municipal organisation and small associations. When one studied municipality offered the disability organisations to assist all building inspections these must decline due to lack of time and resources. Asymmetry does, however, not explain everything. The disability organisations had an advantage of being well-established with members with long-life experience and knowledge about municipal processes. The municipal organisations suffered from reorganisations and rapid change of staff. The disability organisations noted that such conditions caused a lack of long-term learning. Projects were treated as linear and separated, inhibiting development of knowledge and promoting UD ambitions just in singular symbolic places, like squares.

Conclusion

Though UD is understood in various ways, its conceptual core centres on radical inclusion for all people and situations. This paper has approached UD as a collaborative process and promoter of creative processes and an inspiration for innovation that goes

beyond group interests and regulatory compliance. It has related UD to co-creation as a vision of equal, creative, and innovative collaboration.

Since UD transcends conventional categorisations, the dialogue with and among users should involve a diverse participation. Promoting social cohesion and community participation involves citizens with disabilities in their surrounding urban environment not just for being present in public places or going there e.g. with a paid companion. More than visitors in the urban space they should be regarded as citizens, users of the city, or members of an urban community with desires to engage in activities and social interactions. This means that the experiences of disabled people should not be regarded as bound to specific impairments. Their user stories should not be categorised according to impairments. Disability experiences should be seen as experiences of use, context, and everyday life – recognised as a resource and knowledge among other experiences in urban development.

Such intersectional collaboration involves different groups and perspectives in cross-boundary processes, not in separate tracks. It benefits from different roles, desires, and ways of experiencing and handling the environment. In these processes, everyone contributes equally with suggestions. Contrary to negotiation, co-creation necessitates equal participation and responsibilities, not oppositional commenting on ready-made proposals or delivering experiences as information. Long-term and sustainable knowledge development includes integrating disability experiences into knowledge production of current and future processes. This kind of collaboration requires a common knowledge core without dissolving roles of leader, user, etc., in order to not lose essential specialist knowledge.

Responsibility for mutual learning and benefits must lie with both authorities, and civil society. Officials have a formal responsibility to plan according to measurable rules but also to interpret laws in relation to local circumstances. Their moral responsibility encompasses situational judgment concerning visions for opportunities and images of future places coordinated and mediated with users' experiences. Interpretations and practice of rules must be anchored and applied in local contexts and situations, otherwise the next step will not be taken. According to this view, each process should involve more people and situations than the former, expanding the realm of participation. These co-creative processes require clarity regarding roles, conditions, purposes, resources, and expected roles. Instructions should not be too detailed and goals tentative, so emerging interests can reveal new possibilities.

Disability organisations may promote social innovation by offering invaluable experiences. However, a future challenge is the recruitment of users from diminishing civil society organisations. Further, user participants must be prepared and develop basic knowledge and ability to envision future places, and skills in interpreting images and models. Creative design processes require the training of imagination, visualization, and communicating images and visions. Workshops may use surprise, disruptiveness, and provocation to promote a break from ingrained patterns. Reflection on personal support and interaction is needed, letting the usage inform the creation phase.

This paper encourages urban designers, planners, architects, civil society activists, and ordinary users, to re-imagine human rights at the local level, linking them to sustainable urban development and promotion of equality. As an ethical principle and vision, UD is an inspiring ideal and challenge, never reached or completely fulfilled, but nevertheless encompassing a forward-looking space of possibilities.

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Culturally Sensitive Design Tool Kit Developed Through Global Co-Design

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Abstract. Designers are increasingly navigating translocated contexts, presenting the need to develop strong skills in sensitively working with host communities, avoiding surface-level engagements, and considering the longevity, ownership, and impact of designs [1]. This paper reviews a series of co-design workshops organised by Imperial College London and Royal College of Art's MASc Global Innovation Design (GID) students, Abigail Hoover, and Tori Simpson. These workshops assembled a global community of design experts, students, and academics to share their experiences and approaches when designing for diverse communities to create culturally robust design interventions that are contextually innovative in the cultures and communities they exist in. The outcome of these workshops is a collection of co-designed guidelines to support design practitioners in ethical co-design practices, particularly when engaging with communities to which they do not belong. The goal of conducting these workshops was to discuss, and create strategies to avoid design tourism, a concept that straddles many names, including parachute design, design littering, and design imperialism. Meaning 'projects where the primary purpose of the project is the educational or personal development of the visitors, and the resulting ideas are left without any potential for realistic implementation.' [2] This paper outlines the tools, techniques, and knowledge generated through collaborative participation and reflection during the workshops that can be applied within culturally sensitive projects and ever-evolving design environments. It will review the created workshop structure and outcome analysis strategies cataloguing results against pre-existing design ethics structures. These outputs prompt the designer to reflect on their own practice, how they involve users, and what is left behind for communities involved. This paper serves as a valuable resource for designers seeking to navigate design with cultural sensitivity and adaptability, incorporate best practice, as well as new approaches to innovation, and facilitate actionable response to generate sustainable futures.

Keywords. Co-Design workshops, Global Design, Cultural Design, Design Strategies, Design Tourism, Parachute Design, Design Education, Design Tools, Participatory Design, Multi-disciplinary design

1. Introduction

More and more frequently, a design thinking approach is being used to imagine solutions for diverse, wicked problems, in equally diverse contexts and communities [3]. This means that increasingly, designers are being asked to work in cultures and communities to which they do not belong, as active agents in driving both local and global change [4]. With this opportunity to create impact comes a responsibility for designers to build models of sensitive cooperation and exchange that create mutual benefit; for the designer

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and the community with which they are working. Designers must focus on developing strong skills in sensitively working with host communities, avoiding surface-level engagements, and considering the longevity, ownership, and impact of designs [2].

In a modern world, design has moved to a practice that is concerned with connecting and integrating useful knowledge from both the arts and sciences, in a way that is relevant to present problems and use cases. Designers, therefore, are concerned with exploring integrations of this interdisciplinary knowledge that will combine theory and practice towards new productive purposes, or innovation [3]. This phenomenon has arisen due to the scale, ambiguity, and complexity of each of the issues our world faces today: social, economic, and environmental. Furthermore, in a globalised world, where many of the aforementioned issues are border agnostic, designers must work cross-culturally to explore solutions whilst including interdisciplinary perspectives involving all project stakeholders [5]. By nature this collaborative work requires members of the community in which the design outcome will be situated to adopt a 'design approach', cascading to mean that those trained in design, considered 'design experts' must use their knowledge and skills to design, promote, and support effective methodologies of engagement in co-design processes, that enable participants to realise and use their own design capabilities [6].

However, it must be acknowledged that this role presents complex and multifaceted challenges, which are often specific to individual projects: their scope, funding, available time, and the structures of communities whom project leads hope to design with. Co-design, as intended here, can be defined as "social conversations in which everybody is allowed to bring ideas and take action, even though these ideas and actions could, at times, generate problems and tensions" [6]. Co-design therefore is not a space in which all individuals will agree, have the same skills, or access to power. The designer's role therefore becomes to facilitate these processes and close the gap between those who have the power to shape solutions, and those who are direct users, or directly affected by the solution [7].

Therefore, for a co-design process to be effective, communities designers are working in must receive mutual benefit: through implemented projects, capacity building, and positive legacies left behind by designers, with consideration given to promoting the longevity of co-created designs. Various terms have been conceptualised for defining the different contexts in which there is an imbalance in how much a design project's benefit is received by the designers versus the community groups they are working with:

Parachute Design describes situations in which "western designers embark on short-term projects where they design a product for developing regions in their spare time, deploy in and then leave" [8].

Design Tourism describes a potential pitfall of international educational collaborations, consisting of design projects where design students are working with host communities in translocated contexts, "where the primary purpose of the project is the educational or personal development of the visitors, and the resulting ideas are left without any potential for realistic implementation" [2].

Design Imperialism describes projects where "rather than helping increase collaboration between communities, policy makers, and institutions to bring about social change and ideas through design, projects exploit the communities in which they pursue the work" [9].

What all these terms capture are the potential pitfalls of co-design practices. Whilst these potential pitfalls and risks of co-design can be project or context specific, these

terms and their surrounding research have allowed us to understand some of the most common critiques of co-design processes. These often centre around designers conducting their work "without immersion with users, without being in-situ, and without a sense of culture, language, norms, and deep understanding of the problems people face" [10].

The workshop methodology recounted in this paper stemmed from experiences had by the researchers, Tori Simpson and Abigail Hoover, whilst completing the MASc Global Innovation Design (GID) programme, a joint masters course held at Imperial College London (ICL) and The Royal College of Art (RCA). The programme consists of time in three locations. All students will spend time in London, and then each student will spend time in two of the other partner countries: Japan, USA, China, and Singapore. This programme represents a "trans-national innovation-led, educational experience" that aims to help students "develop skills in applying creative methods to complex problems framed in real-world constraints" [11]. The group of students participating in the programme are inherently multicultural and multidisciplinary, each of whom bring their own individual perspectives and interests, leading them to focus their work on a wide range of contexts, from healthcare, to sustainability, technology, material sciences, activism and beyond. Within an incredible broad programme, a core objective of the course "is to prepare students to enter new situations where they can attune their manner and behaviour to a culture that may be very different from their own", to ultimately equip them better for "conceiving and realising innovative services and products for others, where stakeholders may come from many other cultures, and also for high-level, meaningful engagements (including negotiation, influence, and decision making) with people from other nations and cultures" [11].

This study aimed to review these experiences from a global community of designers who engage in co-design practices through a series of collaborative workshops. Each event was focused on sharing, critiquing, and documenting desired strategies to implement. Considering which ones were feasible to implement, which were ignored and the corresponding reasoning. Because designers were asked to focus on their own lived experiences when coming together to create these guidelines, it is acknowledged that too many were produced for an individual to follow them all. Therefore, these produced results should be seen as a resource to open discussion, guide project ethos, and act as a starting point for evolving sensitive design practices. Their purpose is to provide designers with guidance on how to sensitively approach their work, it is equally to help designers feel heard, to allow them to acknowledge the challenges of their role and create a space to co-design our working practices. This paper recounts the workshop methodology, and principles produced at the initial workshop, based at ICL, including alumni, students and professors from the GID programme, as well as a follow up workshop, conducted with the World Design Organisation's (WDO) Young Designers Circle (YDC), another international group of designers working across cultures to promote the use of design to help meet the United Nations Sustainable Development Goals (UN SDGs) [12].

2. Methodology

Two workshop frameworks were generated to facilitate personal and collaborative reflection on co-design experiences. To accommodate a range of participation, formats consisted of both in-person and online structures. Furthermore, exercises were

deliberately selected to prioritise a safe space for communication, anonymity, vulnerability, and reflection towards design projects which may or may not have held best practices in co-design. The outcome is a set of guidelines intended to support design practitioners in ethical co-design practices, especially when collaborating with communities to which they do not belong.

2.1. Participant Selection

The workshops included students, academics, and design professionals, who have gained tangible experiences working on and leading design projects in translocated contexts. The in-person workshop focused on students, professors, and alumni of the GID programme. This involved critically considering successes and shortcomings of their design work conducted to date; iterative discussion on how designers might improve their working practices; how to better incorporate the communities the designers are working with and consider the longevity and legacy of their projects. The second workshop was conducted virtually and comprised members of the World Design Organization's (WDO) Young Designers Circle (YDC), an international group of young multimedia designers dedicated to engaging with local communities and creating sustainable actions aligned with the United Nations Sustainable Development Goals (UN SDGs).

2.2. Ethical Considerations

Prior to the workshop each participant received a comprehensive overview of the workshop, along with additional readings and documentation on design tourism and global design. Consent forms were presented to and signed by all participants, ensuring they understood their rights to withdraw from participation at any time and that all content shared did not jeopardise themselves or communities specifically mentioned. Finally concluding the workshop, all participants were allowed to document their work to continue use and referencing in future endeavours. All workshops and content werr produced in the English language.

2.3. Workshop Structure

The workshops were designed to enable participants to generate co-design strategies based on tangible experiences rather than solely on personal or theoretical beliefs. Consequently, the guidelines developed are granular and based on lived experiences, acknowledging that they may not be universally applicable. The in-person workshop lasted three hours, while the virtual workshop lasted one hour. Time was allocated to ensure sufficient context setting, development of trust, iteration, depth of conversation, and thorough documentation of content.

The workshop structure and inspiration were primarily derived from Jawad Anjim's Power Hierarchy in-person workshops, Sarah Stein Greenberg's "Creative Acts for Curious People: How to Think, Create, and Lead in Unconventional Ways,"[13] and Maya Goodwill's "A Social Designer's Field Guide to Power Literacy." [14] Each workshop underwent review by professors from Imperial College London and the Royal College of Art who specialise in cultural design. Additionally, the three-hour in-person workshop was piloted with three ICL graduate design engineering students to assess the structural flow, identify activities that hindered productive conversation, and ensure the

development of group and workshop trust. Appendix 1 displays the workshop structure, and the time allocated for each activity. After each workshop, an anonymous survey was provided to all participants to express their opinions on the event and suggestions for future iterations.

2.4. Analysis Methodology

In final reflection, participants were tasked with sorting developed insights and strategies into the categories of do's, don'ts, and acknowledgments, defined as:

Do's are instructions on processes designers should ensure they follow, and positive mindsets they might adopt.

Don'ts are common pitfalls designers should endeavour to avoid in their own practice.

Acknowledgements are items of conversation that arose that did not necessarily translate into concrete instructions or guidelines but were highlighted as aspects designers should be aware of and dedicate time to considering within their working practices.

Recognizing that not all processes are relevant to every project, no suggestions were eliminated during the workshop or in analysis. These insights were then organised into the relevant sections of IDEO's "Little Book of Design Research Ethics"[15]: respect, responsibility, honesty, inclusion, and evolution, as shown in Figures 1,2&3. This sorting provided a visual framework to examine similar or contradicting insights in relation to pre-existing values defined by ethicists and design researchers in both academic and professional fields. Furthermore, helps understand which of the 5 ethics pillars were most addressed and which were more ignored and why.



Figure 1. Description of IDEO's Little Book of Design Research Ethics Research Practice Sections.

3. Findings

Presented in Table 1 are the amalgamation findings based on workshop participants co-built and synthesised suggestions. These findings are categorised into 'do's' 'don'ts' and 'acknowledgements' and as aforementioned, are mapped to the relevant sections of IDEO's "Little Book of Design Research Ethics": respect, responsibility, honesty, inclusion, and evolution. Within the table highlighted in bold are the guidelines that arose multiple times, either from separate groups in the same workshop, or in both workshops.



Figure 2. Sorting of collected workshop insights

Table 1. Workshop Findings

	IDEO categories				
Principles and Guidelines	*Respect*	*Responsibility*	*Honesty*	*Inclusion*	*Evolution*
Do's					
Think about scaling and ownership	x				
Try to give something back	x				
Prepare	x				
Recognize participants may want change but don't carry agency		x			
Feel excited			x		
Record the process					
Use inclusive & empowering methodologies				x	
Bring external opinions to challenge existing ideas				x	
Include as many people as possible, from all stakeholder groups				x	
Include philosophy of other disciplines/ fields. Collaborate if possible				x	
Record the process					x
Research before a test	x	x			
Allow for spaces where people can speak freely and share experiences	x	x			
Prepare- start introductions before in the field	x	x	x		
Listen deeply and openly	x	x	x		
Ask what you can provide with your skillset		x	x		
Make decisions		x	x		
Give limitations as well – in a non-arrogant way		x	x		
Be open to changing everything					
Feel inclusive			x	x	
Make friends - take time engage socially as humans			x	x	
Be open to unplanned meetings / talks / serendipities					
Respect the culture whilst respecting yourself	x		x	x	
Take time to learn the language and recognise language barriers	x		x	x	
Be kind & sincere	x		x	x	
Truly understand and recognize the nuance of communication	x		x	x	
Seek, understand, and offer to include individuals who self-exclude		x	x	x	
Set expectations early (deadlines, deliverables)	x		x		
Give collaborators the option of whatever attribution they wish		x		x	
Incorporate feedback		x		x	

Use your privilege to empower (legacy as well)		x		x	
Create a local team to become champions		x		x	
Find out what matters to the community members	x			x	
Respect the culture	x			x	
Take multi-disciplinary approaches (2D&3D) to engage hands and eyes	x			x	
Recognize its a larger challenge to access marginalised communities	x			x	
Leave for synthesis	x				x
See it through to the end or create legacy	x				x
Approach with an adaptive mindset	x				x
Examine existing innovations in the space	x			x	x
Communicate effectively & often using a system that works for all	x			x	x
Ensure there is tangible benefits for all participants		x			x
Build trust, which can take years		x	x		x
Bring in diverse voices		x	x		x
Define the measure of success			x	x	x

Don'ts

Be afraid to reach out to people				x	
Think that you can get it all done / make it all perfect					x
Take advantage of people's time	x	x			
Be overly precious about your ideas	x	x			
Be against hearing fresh angles		x	x		
Be arrogant		x	x		
Be afraid to ask questions if you don't know/understand something			x		x
Be intimidated	x		x		x
Avoid being in the field	x			x	
Focus on what you are interested / care about	x			x	
Be resistive to adapting	x			x	x
Presume your way is best	x	x		x	x
Focus on too small of a target audience		x		x	x
Differentiate within the team		x		x	x
Assume communities will be welcoming		x		x	x
Design without long term engagement		x		x	
Forget who is running the show	x	x		x	
Be inflexible, with inefficient communication			x	x	x

Acknowledgements

Building skills to understand different perspectives takes a long time					x
You can't change how you look and will be perceived	x		x		
What we choose to say & not to say are equally important		x	x		
You will form relationships			x	x	
You may feel anxiety			x		x
You won't always get it right, but you can have the right intentions			x		x
Attitude & approach to topics can be different depending on the group	x				x
What they know and who they are	x			x	x
Communication as an asset for all parties	x		x	x	x
It will always be a new experience with new perspectives	x	x		x	
Building trust takes a long time		x	x		x
Vulnerable communities will be hard to access	x	x		x	
Stereotypes	x	x		x	
You may not have thought of everything, even if you think you have	x	x		x	
That you don't know everything			x	x	x
Who you are and respect difference			x	x	

4. Discussion

The two workshops produced a plethora of guidelines, making it impractical for individuals to follow all of them, especially when some guidelines contradict each other. Instead, these guidelines should be seen as a dynamic library of principles, some more relevant to specific projects than others. The goal is to initiate discussions and create a living, evolving set of principles that are agile and adapt to the ongoing evolution of design practices and ethics.

It is also acknowledged these insights were generated from the perspectives of designers and design researchers alone. Action should also be taken to engage directly with the communities involved, to understand which actions foster successful or limiting experiences before, during and after project closure. Workshop participants' nationalities primarily arise from the Global North and/or now practice/reside in Global North countries. All participants also hold formal academic training in design thinking or relevant design fields. Involved nationalities included: American, British, Indian, Australian, French, Italian, Chinese, South African, Columbian.

Insights dramatically range in specificity, comprehensibility, and universality. Recognizing that not all processes are relevant to every project, no suggestions were eliminated during the workshop or in analysis. Although assumption of repeated insights could indicate a higher level of importance, this can be further refined through specific exercises that focus on ranking general impact, urgency, and effort needed. Considerations of project structuring could also be considered to navigate often limiting factors such as funding, time, community access, ethics, and safety of both design researchers and engaged community. As research and analysis of findings continue, specific consideration will be placed on the usability of insights in real-world contexts. This can include but not limited to success metrics, and generating open-source, and accessibility conscious presentation of results to be used across all design mediums and project applications.

Through facilitating honest discussions of effective methodologies across translocated designers and projects, realistic understandings of design practice's effectiveness to hear and collaborate with were mapped alongside contribute to a growing understanding of what responsibilities a design researcher holds. Co-design processes are inherently complex, contradictory, and sometimes antagonistic. Different stakeholders, including design experts, participate in various ways, bringing their specific skills and cultural backgrounds. These social conversations allow everyone to contribute ideas and take action, even though it can sometimes generate problems and tensions. It is crucial to recognize that a co-design process is not a space where everyone agrees and speaks the same language; it is a dynamic environment where diverse perspectives and expertise come together to create innovative solutions.

5. Conclusion

This paper underscores the crucial role of design thinking in tackling diverse and complex problems across different cultural contexts. Designers increasingly working in unfamiliar communities must foster sensitive cooperation and mutual benefit. The study highlights potential pitfalls in co-design practices, such as parachute design, design tourism, and design imperialism, emphasising the need for immersion and cultural understanding.

The workshops aimed to generate co-design strategies based on tangible experiences, using recognized design methodology and safe communication/collaboration. The resulting principles support designers in approaching their work sensitively, providing a platform for reflection and mutual understanding.

By developing a workshop methodology that encourages ethical consideration, this study contributes to practical, context-specific guidelines. These guidelines, while not universally applicable, serve as a valuable resource for designers, guiding project ethos and fostering the evolution of sensitive design practices. Future work will refine these insights into an open-source resource, enhancing the ethical framework within which designers operate.

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Appendix

Appendix 1. Workshop Structure

Workshop Structure	
In-Person, 3hr duration	
Allocated Time	***Exercise duration***
5 mins	Introduction and Positionality Form [14]: An overview of what this workshop is and its desired output
5 mins	Vulnerability Entries: leaders each read a journal or a piece of writing from their experiences that will set a safe environment for the workshop
10 mins	Design Tourism Talk: leader led discussion overviewing what design tourism is
30 mins	Warmups: The story of your name [13], Listener/Talker exercise [13]
5 mins	Card Telephone: On a flash card write on a key experience you have had when designing for another community. It can be positive, negative, or neutral.
10 mins	Break
35 mins	Expert Introductions & Card Telephone con't: 5 experts who also participated in the workshop present on previous work and their experiences in Design Tourism. As this happened each participant received a random card from the previous exercise to provide a critique or comment.
10 mins	Break
20 mins	Experience Reflection: Participants were randomly divided into groups of 5. Each group provided a large sheet of paper to collaboratively reflect on design experiences within global contexts.
10 mins	Break
20 mins	Do's, Don'ts, Acknowledgements: each group then sorted generated rules, guidelines, and strategies into the exercise titles definitions
20 mins	Cool down and class work reflective piece: Each participant writes down something they learnt from another group member in this project, tossing them in the air each person reads another piece of paper out loud. A workshop survey was then sent out to collect workshop feedback.
Virtual Workshop, 1 hr duration	
5 mins	Introduction of workshop and participant vulnerability and rights reminder
5 mins	Design Tourism Overview and discussion
5 mins	Warm up: Where are you from, what do you do, and the Story of your name [13]
15 mins	Access to Power worksheet [14]: Steps 1-4
15 mins	Have an open conversation of learnings and have each individual generate their access power rating (step 5).
20 mins	Do's, Don'ts, Acknowledgements: *see in-person workshop*
10 mins	Cool down and class work reflective piece: *see in-person workshop*

Universal Design for Health, Wellbeing and Equity

Universal Design 2024: Shaping a Sustainable, Equitable and Resilient Future for All
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Inclusive Architecture, from Theory to Practice: Illustrated Through a Case Study of the Center for Cancer and Health in Copenhagen

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[c] SINTEF Digital

1. Introduction

Over the past decade, universal design has become a well-known term for most architects and designers in Scandinavia. The concept has been implemented politically, legally, and within construction through crucial documents and writings. Despite the apparent interest in the term, there remains a need to develop and discuss the concepts of universal design from an architectural perspective. How can we improve and develop solutions that account for different people's needs? How can we nuance, understand various user needs and perspectives, and then translate this understanding into concrete solutions that enhance architectural quality for all users of buildings? By examining the use of the term universal design, one can see that it has taken on slightly different meanings across various disciplines. Still, in all fields, it encompasses an approach to the design process that places the people who use and experience the solutions at the center. Understanding different people's experiences and uses of buildings is a strategy we believe leads to higher-quality solutions. However, a crucial prerequisite is to accept and understand that people can use and experience buildings and surroundings differently. Insight and knowledge about these conditions can form a framework for creative thinking and the development of new and better physical environments. The book "Inclusive Architecture" [8] focuses on a methodological approach that starts with people's experiences and use of buildings.

2. Theoretical Framework

This paper's first part discusses theory and knowledge on analyzing architectural qualities from different user perspectives. The second part is a case study in which we illustrate the theories and methods described in the first part.

How can we translate user insights into design and better solutions? Simple control questions to help with programming and evaluation are **"What should the buildings**

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support?" and **"For whom?"**. Historically and traditionally, the field of architecture is one where examples form a central foundation for learning, professional discussion, and inspiration. Therefore, we have tried to develop a professional understanding and framework that can be used to nuance and explain how we can understand and analyze the quality of architectural solutions.

We claim that qualities in architecture can be seen as a relationship between the physical environment and the people who use and experience it. Kevin Lynch emphasizes this in his book [5]. He points out that architectural quality cannot be described as a property of the building alone, but that quality arises precisely in this interaction. "Concepts such as harmony, beauty, variety, and order have been thought of as attributes of the physical environment itself. Designers have unconsciously relied on their own implicit values and perceptions, projecting them to the physical world as if they were inherent qualities. Not so – one begins with the images and priorities of the users of a place and must look at place and person together." [5]. We have chosen to base our approach on the works of Nordic architectural researchers Inge Mette Kirkeby and Jan Paulsson. Inge Mette Kirkeby's thesis is a comprehensive work in this field [3]. She highlights the relationship between pedagogy and architecture. She argues for an understanding where this relationship consists not only of the interplay of the two parties (people and environment) but also of the interplay itself. Kirkeby draws on theorists such as Foucault, Latour, and Bernstein and elaborates on this in her thesis [3]. Paulsson argues that this methodological approach is important both to provide a better basis for evaluation and lay the groundwork for better dialogue in programming and design processes. Two of the most important concepts used in ANT [4] are "inscription" and "translation". An inscription refers to how a technical object influences a usage pattern, that is, how the object facilitates a specific use. This refers to so-called inscriptions. Examples of architecture with both strong and weak inscriptions can be found. An object with a strong inscription will force the user to follow a given usage pattern. A weak inscription can open up the object being used in several other ways than the designer planned. Between these two extremes lies what we call "nudging." We make daily choices based on impulse, influenced by our situation, and these are not always rational and logical choices. "Nudging" is about influencing choices. [11]

The term "translation" explains how an intention is transferred from one mode of representation to another. The goal of a translation is thus to make knowledge, experiences, and reflections usable in another medium. This should then be "translated" into concrete physical solutions through the design of buildings, interiors, and products. One must map both the "intention with the solution," "the actual physical solution," and "activity/use" to analyze the relationship between these aspects. The translation from intention—what the building is supposed to do—to a chosen design must be seen as a translation process communicated through many documents and often several actors.

The significance of physical surroundings at different scales: When drawing experiences from buildings in use, it is often easy to become irritated over or focus on small and impractical details like cabinet placement or room furnishing. However, it is equally important to consider the relationship between spaces, room shapes, sizes, and locations. These are solutions that are even harder to change afterward. In architecture, the significance of the physical surroundings is often discussed from different scales: Furniture and equipment (loose); Details, materials, and colors (fixed); Size and shape of rooms (including daylight and lighting); Concept and organization of spaces (interior and exterior); Location in relation to area qualities

2.1. Theory of Understanding the Interaction between Buildings and Users

We argue that to establish a foundation for interdisciplinary discussion and collaboration more efficiently, it is essential to have a shared conceptual framework and vocabulary from which solutions can be discussed. This will also provide a better basis for reflecting on and systematizing experiences from already-built solutions, transforming this into knowledge that can be used to build better buildings. It is important to clarify what the various quality concepts mean—not to emphasize or prioritize one perspective over another, but to highlight different significant aspects and organize experiences thematically. Additionally, it should be mentioned that people quickly become accustomed to their surroundings, making it difficult to imagine that things could perhaps be entirely different. In the book "Inclusive Architecture" [8], we define five attribute areas that describe the use and experience of physical environments. Developing a nuanced conceptual framework creates a common frame for discussion.

The practical/functional attribute area deals with how a building is practically made accessible and usable for different uses. By asking the question "usable for what?" and "for whom?" one can discuss qualities and suitability for various purposes. By concretely describing different activities, the extent to which the rooms indoors/outdoors are suitable for specific activities and purposes can be assessed. Examining these aspects makes it possible to analyze to what extent the building is well laid out or poorly suited for these activities.

The communicative characteristics deals with how the physical environment signals and informs about use and meaning. This involves how we perceive the surroundings as symbols and language. It signals what activities the area is intended for or how it invites or inspires use. How the building communicates regarding orientation within the building is also a significant part of this.

The social characteristics concern how the physical framework enables meeting and feeling a sense of belonging with other people and how the environment can also support the experience of integrity or separation from others. The area can, for example, be defined as semi-private common areas for those living in the group. The building's location also affects who you can meet or who and how you are invited in.

The relational characteristics focus on how people can, in a deeper sense, perceive and establish relationships with places and buildings. This can involve relationships with objects, rooms, areas, or landscapes. Such relationships often emerge over time with repeated use. Special events can also make people establish a relationship with a specific place. Research on relationships between people and places requires understanding models and research methods from different fields of knowledge. Understanding and interpreting the sense of place builds on theories from phenomenology and existentialism.

The sensory characteristics address how people with different senses experience the atmosphere in a building. This includes smell, sound, and visual impressions. This attribute area concerns how spaces and places are experienced. Aspects of how architecture affects the emotional part of the brain. In her book Birgit Cold [1], she refers to brain research that explains how different parts of the brain work, with the limbic system being the place for feelings and the non-rational. Various studies show that aesthetic qualities can also affect health." The article "Psychiatric Ward Design Can Reduce Aggressive Behavior" [10] is based on data from a survey at two psychiatric hospitals in Sweden. It describes a conceptual approach to designing physical environments for people with mental illnesses that can reduce stress and aggression.

These five attributes provide a tool to formulate and communicate essential aspects of the physical environment. Through a programming process that outlines common intentions and employs these different concepts, the intentions and discussions of a building project can become more precise and better. Case Study: Centre for Cancer and Health, Copenhagen

2.2. Brief Description of The Building and Services

The Municipality of Copenhagen offers a rehabilitation program to residents diagnosed with cancer and those in or post-treatment. This center is designed to support this mission based on the understanding that citizens should experience a coherent effort throughout their "cancer journey." This collaboration is between the municipality, the Cancer Society, and Copenhagen hospitals. Supporting residents in managing and living with their illness is crucial. For example, residents are offered exercise based on their functional levels and needs. The building provided various supportive services and was completed in 2011. Since then, it has been expanded with new buildings and developed outdoor areas. The building has received several awards. Architects are NORD Architects Copenhagen. (2009)

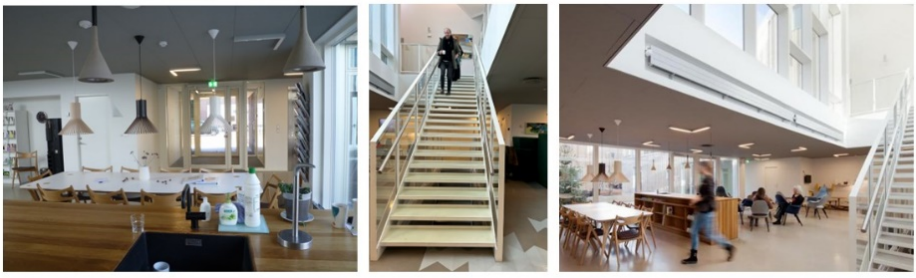


Figure 1. *Fotos: Karin Høyland*

2.3. What the environment should support

Through both the construction program and interviews with the founder of the center, many intentions, and thoughts about what the building should achieve were revealed. The founder, a doctor with years of experience with this patient group, emphasized how the building should be an essential tool for providing services. It should be easy and inviting to enter, inspire physical excercise, and be crucial for the psychosocial aspect of peer support. The ability for people to talk and share their experiences was important. The program further explains that a cancer diagnosis can cause anxiety and fear of the disease. Cancer patients may experience psychological vulnerability, loss of control over their lives, social isolation, stigma, and threats to their identity. These problems can lead to a reduced quality of life years after the diagnosis. Therefore, residents diagnosed with cancer need psychosocial support, advice, knowledge, care, and tools to support and promote their individual choices. Coping with such a diagnosis is tough, and many need time to process and accept it. Thus, the center aimed to signal a non-institutional, comfortable environment with rooms where light, color, art, and acoustics contribute to a friendly, welcoming, and relaxed atmosphere. Center users should feel they have a

space to relax and meet other cancer patients going through similar experiences. The program also described the goal of creating an environment that promotes social interaction, physical activity, and personal change, using the term "enriching environment," which is crucial for health promotion. This is described as surroundings directly and indirectly influencing people's conditions and experiences. The room program details various functions such as gym rooms, cafés, etc.

2.4. Who should the environment support?

The program indicates that this center targets a defined patient group. Cancer patients vary in age, gender, and social background. They share the common experience of undergoing or having undergone a treatment pathway. They are at different stages but have a shared experience. The program emphasizes accommodating "whole" people, not just their diagnosis. It reflects dilemmas such as joy and sorrow, laughter and silence, activity and relaxation, men and women, old and young, (cancer affects all). It can be complex for many to deal with a cancer diagnosis. Therefore, it is crucial that the service is inviting and places emphasis on encouraging different people to feel welcome.

Practical/Functional Characteristics of this building:
Information: Meeting professionals and experienced peers; **Exercise:** Physical activities suited to individual needs. **Café and waiting areas:** Opportunities to meet others in similar situations. **Additional offers:** Cooking classes, group discussions, etc.

When we look at the experiences with the building, it becomes clear how various services are interconnected and affect one another. Nearly all users emphasize that the exercise program brings them there, and other services come as a bonus: "I find that it is a building with many, many things you can do. My primary reason for coming here was to exercise*." My main focus was training, but then everything else followed. They might recognize that you need something else, and I find joy in participating in activities I still did not plan to do." -" The most crucial thing might be meeting others in the same situation; the large entrance area facilitates this." Some* explain that they often go there in connection with hospital treatment, making it convenient that the center is located nearby, which makes it easy to use. Many come by public transport or bicycle.

Information Access/Meeting Professionals and Experienced Peers: This center is primarily an information center but consists of a combination of many co-located services. This is positively received by the users. They do not always know who provides which service but are aware of the various organizations involved, including volunteers. They appreciate the professionals' expertise and the ability to ask for a conversation without a prior appointment. Personal contact is regarded as most important. The brochure wall is considered "overwhelming" by many, and some users welcome the chance to read a regular newspaper instead of flipping through informational brochures: - *"I would say that the information wall downstairs with all those brochures was overwhelming for me when I first came in. It was just like, wow, I've also received a huge number of brochures… probably a whole rainforest's worth. So, I couldn't navigate through it all, though I do appreciate that there are many offerings... but the pamphlets about cancer or 'for you who have lost someone' felt overwhelming".*

What becomes clear from the interviews is how effectively peers meet and share both experiences and information. Personal insights can be more impactful than professional advice: *"There is also the issue of waiting time; for example, I get answers*

*to something at two o'clock, and everyone here knows how time drags until then. It's slow. -"*I don't *need to 'explain' the smell of that ointment injected. Others have mentioned that talking to others can inspire participation in activities."*

Different people play different roles, but it is not essential to distinguish between professionals and volunteers: *"I find it very, very nice that volunteers are here. It means a lot; – they are always welcoming – you just feel welcome." -"I don't care if they are paid staff or volunteers because they have their role in this house and are very good at it." –" It's wonderful. They are possibly chosen because they are excellent in what they do"* Many talk about how professionals and volunteers are good at understanding who they are talking to, as people are very different.

Exercise: Most emphasize that the primary reason for coming is for exercising, but all the other functions add value once they are there. At the users' request, gym rooms were moved to the second floor to avoid being overlooked from the street, as they found this uncomfortable. The second-floor solution was preferred by the users, and seems like a good solution. Both the internal and external stairs are actively used for exercise. After construction, the facility was expanded with an outdoor exercise area and another nearby existing building (Elefant House) used for strength exercise. The outdoor areas are also accessible to the public and part of a park. Many users highlight the importance of exercising in such a sheltered place so they can eventually continue elsewhere later. *"It feels strange to get used to training like this – it was helpful that others had gone through the same thing. Having someone to say, take it easy because my body can't do the same as before." - "I have had periods when my energy levels were very low. So, I told myself, you might not be able to train. But you can go there, sit and be with others afterward. When you get here, maybe you will join something. So, it feels like a bit of a victory. Maybe I couldn't train at a high level, but I was here, and you get the benefit of everything others give simultaneously because it lifts you, right? And the trainer also follows closely, so even though there are many of us in the group, the trainers see me too." -"I think training is good for me because it's outside. I feel completely normal when we train there, and it's great." "I expect to stop by Christmas. By then, I will be in the routine, and it will be easier to keep training on my own."*

Café and waiting room / The opportunity to Meet Others in the Same Situation: The most important room in the facility is probably the large café area at the entrance. As you walk in, you are greeted by a long table with chairs around it, a kitchen island with mugs, and a table with a puzzle. Often, a volunteer is at the kitchen island, welcoming you with coffee. The rest of the room offers various seating options at small tables or in more secluded seating arrangements. Central to the room is a coffee machine where you can purchase and take coffee. Newspapers and magazines are available on the tables. The stairs rise directly from this entrance area. The room overlooks nature in the park and an inner "cloister garden," accessible from the large central room. *–"What is important? Well, coffee. I think it's a very concrete thing; we go in and grab a cup of coffee or something. And once you've sat down, people start talking."*

Many users find social interactions crucial: *"I was on the verge of falling into a black hole because I just lay on the couch at home and the same thing happened day after day, so getting here was about not falling completely in. You really appreciate all the people you meet because they help pull you up. Just being here and doing things together is the most important." "I had it the same way; I probably would have gotten depressed if I hadn't come here because everything felt very dark otherwise."*

2.4.1. The Communicative Characteristics

From the program, it was clear the building was not supposed to look like a hospital. It was important for the users that the service communicated something different; the rooms should convey a homey, informal meeting place. Externally, the building should be easy to find but not necessarily announce itself as a Cancer Center." The entrance should be welcoming, discreet, and kind. This was addressed by designing rooms communicating various messages, allowing for different choices and diversity. The building should be easy to navigate and find your way around. In many ways, the center has succeeded with these intentions. Many users point out that it doesn't resemble a hospital. Furniture and interiors create a different and more informal atmosphere. However, some younger users feel the amount of white gives a slight hospital hint, and they would prefer more colors. *"I feel like I've had enough of hospitals, personally. I am very grateful, but I've had enough! "It's important that this isn't like a hospital." "I don't find it hospital-like, and the courtyard and the park are lovely.*

The building is organized around an inner courtyard. Some find navigation in this a bit challenging: *"If you need to go to the second floor to speak with your contact person, you must... just follow along because you don't know which direction to take when you exit the room where you've been talking. Should you go left, or right?" - "There could be a sign with a number, just to follow; it feels a bit like being back in kindergarten.".* Meanwhile, others feel differently about this: *"I feel it gives a sense of freedom, because in any room, you always have two ways out. And you can always wander around.*

2.4.2. Social Characteristics

The way the building facilitates both formal and informal meetings is considered one of its greatest successes. The center deeply understands how different people need to feel safe to open up. The kitchen table and the hosts welcome you in a warm and inviting atmosphere. The hosts and the building provide space for gradual social engagement. Many users mention how easy it is to sit at a table with newspapers without feeling obliged to interact. Various seating options—single tables with newspapers, a large communal table at the entrance, and more private seating areas with views of the park and nature— help accommodate different preferences. Simple physical elements like puzzles and a coffee machine offer valid reasons to be present without having to talk, yet also create arenas for interaction. *" The coffee machine really becomes a meeting point."*

2.4.3. Relational Characteristics

Interviews reveal that visiting the center was a significant step for many. A barrier exists when visiting a new, unknown place, and it comes as a part of accepting the diagnosis. Getting to know and feel comfortable and safe in the center was a process for many. This explains how the visitor gradually builds a relation to the place. – "*I am here for the first time, and it's nice to just be here a bit, sit and read a newspaper, and have a coffee. Not having to read brochures about cancer…" - "Yes, the first time [...] maybe it's just enough to be there for a while and then leave again, so you take that first step. But you don't have to talk to everyone about everything immediately; just being a little bit there,*

daring to take the first step, is important." -" In the beginning, I mostly sat alone, even though others were around [...] That's how it felt the first few times, but I've improved." - "I'm just here to see how it is today because I think it might be important for me as I start radiation treatment and progress through the process."

2.5. Sensory Characteristics

The users highlight how they mainly appreciate the aesthetic qualities of the place. Some points out how it is beautiful and nice -*"I find it to be a pleasant place to be. It's easy to come here. It's a truly beautiful building, and it feels good to come here. There is plenty of light and high ceilings, and it's easy to go outside and enjoy the view of nature from inside. The light is excellent. It is very cozy! It doesn't resemble a hospital, [...] The rooms are pleasant with some good chairs; they have decorated with flowers, and there is coffee".* Meanwhile, some also expressed critiques on how the building looks from the outside - *"I think on the outside, it looks like a bunker, from the war. But inside, it's friendlier".*

3. Conclusion

This case study shows that an expanded understanding of users, integrated into the design process, leads to solutions that work well in practice. In this case, it's essential to understand both users' physical and psychosocial challenges. Various dimensions were articulated and guided to the solution. The communicative dimension ensured it should NOT be like a hospital, while social dimensions provided thoughtfully designed seating options in the café and waiting room, allowing users to choose whether to sit alone, sit secluded in a group, or more openly around a large table encouraging discreet interactions. The theoretical framework demonstrates how different dimensions and characteristics can be a valuable tool for analyzing a building retrospectively. It can also be helpful to define the softer intentions in the programming phase. and could also be used during the programming phase.

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Towards Equity and Universal Design in Pelvic Floor Care - Patient Experiences After Birth

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Abstract. This article presents preliminary findings from a design ethnographic study examining pelvic floor care practices from the perspective of patients with pelvic floor injuries caused by birth treated at the continence clinic in Sundsvall's Hospital, Sweden. The aim is to enhance our understanding of women's experiences of pelvic floor injury, provide insights into living with pelvic floor injury, and discuss this from a universal design perspective. The study combines qualitative observations during clinic meetings and individual interviews with participants in a separate room. In total, seven patients participated. The material was analysed using thematic analysis focusing on the patient's experiences and the continence clinic healthcare meeting situation. The initial findings show that pelvic floor injury symptoms such as leakage, pain and discomfort were seen as a routine part of giving birth and as expected and normal among patients. Another finding is how manifestation through visual evidence with mirroring or illustrations is found to be helpful among patients as it helps them with their healing process. Many participants have unresolved thoughts on the reasons for their pelvic floor injury. The narratives of patients living with pelvic floor injuries highlight themes of ambivalence and uncertainty, with the injuries often overshadowed by the subsequent demands of caring for a newborn, causing overload. The change is not only interpersonal; from a design perspective, the situation as a whole is of interest, including the environment, people, and artefacts. Further research is needed to explore women's experiences beyond the purely medical aspects. Here, universal design can contribute to increased sensitivity regarding stigma and values and how these can manifest socio-materially in healthcare interactions. This study provides a basis for continued work with co-creation workshops with participants in the following study.

Keywords. universal design, design ethnography, patient perspective, design research, equity, pelvic floor injury

Note. Please note that this paper contains illustrations of women's pelvic floor anatomy.

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1. Introduction

This article presents early results from design ethnographic research targeting insights and experiences of women living with grade three and four pelvic floor (PF) injuries caused by birth and their experiences of the care they receive in Sweden. The article discusses early results through the lens of universal design (UD), including six observations from continence care appointments, seven interviews that were listened to, and one interview transcribed. (Ongoing recruitment work with five more participants.) Using design ethnographic methods, this first study lays the ground for the upcoming studies including co-design and universal design. The whole project is a multidisciplinary and explorative design research in healthcare as a field.

Awareness about PF injuries is quite often overshadowed by the focus on pregnancy, birth and the newborn baby after birth. The Swedish government, for example, reports PF care as an area that needs to be prioritised and developed (1) further considers the effects it causes on a woman's life, such as social isolation and work and family-related problems. WHO defines health equity as health differences that are unnecessary and unavoidable (2). 'Equitable' is a concept used in this paper to cover equal and impartial health care. A relevant question is, for this reason, how might UD principles help discuss characteristics and patients' insights of PF care from their perspectives?

To provide some examples, the symptoms followed by PF injury can be urine, gas and spoil leakage problems. According to the routines of the maternity care department at Sundsvall Hospital, participants in this study were recruited from women who came for follow-up of childbirth-related injuries. After examination and interview, women could be classified as patients with functional impairments if the physical or mental issues persisted after eight weeks or released as healthy women. Looking at long-term effects of PF injury, some studies show that those problems may lead to long-term psychological problems and low quality of life (3,4) other studies state "varied results" depending on the individual (5,6) and other studies claim little or no change in the quality of life (7). As the research shows different results for the same medical classification, it is essential to focus on women and their context when defining their experiences, needs, wishes, and dreams related to their PF function. Universal design, with its philosophy and methods as a field and focus on context and environment rather than only the individual, fits well when meeting this variety among participants.

The study intentionally involves women who have sustained more extensive injuries. Their need for care is more significant, they receive more extensive interventions over a more extended period, and they live with the intense consequences of the injuries during the first weeks. There is more to learn from them because they have more extensive and unusual injuries. UD is a concept guiding design processes that aim to create products, environments, services, and systems that are accessible to all individuals, regardless of their abilities, without the need for adaption or specialised design (8). UD deliberately addresses the specific needs and preferences of marginalised or underrepresented groups by engaging with and gathering input from these communities throughout the design process to create suggestions based on their needs and preferences. In this study, UD is a means to understand and discuss the situation and to contribute new insights regarding women's experiences of their PF injury and care.

1.1. Aim

This research aims to enhance our understanding of women's experiences of PF injury, provide insights into living with PF injury, and discuss this from a universal design perspective.
RQ1. What characterises the experiences of women having a grade three and four pelvic floor injury during birth and coping with it in the following weeks?
RQ2. How can these experiences be critically analysed from a universal design perspective?

2. Method

This is a design research study on a multidisciplinary subject involving researchers from design and medicine. It is based on qualitative methods: non-participant semi-structured observations (9) in continence clinic care meetings and semi-structured interviews (9) in a separate room with participants.

2.1. Participants

Participants in this study are seven women who received a PF injury of grade three or four caused by birth, earliest eight weeks and latest 12 months after delivery, registered in Sundsvall's Hospital in Sweden. Participants are randomly chosen from those with regular continence clinic appointments and are asked via mail if they consent to take part in the study. Exclusion criteria are age younger than 18 years, pregnancy, mental illness, known or suspected local pelvic and/or urinary tract infection, and chronic pain before childbirth.

2.2. Non-participant, Semi-structured Qualitative Observations

Observations (9) is a well-known technique for better understanding what people do. Design methodology, using observations, aims to understand more tacit knowledge and can contribute to a deeper understanding of a phenomenon than just an interview. To discover new and inclusive approaches to care practices, procedures, and events, non-participant, semi-structured observations (9) are employed to identify insights, including the study population's experiences of PF care they receive.

For patients who agree to be observed, a Biodesign list for observation documentation guidelines, as used by P. Yock et al. (10), and the list is completed with simple sketches. The guideline includes the date, time, context, all attendants, specific facts, numbers, details, sensory impressions, particular words, phrases, and the timing of various steps of a process, procedure, or interaction with healthcare. Guidelines are updated with sketching because it is a natural method for a design researcher to document what is happening. The sketching process is analytical in itself, an interpretation of what is being observed. Observation results include notes and sketches gathered using the guidelines.

2.3. Semi-structured Interviews

Semi-structured qualitative interviews (9) are conducted with seven patients to ensure their participation and perspective of PF care, including their experiences living with PF injury. Interview questions are formulated as factual inquiries with neutral language that places women's individual experiences at the centre. The researcher writes questions based on the observation study in continence clinic appointments and literature review. Interviews are semi-structured to allow patients to speak and tell their side of the story. The interviews with 7 participants were conducted in a separate room close to the women's clinic.

2.4. Methods of analysis

Listening to and analysing interviews and reading the materials from observations are the methods of analysis that help to get an overview and identify themes that stand out, focusing on the patient's experiences and the continence clinic healthcare meeting situation.

2.5. Ethical considerations

This study concerns an ethically sensitive subject that is worth researching, as pelvic floor injuries are described as a deprioritized research area that needs development (11). The ethical permit is approved prior to the start of the study to ensure that the research is conducted ethically. All patients asked to participate in the study are provided with written information and consent forms. All patients are coded to numbers to guarantee the anonymity of participants for study documentation. The study is part of a PhD project research plan approved by the Swedish Ethical Review Authority (Dnr 2023-06969-01).

3. Results

The results are divided into four themes: normalisation of pelvic floor injuries, manifestation through mirroring and visualisation, why did I tear?, and overload in the first weeks after childbirth.

3.1. Normalisation of pelvic floor injuries.

The normalisation of PF injuries through accepting symptoms such as leakage, pain and discomfort as a routine part of giving birth is one of the common subject among the participants. Examining the normalisation processes through the interviews, we understand what the women accept daily. Normalisation can then lead to limitations. It can set boundaries for women regarding which work environments they can participate in, which social contexts they can be in, and generally, their ability to move in public spaces. The participants expressed that one has to tolerate some discomfort and it is expected to have some urine leakage after giving birth. As a woman, one is traditionally expected to be more pain-tolerant.

Access to toilets and necessities, such as laxatives, women must prepare a lot in advance to be able to go out into society. This requires a lot of time, effort, tension, and

uncertainty. "This meeting has gone on too long; I need to leave; what do I do now?" is a fear many women mention when considering their work that will start after maternity leave. This may require the person to take the initiative for a break, which can be difficult. Society needs to be tolerant so that everyone can feel comfortable. By looking at what is being normalised and how long the symptoms keep being normalised, we can gain insight into what needs to be changed and what society and healthcare providers need to do to help these women in the early weeks after giving birth.

Another finding from the interviews is how the process of the interviews itself went by. Talking about PF injury and its consequences is seen as tabu, and it might take time to open up and feel safe talking about it. At the beginning of the interview, many women mention doing fine when asked about daily life. It takes a while before women open up. After about 15-20 minutes, they warm up to the subject. Normalisation, feeling good, is no longer present when they start talking about how PF injuries affect primarily themselves but even in their role as mothers, partners and future employees. Normalisation is like a coating that then dissolves.

3.2. Manifestation through mirroring and visualisation

Manifestation through visual evidence of presence may help go through a mental process of understanding what has happened. Many women talk about how caregivers use illustrations of PF injuries completed by their injury drawn by pen. See Figure 1, where a doctor shows how he draws different types of PF injuries on the illustration of the PF. They remember the moment of drawing as memorable and how helpful it was for them to understand their PF injury and its extent. Women also mention caregivers using a mirror to show how their PF tear looks after surgery, which is helpful as it helps the healing process by reflecting reality and allowing the women to see it as it is. Offering different modalities, such as verbal and visual communication, is more educational and inclusive (12). If the women have not seen their PF and do not know how it looks, they might imagine a picture that is either worse or better than reality. Personalisation of information through visualisation of an illustration or showing it in a mirror helps to express the individual situation and helps women understand what happened. The women go through a mental process of externalisation, which helps them to understand the consequences of their injury, begin to cope and take a step forward. Seeing reality as it is is a threshold women must go through in their healing journey.

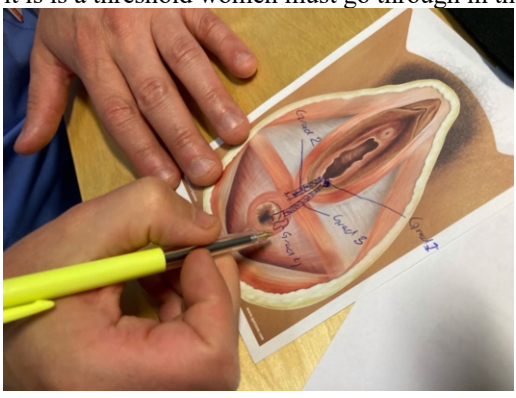


Figure 1 A doctor drawing different types of tears on a PF illustration they use to communicate with patients. Photo by the first author.

3.3. Why did I tear?

Lack of communication during childbirth is, in the women's minds, a factor that might have led to the tearing injury. In some cases, the midwife gives instructions that the woman might not fully hear, causing her to do something else, which leads to thoughts about whether this was the reason for the tearing injury. The woman is in a lot of pain and her own bubble. It is a difficult situation to be in and to communicate at the same time. Personalising communication methods during birth may help women feel more involved in their care. Verbal communication supported by other means as visual and tactile communication may be ways to investigate further to see if they improve communication.

After-birth care includes a dialogue with the midwife, partner, and the woman who gave birth. They talk about what happened during birth. Women receive their birth journals printed on paper so they can read them later. Many women speak positively about the after-birth dialogue. Some women read their journals, talk to their partners, and reflect on what happened during birth when they returned home. That is when they start thinking about the reasons for their injury and whether they could have done something differently.

3.4. Overload in the First Weeks after Childbirth

Many other routines need to be in place in the first weeks: strollers, baby car seats, pacifiers and nap bottles that need to be sterilised; carrying and feeding the baby involves adjustments for the body. The change is not only interpersonal; it is not just between the woman and the child, partner, family, friends, or healthcare staff; it also involves the physical environment. From a design perspective, the situation includes the environment, people, and artefacts. See Figure 2 for a sketch of a situation where a mother holds her newborn while filling out a form, surrounded by artefacts such as a baby carriage, table, and chair.

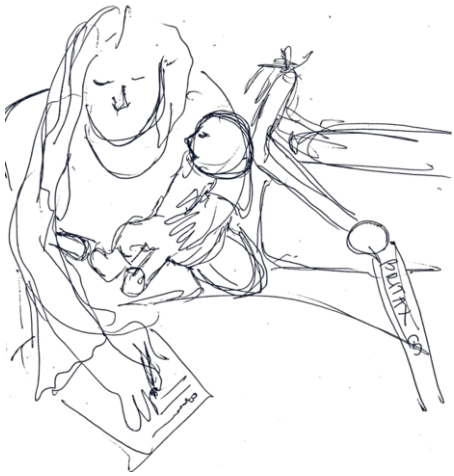


Figure 2 A quick sketch of a participant holding her newborn baby and filling out a form simultaneously, a baby stroller in the background. (Sketch drawn by the first author, scanned and edited in Word.)

The first weeks are the time of the most adjustment with a newborn baby and the new role of being a mother. These are vulnerable weeks, requiring support and someone to listen. Women report that it is also during this time that the symptoms from tears are most felt. Most women interviewed were first-time mothers, which involves significant adjustments. Various consequences of the injury lead to an overload of things to deal with. Problems with leakage, pain from the wound, and possibly irritating stitches, among other painful issues, can be stressful for some, according to the women's stories. There is no clear consensus in narratives. It is not that they are unaffected, but they are affected differently individually.

4. Concluding discussion

The situation women with PF injury find themselves in directly after giving birth is characterised by a couple of intensive and fragmented weeks. From a UD perspective, healthcare as an organisation and the society we live in need to understand the ambivalence and the intensity of the first weeks women with PF injuries go through and provide them with individually adapted support systems. It is essential to mention the stigma connected to PF injuries and the consequences it can have on women's family, social, and work lives. Here the UD goals (13) fit better with this study than the UD principles introduced in 1997 by Connell and colleagues (14). The principles focus primarily on physical products and environments, while the UD goals also include social and cultural aspects.

Normalisation and attitudes about childbirth often dismiss the severity of postpartum pain, whereas injuries like a broken leg may be taken more seriously. If PF injury-related pain were equally acknowledged, more aids might be available. Recognition of PF injury is necessary so that women don’t downplay their problems, seek medical care, and discuss the issue, which would help raise awareness. These injuries may significantly affect a woman's daily life, and healthcare needs to step up to spread awareness about when it's time to seek help. Here, UD can contribute with increased sensitivity regarding stigma and values and how these can manifest socio-materially in healthcare interactions.

The findings from this study indicate that women need personalised support, considering the changes in the physical environment and the intensity of PF injury symptoms in the first weeks after birth. This is the first step toward understanding how to live with PF injury from a UD perspective. Further research is needed to explore women's experiences beyond the purely medical aspects. Design research can contribute with methods and knowledge to investigate how people and artefacts interact in the situation as a whole. This study provides a basis for our continued work with co-creation workshops with participants in the following studies.

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Exploring the Relationship Between Identity, Physical Activity, and Accessibility Perceptions

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Abstract. Physical activity (PA) has a well-documented, positive effect on overall health and wellbeing. Additionally, addressing activity-friendly infrastructure in communities can promote PA in everyday life. A universal design (UD) lens on PA promotes accessibility to the broadest audience and contributes to equal benefit of increased PA. This study explores the intersectionality of age, gender, and disability in United States-based gender minority adults using multiple regression analysis. A statistically significant relationship emerged between participants' (n=125) disability status and their corresponding perceptions of accessible design in their communities. However, gender, age, and PA did not have statistical significance in the regression model. The results reported in this paper are specific to the unique challenges these populations face in accessing inclusive and accessible community environments. Few health disparities studies have combined multiple elements of one's identity with measurements of PA to examine environmental perceptions among multiply marginalized communities. This research seeks to address this research gap.

Keywords. physical activity, built environment, health equity, accessibility

1. Introduction

Human identity is a set of complex, interrelated social factors that influence how humans perceive the environments around them [1]. This difference in perception can directly affect health behaviors and their corresponding benefits [1,2]. Additionally, it is well documented that multiple forms of marginalization affect perceptions of and interaction with the environment [1]. However, little research exists describing multiple intersecting identities (intersectionality) in relationship to environmental experience, and the existing research is frequently limited to one element of identity (e.g., race, ethnicity, or age) and neglects to examine the relationship of multiple variables' simultaneous impact on active aging and interactions with the environment [2,3].

Furthermore, socioeconomic and cultural factors interact with identity elements like gender, age, race, and disability to influence physical activity (PA) behaviors [1,4,5]. Systemic inequities such as ageism, ableism, and homophobia also contribute to unequal attainment of the health benefits from PA [1-5]. Additionally, life course processes, such as changes in physical ability, are dynamic and defined as inherently intersectional, making them more challenging to measure [3]. These dynamic approaches to activity,

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accessibility, and aging support an intersectional approach to research that seeks to understand active living and the associated life events that accompany it, specifically regarding perceptions of the surrounding environment [2,3].

Participation in regular physical activity (PA) can reduce the risk for heart disease, stroke, diabetes, certain cancers, and depression [4,5]. Physical inactivity is estimated to be the principal cause of multiple noncommunicable diseases and is one of the leading risk factors for global mortality [4,5]. However, global PA recommendations have largely been developed using studies that do not involve people with disabilities (PWDs) or explicitly state sexual gender minority (SGM) status [4,5]. This is important because SGM individuals (often referred to as lesbian, gay, bisexual, transgender, queer (LGBTQ+)) and PWDs experience higher rates of victimization and social scrutiny which influence their ability to engage in PA throughout the life course [6].

SGM older adults are more likely to report poor general health and mental distress along with elevated rates of cardiovascular diseases and chronic conditions when compared to heterosexual adults of similar ages [6]. Similarly, PWDs are significantly more likely to have obesity, heart disease, and diabetes [4-6]. Not only is PA safe for many PWDs, but it is often required to maintain function and health among those with chronic, progressive diseases [4,5]. Both SGMS and PWDs experience higher risk for poor health outcomes across the life course due to a combination of psychophysiological factors, biological processes, and systemic oppression related to their social positions [6]. The promotion of accessible PA among SGMs and PWDs needs to consider these unique challenges in order to equally distribute the benefits of PA [6].

Central to this research, *mobility* is the ability to move independently, a critical and fundamental component of maintaining independence and quality of life [7]. A mobility disability is the result of incongruence between an individual and their surrounding environment [7]. Mobility disabilities are experienced by people of all ages and are characterized by various physical disability types where people may use diverse movement aids (e.g., white canes, walkers, wheelchairs) that increase the need for accessible environmental design. Therefore, addressing activity-friendly infrastructure in communities may help promote PA in everyday life for PWDs.

Community infrastructure influences PA access and is a vital unit of change for health equity [8,9]. The quality of the BE directly influences one's ability to live an active life by facilitating or preventing PA practices through built and social elements [8,9]. By integrating PA into daily life, it becomes a catalyst for protective factors, health, and longevity. Thus, promoting accessible BE infrastructure may facilitate positive experiences while promoting free mobility and active living [9].

Employing universal design (UD) principles to assess perceptions of accessibility in community environments can encourage accessible PA promotion at the community-level [8]. UD is the practice of promoting design and composition of environments, education, and services or systems that are easily and widely accessible, understandable, and usable [10]. The seven core principles of UD are defined and operationalized for this study in Table 1.

Finally, the intersectional approach to research used in this paper is based on principles of multiplicative effects that illustrate how different social categories compound each other in forms of systemic oppression and social differentiation [1-3]. When considering people whose identity belongs to multiple groups historically marginalized by society, PA research needs to address the increased health risks at the individual level that result from compounded marginalization [1-5]. This research uses an intersectional lens on active living to characterize lived experiences of PA [among

SGM older adults with and without mobility disabilities] and examines the contribution of co-occurring identities to environmental experiences.

2. Methods

An online survey distributed via social media (Facebook, Instagram, and LinkedIn) was used to gather data regarding health status, PA behaviors, and built and social environmental perspectives from SGM adults, over the age of 50 years, residing in the United States (n=125). This study was approved by the Texas A&M University institutional review board on April 30, 2024 (STUDY2024-0465).

The seven UD principles were adapted into Likert-scale questions to gather information regarding to what extent participants perceive the areas where they live to be accessible. PA was collected using the International Physical Activity Questionnaire (IPAQ) [11] short form that was adapted to include language for mobility disabilities (e.g., the inclusion of wheelchair rolling with walking). This seven-item scale showed a high level of internal consistency, as determined by Cronbach's alpha of 0.92.

Table 1. UD principles, definitions, and questions.

UD Principle	**Definition** [10]	**Question**
		How much do you agree with the following statements?
Tolerance for Error	The design minimizes hazards and the adverse consequences of accidental or unintended actions.	My community is designed in a way that keeps me safe from accidents.
Equitable Use	The design is useful and marketable to people with diverse abilities.	The places I go in my community are available and useful to me.
(Low) Physical Effort	The design can be used efficiently and comfortably and with a minimum of fatigue.	It is easy for me to move through my community on foot (or by wheelchair).
Perceptible Information	The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.	I can easily access any necessary information to engage with my community.
Size and Space (for Approach and Use)	Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.	The public spaces in my community are an appropriate size and have enough space for me to go where I want to go.
Flexibility in Use	The design accommodates a wide range of individual preferences and abilities.	There is more than one way to access and engage with the public spaces in my community.
Simple and Intuitive	Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.	The design of public spaces in my community is easy to understand and accommodates my needs.

Descriptive statistical analysis was conducted using SPSS (version 29.0.2.0) [12]. Multiple regression examined the relationship between age (standardized with z-scores), gender (cisgender or gender diverse), disability (yes/no), PA (z-scores), and the total UD score. The regression equation can be seen below:

$$\text{Predicted UD score} = b_0 + (b_1*\text{age}) + (b_2*\text{gender}) + (b_3*\text{disability}) + (b_4*\text{walk}) + (b_5*\text{MPA}) + (b_6*\text{VPA})$$

3. Results

125 SGM adults with (n = 71, 56.8%) and without (n = 54, 43.2%) disabilities were included in the analysis. Participant averaged 61 years of age (sd = 6.6). 50.4% (n = 63) of participants reported being assigned female at birth, but only 68.8% (n = 86) identified as cisgender (having the same gender identity as sex assigned at birth) at the time of the survey.

Table 2. Demographics

	Total sample		**Without disability**		**With disability** [a]	
N	125		54 (43.2%)		71 (56.8%)	
Age (years)	123 (98.4%)		53 (42.4%)		70 (56%)	
Mean	61.21		59.75		62.31	
Standard deviation	6.60		6.27		6.66	
Sex[b]	n	% of Total	n	% of Total	n	% of Total
Female	63	50.4%	24	19.2%	39	50.4%
Male	62	49.6%	30	24%	32	25.6%
Sex Total	*125*					
Gender	n	% of Total	n	% of Total	n	% of Total
Cisgender	86	68.8%	41	32.8%	45	36%
Transgender	3	2.4%	1	0.8%	2	1.6%
Gender nonconforming	18	14.4%	6	4.8%	12	9.6%
Native gender	2	1.6%	1	0.8%	1	0.8%
Other/questioning	1	0.8%	1	0.8%	0	0%
>1 gender	15	12%	4	3.2%	11	8.8%
Gender Total	*125*					

[a] Calculated as 'yes' if respondent answered 'yes' to any of the following: currently experiencing mobility disability, difficulty walking, difficulty with stairs, or use of any mobility assistance in the last year.
[b] Intersex was an available option.

A multiple regression analysis (Table 3) was conducted to examine the relationship between various predictors and UD total scores. The model was statistically significant, $F(6, 116) = 3.870$, $p = .001$, and accounted for 16.7% of the variance in UD total scores ($R^2 = .167$, adjusted $R^2 = .124$). Among the predictors, mobility disability emerged as a significant factor ($\beta = -.313$, $p = .001$), indicating that participants with mobility disabilities tended to report lower UD total scores, suggesting they perceived their environments as less accessible. The standardized walking score approached significance ($\beta = .173$, $p = .056$), hinting at a potential positive relationship with UD total scores. Other variables, including standardized moderate physical activity ($\beta = .059$, $p = .522$), standardized vigorous physical activity ($\beta = -.039$, $p = .688$), gender ($\beta = -.089$, $p = .298$), and standardized age ($\beta = .064$, $p = .470$), did not significantly contribute to the model.

Table 3. Multiple regression results for predictors of universal design scores

Variable	B	SE B	β	t	*p*	95% CI
Constant	19.419	0.926		20.977	<.001	[17.586, 21.253]
Walking Total[+]	1.113	0.576	.173	1.931	.056	[-0.029, 2.254]
MPA Total[+]	0.377	0.588	.059	0.642	.52	[-0.786, 1.541]
VPA Total[+]	-0.248	0.617	-.039	-0.402	.688	[-1.470, 0.974]
Mobility Disability	-4.059	1.226	-.313	-3.310	.001	[-6.488, -1.630]
Gender	-1.234	1.180	-.089	-1.046	.298	[-3.571, 1.103]
Age[+]	0.413	0.571	.064	0.724	.470	[-0.717, 1.544]

[+] = standardized with Z-scores

Note. n = 123. CI = confidence interval. MPA = Moderate Physical Activity. VPA = Vigorous Physical Activity. R^2 = .167, Adjusted R^2 = .124, F(6, 116) = 3.870, p = .001

4. Discussion

The results reported in this paper are specific to the unique challenges resulting from compounded, systemic disenfranchisement that stands in the way of equitable PA achievement in community environments. Specifically, this research contributes to the growing body of knowledge on health disparities and the relationship between the BE and PA among multiply marginalized communities by exploring the intersecting identities of age, gender, and disability in SGM adults. Notably, this paper also integrated a novel approach to measuring accessibility perceptions among multiply marginalized people. This pilot study dataset shows considerable promise for investigating PA, environmental perceptions, and health influencers for SGM adults with disabilities.

The significance of disability in this model aligns with current research discussing disabling socioenvironmental factors among both PWDs and older adults [1,13]. Perceptions of accessibility have consistently been shown to influence PA across the life course [13]. However, other research discusses how subjective perceptions of accessibility often differ from objectively measured accessibility in a community [13]. Additionally, environmental evaluations for accessibility illuminate opportunities for health equity by providing necessary context, describing unequal communities and conditions where individual preferences may be selectively available due to inaccessible design and inequitable social conditions [1].

While gender did not emerge as a statistically significant predictor in this paper, previous studies have successfully described how being a SGM influences PA participation [14]. Interestingly, gender may have lacked statistical significance due to increased homogeneity that resulted from the sample self-identifying as part of the LGBTQ+ community [1]. The use of control groups in other studies allows for heterogeneity of gender, resulting in clear between-group differences [1,6]. Future research should continue to examine differences due to SGM-status, especially in the context of life course approaches to accessible and active aging. However, this will likely involve continuing to challenge the gender binary in research and research translation, a practice where many scholars will benefit from increased training [1-3, 6, 14].

Age was not statistically significant in this regression model, possibly because the sample is entirely middle-aged and older adults. However, the relationship between age

and environmental perceptions has been well-explored, particularly regarding perceptions of accessibility as barriers to PA [13]. Inconsistent, lifelong physical activity, psychophysiological barriers, and external barriers (such as inaccessibility) contribute to challenges with engaging in PA across the life course [15]. Research, programming, and policies accrue additional value when they take age-based health disparities into account [16]. Conversely, ageism in health rhetoric often uses deficits-based messaging to highlight physical and cognitive functional decline throughout the life course, which can lead to ageist and oversimplified health promotion materials. Future research should continue to use a life course approach that accounts for variation in the aging experience among multiply marginalized groups [3,6].

The insignificance of PA variables in this regression model may be attributed to the specialized nature of the study's sample, which consisted entirely of SGM adults aged 50 and older. This homogeneity, coupled with the relatively small sample size (n=125), could have limited the variability in PA levels that would be necessary to detect significant associations with UD perceptions. However, these findings should not be interpreted as a lack of importance of PA in relation to environmental perceptions. Rather, they highlight the complexity of studying PA behaviors within multiply marginalized populations [6,14]. The absence of significant PA associations in our model may suggest that for SGM older adults, factors such as disability status might play a more prominent role in shaping perceptions of environmental accessibility than PA levels alone. This underscores the need for nuanced approaches in active living design practices that consider the intersecting identities and experiences of SGM older adults [1,3]. Future research should explore larger, more diverse samples of SGM individuals across different age groups to better elucidate the relationships between PA, environmental perceptions, and accessibility [15]. Additionally, longitudinal studies that capture changes in PA patterns and environmental perceptions over time could provide valuable insights into the dynamic nature of these relationships throughout the aging process [13,16].

Intersectionality exploration in public health has long examined social conditions as a fundamental cause of health outcomes [1-3]. It was not until fairly recently that health equity scholars have attempted to model the complex processes of systemic disinvestment and scrutiny as they relate to unequal health outcomes and health behavior adoption [1-3]. While recent advancements to this area have been made by proposing standardized ways to incorporate intersectionality in research and analysis [17,18], the processes for analyzing and reporting quantitative research are inconsistent [1-3]. Incorporating intersectionality as a lens aids in examining how social positions and their underlying power structures shape health and health outcomes.

Several tools exist to aid in the evaluation of community-level environments. Scholars have documented the benefits of using an intersectional lens for health policy evaluation and practice [1,6,16]. Additionally, there are clear suggestions for incorporating intersectionality into research and analysis [1,2,17-20], even when attempting to model processes of intersectionality and social conditions related to health [1,3,16-22]. However, the literature is insufficient regarding data collection protocols that use inclusive language. Specifically, inquiry into sexual and gender identity and dynamic disabilities needs to be adapted to fit any intersectional and inclusive language needs of the study [23,24].

4.1. Limitations

This study is not without limitations. The self-report measures and convenience sampling of LGBTQ+ middle-aged and older adults introduced potential bias, and more frequent measurements could contribute to enhanced understanding of fluctuations in PA attainment and environmental perceptions over time. Furthermore, other analytical approaches, such as examining multiplicative effects with a control group, could produce complimentary insight into the complexities of intersectionality research in this area. Despite these limitations, this research provides important insight into the complex relationships between compounded vulnerabilities, PA participation, and perceptions of accessibility among SGM middle-aged and older adults with and without disabilities in the United States.

4.2. Conclusion

The intersectional focus of this research characterizes the effect of intersecting identities and PA achievement on perceptions of accessibility in community-level environments. This study one of few that directly examines the relationship between PA and accessibility among SGM adults in the United States. Future research from this dataset should explore isolated PA achievement and spatial perspectives on accessibility to further understand how ageism, ableism, and homophobia may influence community health outcomes. The research team hopes that the discussions that emerge from this study lead to healthier, more livable communities both within and outside of the United States.

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Universal Design 2024: Shaping a Sustainable, Equitable and Resilient Future for All
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Inclusive Public Libraries: How to Adequately Identify Accessibility Barriers?

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Abstract. Inclusive library services rely on accessible buildings and services, and knowledgeable staff. This study explored whether a standard accessibility evaluation of physical library buildings is sufficient to reveal barriers that must be attended to for the library to be universally designed. Data was collected through a survey, two accessibility evaluations, and interviews with staff in the evaluated libraries. The findings show that evaluations based upon technical requirements for construction work is useful to identify barriers related to access and safety in the library and certain conditions inside, such as staircases and lightning. However, there is a need for library specific guidelines addressing the organization and presentation of the collection, signage, and to understand what users need to be self sufficient in the library when it is open outside opening hours and no staff is present.

Keywords. Public libraries, universal design, accessibility evaluations

1. Introduction

Public libraries are institutions intended to serve the entire population of a country by, among others, providing free access to books, facilitating the use of ICT, and offering an inclusive space for all inhabitants. This social responsibility is incorporated in the UN Convention on the Rights of Persons with Disabilities [1] and is a legal requirement in the public library law in Norway [2]. To achieve inclusive services, it is important that they are usable for everyone. Moreover, many libraries offer extended services, which entails that people can enter and use the library outside the opening hours. This service does not entail access to staff, which increases the need for people to be able to access, navigate, and use the library by themselves which requires an accessible library.

Regulations on technical requirements for construction works [3] are often used as a starting point for accessibility evaluations of buildings in Norway. This study investigated whether such an evaluation can sufficiently reveal potential barriers in public libraries. Knowledge of user diversity and measures on how to accommodate the needs of all types of library users can be vital for the development of inclusive library services. According to Pionke [4], however, many librarians feel unprepared to serve patrons with disabilities.

This study reports the findings from a project in collaboration with Viken county library, the 6th largest county in Norway in 2023. The data comprises a survey answered by 52 libraries, two different types of accessibility evaluations of three libraries, and interviews of five staff members from the evaluated libraries. Limited areas for staff only

are not included in the evaluations. Neither are digital services. The purpose is to investigate how to develop robust accessibility evaluation guidelines for public libraries. The findings may have implications for researchers, practitioners, and administrators.

2. Background

Universal design can be defined in many ways and refer to 'the design of products and environments that can be used and experienced by people of all ages and abilities, to the greatest extent possible, without adaptation' [5]. Seven principles for universal designed have been developed: 1) Equitable use, 2) Flexibility in use, 3) Simple and intuitive use, 4) Perceptible information, 5) Tolerance for errors, 6) Low physical effort, and 7) Size and space for approach and use [5]. These principles can be used as starting point for, among others, evaluating the accessibility of physical or digital services or environments.

Accessibility and universal design have been addressed in the research literature, but with an overwhelming attention towards electronic resources. In a content analysis, Hill [6] reported that 25% of the articles addressed accessibility of the digital environment, while only 2% regarded the physical environment and texts. Although this analysis was conducted a decade ago, digital library services still seem to retrieve most attention [7].

In a study of the accessibility of public libraries, Kaeding, Velasquez and Price [7] explored 18 libraries through a survey and interviews. The three main barriers reported were i) library staff attitudes, ii) the library program did not cater for children with disabilities and iii) the physical environment. An inclusive library model was proposed, identifying six key elements for accessible libraries: collections, programs, training, partnerships, marketing, and physical barriers (space and equipment), emphasizing the importance of a supportive management for all elements.

Attitudinal barriers were also addressed by Ferrara [8], who reported that librarians were aware that attitudes towards disability could create barriers. However, identifying the barriers was difficult and often not considered when planning library services. Other studies have shown that some librarians feel unprepared for meetings with patrons with disabilities, indicating a need for more training in user diversity [4].

Library associations such as IFLA (International Federation of Library Associations and Institutions) and ALA (American Library Association) have put forward guidelines to help librarians in the development of inclusive libraries. Examples are Revised Guidelines for Accessible Libraries and Services for Everyone [9] or guidelines addressing more specific cohorts, e.g., people with dyslexia, people who are deaf or have dementia. However, these guidelines are presented in the form of advice on best practice rather than being evaluation criteria for accessibility assessments.

3. Method

Four datasets were collected based upon a survey answered by 52 libraries, two different accessibility evaluations of three library buildings, and interviews with five staff members in the evaluated libraries. The aim of the survey was to explore which aspects of the physical environment caused the most accessibility issues in libraries and to map the knowledge level of universal design among staff and stakeholders. The purpose of the evaluations was to investigate what types of accessibility issues that are uncovered in a "traditional" evaluation and to examine if a more "library tailored" evaluation

method would reveal other barriers. The goal with the interviews was to explore if input from staff would point to other barriers than those reported from the evaluations.

A survey was sent out by Viken county library to 91 public libraries situated in 51 municipalities. The survey was answered by 52 libraries, giving a response rate of 57.1%. The questions addressed topics related to the library building, strategic plans, and universal design.

The accessibility evaluations comprised an evaluation completed by consultants from Universell Utforming AS using official regulations and demands in Norwegian jurisdiction as criteria [3, 10]. The second evaluation was carried out by one of the authors and aimed to address other aspects. A set of criteria was formulated inspired by the usability principles of Jakob Nielsen [11] and based upon recommendations from universal design for perception of the senses [12].

Semi-structured interviews of five librarians at the three evaluated libraries were conducted asking questions relating to the expertise and thoughts of the librarians regarding universal design in the library. The participants were informed about their rights to withdraw from the study at any time without giving any justification. Consent forms were signed before an audio recorder was turned on. The interviews were later transcribed, anonymized, and analyzed using a thematical analysis [13]. Examples of themes include knowledge and skills, challenges in library floor plans, and user groups.

4. Findings

4.1. The survey

The survey asked questions related to three categories: i) administration, ii) the physical environment, and iii) knowledge of universal design. Most of the libraries, 76.9% (n=40), offered extended opening hours, 13.5% (n=7) did not have this service, 7.7% (n=4) had plans to provide this service in near future and 1.9% (n=1) had another solution for access outside of opening hours. When asked whether the library had been evaluated in context of universal design, 48.1% (n=25) answered yes, 19.2% (n=10) said no, 30.8% (n=16) did not know and 1% (n=1) had plans to do an evaluation. A total of 9.6% (n=5) knew about planned accessibility measures in the near future, while 63.5% (n=33) said no plans were made and 26.9% (n=14) were unsure. The libraries were asked if universal design was included in strategies, action plans, or annual reports. Here, 23.1% (n=12) said yes, 51.9% (n=27) answered no, and 25% (n=13) did not know. A total of 25% (n=13) had collaborated with user organizations or municipal councils, 30.8% (n=16) had not, while 44.2% (n=23) did not know.

The survey also explored some physical aspects of the accessibility of the libraries to identify areas that were most frequently causing barriers (see Figure 1). Most libraries had parking spaces, accessible entrances (with some exceptions caused by heavy doors and uneven foundations), and toilet facilities for patrons with impaired mobility. While many of the libraries had clear signage to help people locating the library, there was not satisfactory signage inside the library to find departments or specific books. Not all libraries had sufficient lightning, adequate sound environment or handrails on staircases and clearly marked steps.

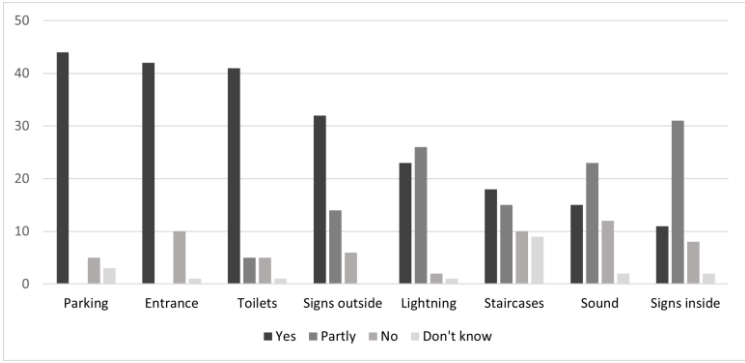


Figure 1. Survey answers regarding accessibility of the physical environment (N=52)

The survey asked if all types of users had equal access to the library and to utilize the library services. A total of 25% (n=13) answered to a high degree, 53.9% (n=28) said to a medium degree, 15.4% (n=8) to a certain degree, 3.8% (n=2) to a small degree, and 1.9% (n=1) to no degree. Regarding measures needed to ensure that the library had sufficient negotiability, usability, and quality for all types of people despite functional variations, the libraries were allowed to give multiple answers (see Table 1, four libraries answered "do not know" and are therefore not included). The survey also addressed whether library staff had received education or courses in universal design. Here, 7.7% (n=4) libraries answered yes, 11.5% (n=6) said partly, 65.4% (n=34) had not and 15.4% (n=8) did not know. For the libraries that answered partly, only one person in staff had such training or it was directed at a very specific area, e.g. dementia friendly libraries.

Table 1. Answers regarding measures needed to increase the accessibility of the library

Measure	n
Checklists, standards, etc.	31
Increased knowledge level among library staff	30
Better knowledge among decision-makers about the significance of the library	30
Better knowledge among decision-makers about universal design	27
Increased economic resources	27
Courses and counselling from the county library	23
Better anchorage in the library's plans	23
Better anchorage in the municipality's plans	22

4.2. Accessibility evaluation 1

The evaluation using official governmental regulations identified several issues, mainly related to access, navigation, and overall safety of the buildings. Some examples were lack of bathroom facilities for people with disabilities, entrances not compatible with wheelchairs, too narrow door openings, door sills, and unsafe staircases. Aspects of the buildings related more specifically to libraries were not included, such as the organization of library collections, self-checkout devices, and events. Some of the accessibility issues reported were common for several of the libraries, while others were specific for just one. It was also pointed out that the libraries were very different regarding age and ownership of the building, which may impact the possibility for the library to influence the design of the building.

Details pertaining to, e.g., door openings, door cases, parking spaces, and accessible toilets are not reported in detail in this paper. The most relevant findings in this context are the following up measures suggested by Universell Utforming AS, namely: i) developing a methodology for evaluation of universal design in libraries, ii) the design of bookshelves, iii) auditive equipment in the library, iv) fire alarms for persons with impaired hearing and minimum requirements for the periods of extended (self-operated) opening hours, v) revise procedures for purchases related to universal design, and vi) enhancement of competence of universal design.

4.3. Accessibility evaluation 2

Accessibility evaluation 2 focused on the more library specific criteria noise level, bookshelves, organization and visibility of collections, and signs. Accessibility issues in all categories were identified when looking at the three libraries combined. The evaluated libraries differed in age, size, and location, which entailed they had dissimilar challenges in context of universal design. One library was situated in an open solution across two floors in a community building. Such a location presents specific barriers related to noise, and wayfinding in terms of signage to help the patrons locate the different sections of the library. The two other libraries did not report noise-related challenges but reported difficulties implementing sufficient sound systems that cooperate with hearing aids.

Several issues were identified in terms of bookshelves and signage. For example, one of the smaller libraries had placed the shelf signs on top of the shelves. This space, however, was also used for displaying books, which resulted in the signs being entirely covered and hence not visible for the users (see Figure 2). Another library had placed the signage on the walls with large fonts, making the shelves easier to locate. A problem with such a solution, however, is the lack of flexibility to reorganize the collection.



Figure 2. Examples of different ways of labelling shelves.

Although the shelves had signs at the end for navigation purposes, these signs were typically placed on one side making it impossible to navigate the collection from both sides (see Figure 3). Navigation in the library can potentially be improved if the user can choose the navigation path, especially if there are physical barriers or lightning conditions that make one side favorable for certain users. Some signs were quite small. In one library, the signs were relatively large and had good readability, but were marked on one side only and not all signs were intact (see Figure 4).



Figure 3. Signs on one side of the shelves only



Figure 4. Potentially readable signs, but not all were intact

In one of the libraries, there were many dark areas due to dim fluorescent lighting and shelves that prevented natural light getting in (see Figure 5). The second library also had some dark areas related to dim overhead lightning, making it difficult to locate books in the shelves. The third library had much natural light, but the placement of the computers caused usability issues in sharp sunlight (see Figure 5).



Figure 5. Examples of poor lightning conditions

4.4. The interviews

Staff from all three libraries were interviewed to explore potential challenges not uncovered by the evaluations. The interviews comprised topics such as knowledge and skills related to universal design, floor plans, organization of the library, and user groups. One of the respondents had some knowledge of universal design related to the association of the blind and partially sighted, while the remaining participants based their knowledge upon encounters with library users. When referring to user diversity among the patrons, the staff discussed children, youth, and elderly people. Wheelchair users was the only cohort with functional variations that was mentioned.

The library staff typically brought up recounters of specific changes in the interior when discussing accessible design, for example measures to increase contrasts in the library space or dividing the library into different sections. When asked about the accessibility of the library all participants were aware of some issues. However, they did not know whether there would be sufficient funding or adequate solutions to remove

these barriers. The respondents suggested that a lack of money could be related to insufficient government sanctioned regulations for universal design in library buildings.

Most of the accessibility problems had been brought up by patrons. For example, elderly users in one of the libraries would comment on the noise or lack of satisfactory lighting in certain areas. The respondents tried to solve issues as they arose, once they were aware of them. Some of the staff also expressed a desire to change some of the library layout to better accommodate accessibility criteria. They did, however, not know where to start or how to proceed with such improvements. One of the staff commented on the lack of interest from local government employees regarding certain major accessibility issues, such as the entrance to the library opening the wrong way, which was not in accordance with official universal design regulations.

All the respondents mentioned extended services as a challenge, among others difficulties keeping the walking paths free of obstacles. Moreover, in one of the libraries, a frequent reorganization of shelves was regarded as a problem, because the movement of collections made them harder to locate for the patrons. Others mentioned difficulties understanding the way the collection was organized or providing sufficient signage. The pilot project conducted at the respondents' library comprising the first evaluation was also mentioned when the participants discussed the need for library specific guidelines. This evaluation had confirmed issues the libraries had pointed our earlier, such as lacking accessible bathrooms. The report was therefore considered an important tool to put pressure on decision makers to prioritize solving such issues.

5. Discussion

The findings from this pilot study indicate that several measures can increase the accessibility of libraries. Universal design was rarely included in the strategic plans in the libraries involved in the study, and few staff members in public libraries had knowledge of universal design. Although several of the libraries had done accessibility evaluations and were clearly aware of aspects that could be improved, only a small number had specific plans to increase the accessibility. The large number of libraries that answered 'do not know' on many of the survey questions also suggest that universal design is not a high priority in strategic planning or a topic that is frequently discussed. Consequently, improving the knowledge of universal design among library staff and decision makers in the municipalities and counties seems purposeful, for example through seminars or continuing education. This conclusion is also in accordance with other studies showing a need for knowledge of user diversity in the library profession [4, 8]. Increased resources allocated to accessibility measures seems required and universal design should be better incorporated in strategic plans.

The findings from the two evaluations suggest a need for more comprehensive and library specific criteria when evaluating library buildings to ensure universal design. The established criteria based upon technical requirements [3, 10] do not seem to adequately cover libraries. The low number of studies reported to address physical libraries [6, 7] indicate that more attention should be directed towards library buildings. Future work should comprise more evaluations, the development of library specific evaluation guidelines and testing of these guidelines to ensure that they cover all relevant aspects of library services. Such evaluations could use frameworks such as the seven principles of universal design [5] and existing guidelines developed by IFLA [9] as starting points. The increasing number of libraries offering patrons to access and use the library outside

of regular opening hours makes it even more important that users can navigate the library collections and locate the desired material by themselves. Otherwise, the extended library services will only become a service for a few people, not the entire population. Such an outcome will go against conventions and regulations [1, 2].

Interviews with the library staff confirmed the need for library specific guidelines. Moreover, the conversations revealed that the main challenge was, among others, difficulties getting money to implement accessibility measures due to insufficient government sanctioned regulations for universal design in library buildings. Moreover, evaluations were considered a powerful tool for change. By addressing common issues before they arise, the libraries will be better equipped to organize and make their library available to all users removing the need for patrons to report accessibility issues to the staff.

6. Conclusion

Based on this study, it seems purposeful to specifically develop evaluation guidelines and regulations to assess public libraries. It is also vital to address skills development among decision makers in the municipalities and the library staff. These issues should be addressed in future research and by practitioners in county and public libraries.

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Universal Design and Education

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Should Student Coursework Be Universally Designed? Universal Design Requirements May Prevent Academic Cheating

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Abstract. This study explores the proposition of requiring students to hand in universally designed coursework and the transferrable benefits of accessibility audits. Coursework that adheres to universal design (UD) principles will be more accessible to fellow students and teachers. In this study we investigate if the universal design perspective can have positive side effects as a vessel for plagiarism detection. An experiment confirmed that an accessibility checking tool indeed can help flag some cheating attempts that go undetected by the plagiarism detection tool, but not all. Universal designed coursework requirements may prevent students from exploiting several of these cheating techniques. Through the process of preparing universally designed assignments, students will gain practice, knowledge, increased competence, and awareness of UD.

Keywords. Accessibility, universal design, education, coursework, plagiarism

1. Introduction

Accessibility legislation requires systems and contents to be universally designed. Public universities have a particular responsibility for ensuring universal design to support equal educational opportunities for all. Electronic learning materials and cloud-based systems including learning management systems and exam systems must therefore adhere to universal design principles [1, 2, 3]. Besides initiatives for establishing cultures for inclusion within education [4] and accessibility study programs [5], there are currently no norms, legislature, or common standards that regulate the accessibility of electronic coursework. Coursework can be classified as *personally generated content*. Coursework typically comprises electronic documents. Imagine if students had to satisfy the same strict universal design expectations as their teachers, teaching institutions, and future employers. Envisage that all student coursework submissions were automatically screened using accessibility-checking tools; coursework that adheres to the requirements would be approved for assessment while submissions with accessibility problems would need to be fixed and resubmitted before being assessed by teachers.

We wanted to explore this proposal in more depth as we were unable to identify coverage of this in the literature. Clearly, imposing such requirements on coursework will require students to acquire universal design competences. Skeptics could argue that this is an unrealistic proposal, yet universal design advocates may argue that this would train the students in universal design practices. Moreover, universally designed coursework would benefit the diverse cohorts of teachers and fellow students.

Pragmatists may argue that such proposals will ascertain little traction as most educators and education leaders have moderate or no interest in universal design. We therefore explore a potential by-product of universal design requirements; namely how universal design requirements may contribute to reducing plagiarism in written coursework. Automatic plagiarism detection has been discussed for several decades [6, 7], but has become more viable during the last decade due to cloud technologies. Several recent studies have evaluated plagiarism tools [8]. Elkhatat et al. [9] explored several attempts at bypassing nine academic plagiarism systems. Their attack vectors included text-as-images, invisible quotation marks, homoglyphs, and word concatenation with invisible symbols (letter *q* in white). Their results showed that none of the systems could detect all the attack vectors. Text-as-image and invisible symbols were the most challenging. StrikePlagiarism.com caught most attacks. The authors acknowledged that there is no empirical data about the extent of such cheating approaches. Alvi et al. [10] focused on methods for detecting homoglyph attacks, namely the use of homoglyph tables and a domain specific similarity measure. Plagiarism tools typically report some similarity score for each submission. Educators usually examine coursework above certain similarity limits for plagiarism. Manley [11] warned against this practice and recommended that educators should examine all the plagiarism reports.

The vast literature on cheating in higher education serves as a testament to the wide interest in this topic [6-12]. Jeergal et al. [12] reported that 76% of students admitted to having participated in cheating. Moreover, recent advances in artificial intelligence [13] and privacy are also much-discussed topics in context of cheating [14, 15]. This study emerged following the extensive media coverage of several cheating cases in Norway involving people in position of power.

This study explores how cheating attempts that pass undetected through a plagiarism tool can be detected by a tool intended for detecting accessibility violations [16]. Manipulative formatting is exploited that is visually unnoticeable to readers yet making the texts unrecognizable to the plagiarism detection tools. We argue that the benefits of universal design for cheating detection can help persuade skeptics to endorse universal design requirements on students' coursework.

2. Method

2.1. Ideation of test cases

We started with an ideation process inspired by ideas from computer security, namely phishing and search engine obfuscation where the users (or crawling robots) are misled through visual trickery. This resulted in the following main "attack vectors": disguising text-as-images, obfuscating texts using homoglyphs, and obfuscating text using invisible formatting including small spaces, color formatting and occlusion. The ideation was conducted independently of, and before exploring, the literature [9].

2.2. Educational context and pdf

Although most students prepare their reports in Microsoft Word there are still a small percentage that for various reasons (cost, ideology, training) use other word processors (Apple Pages, Google Docs, LibreOffice), or document preparation systems (Latex, Overleaf, InDesign). Therefore, pdf-files are commonly used as these can be generated by most tools and prevent teachers having to handle different, sometimes obscure, document formats.

2.3. Plagiarism detection

We used the Ouriginal plagiarism detection system integrated into the Canvas learning management system. Ouriginal is considered one of the leading plagiarism systems used by many higher education institutions in Norway. A national service provider (SIKT) coordinates the service and maintains the coursework database. When grading the submissions the educator will see a color-coded icon with a similarity percentage on the submission overview page. The educator also has the option of viewing a detailed plagiarism report for a given coursework.

2.4. Accessibility checking

We used the PDF/UA foundation PAC 2024 (version 24.2.1.0 beta) [17] for accessibility checks as it is a non-commercial tool endorsed by several disability organizations. Besides PDF/UA compliance, PAC 2024 also validates WCAG2.1 compliance. The WCAG2.1 reports are particularly useful as many readers probably are more familiar with WCAG2.1 than PDF/UA.

2.5. Procedure

For this study a dummy assignment was configured within a canvas course and the various test cases were submitted using the student test mode. After submission, it takes up to half an hour for the plagiarism report to be ready.

2.6. Material

As a test case an arbitrarily chosen paragraph of text comprising 183 words was taken from the introductory part of the PhD dissertation by Oddmund Hoel, the current Norwegian minister of education and research entitled “Målreising og modernisering i Noreg 1885–1940” (NTNU).

To validate that this text would trigger plagiarism warnings the passage was pasted into an empty Microsoft Word document (Office 365 version 2404, build 17531.20152) and saved as a pdf document. Word did not give any accessibility warnings during the pdf generation step. Acrobat reader (version 2024.002.20759) declared that document adhered to the PDF/A (archive) standard which may easily be confused with PDF/UA (accessibility). The plagiarism tool reported 100% similarity with the original document, confirming that the source document was included in the database.

The document was also tested with the accessibility tool to identify a baseline of issues common to all Word-generated documents (to be ignored herein). There were two

PDF/UA issues and one WCAG2.1 issue. The PDF/UA issues included “PDF/UA identifier missing” and “Title missing in document's XMP metadata”. The WCAG 2.4.2 violation was described as “Title missing in document's XMP metadata”. The title issues were eliminated by inserting a title into the document information dialog in Word. No simple way of resolving the “PDF/UA identifier missing” (within Word) was found.

3. Results

3.1. Case 1: Text-as-image

The document was printed, and the printout scanned using an office scanner. When feeding the scanned pdf into the plagiarism tool it showed a grey box with an explanation mark and a warning that the document did not contain any text. This should make the educator suspicious as the text can be seen, yet the tool states that there is no text.

When running the same document through the accessibility tool 9 WCAG issues were reported, namely 6 *perceivable* issues and 3 *operable* issues. These include 1.3.1 (Info and relationships, “document is not marked as tagged” and “tagged content and artefacts”), and 2.4.2 (“display of document title in the window title”). No issues related to missing alternative text were reported.

Next, instead of using a scanner, an image snapshot was taken of the text in the Word document and this image was pasted into a blank Word document and resized to visually look like the original. Next, the document was exported to pdf. During this export Word raised accessibility warnings related to the image alternative text. Word prompted us for an automatically generated alternative text to be checked and/or changed. The alternative text read: “A close-up of a document. Description automatically generated”.

When running this document through the plagiarism tool the same gray “no text” warning appeared. Next, the accessibility tool reported 3 WCAG issues related to criterion 1.3.1 ("Figure" element on a single page with no bounding box) and a warning related to criterion 4.1.1 (Possibly inappropriate use of a "Figure" structure element). The missing title was also highlighted. It may not be obvious for an assessor how these issues can be related to the text-as-image issue.

The automatically inserted alternative texts caused the document to pass the alternative text check on false premises. If removing this automatically generated alternative text, the accessibility checker indeed warns about the missing alternative text (WCAG 1.1.1, Alternative text missing for "Figure" structure element). Hence, the accessibility tool does not appear to be the problem, but rather the pdf-generation tool (Word) due to the automatically inserted alternative texts.

3.2. Case 2: Text-as-image with decoy text

To bypass the “no text detected” plagiarism tool warning the image of the text was accompanied by a brief 130-word passage of arbitrary text. This text was made invisible with white formatting [18]. This text passed with 0% similarity. However, if inspecting the detailed plagiarism report the decoy text is shown with the formatting stripped. Hence, a vigilant educator would catch the cheating attempt, while an educator that simply follows the overview indicator would not notice the attempt. However, the accessibility tool indeed detects the invisible text formatted with no contrast, namely WCAG criterion 1.4.3 - Text with insufficient contrast (distinguishable).

3.3. Case 3: Decoy text occluded by text-as-image

Since the color formatting triggered a contrast violation an attempt was made keeping the text color but instead hide the decoy behind the image of the plagiarized text. The pdf-document was saved as text using the Acrobat reader to confirm that the decoy text was included in the document. This attempt passed undetected by the plagiarism check. Moreover, the contrast violation was avoided. Only the missing bounding box violation gave a clue to the cheating attempt.

3.4. Case 4: Homoglyphs

Homoglyphs offer a well-known security attack mechanism [19]. Homoglyphs are characters that have the same visual appearance as others (i.e. the regular alphabet) but with a different digital representation. By replacing regular letters in the text with such homoglyphs the resulting text becomes unrecognizable. Unicode 0435, a lookalike for e, was used herein as e is the most frequent letter in both Norwegian and English. To prepare the document the search and replace function in Word was used to replace all the lowercase e characters with the homoglyph.

The plagiarism tool reported a 0% similarity. However, the detailed report provides a "mixed alphabet" warning suggesting that there could be an attempt to subvert the plagiarism analysis. The attempt passed unnoticed through the accessibility checker. According to WCAG criterion 3.1.1 (Language on Page) the language used should be specified with a correct ISO language code (e.g. "en-gb" for British English). To the best of our knowledge, most accessibility checking tools simply check for the presence of such language codes. One could argue that the addition of a test for illegal characters for a given language could help detect certain accessibility problems.

3.5. Case 5: Invisible dots

The text was altered by inserting dots between each character (as in "w.o.r.d.". Each dot was formatted to be invisible to readers by formatting the text to 1 point white. A simple script was written to perform this task. Hence, the text was pasted into the tool, and its result pasted back into Word. Word indeed warned about the lack of contrast when converting the document to pdf.

The plagiarism tool reported a similarity of 87% with other texts. Five different sources were listed but not the original document. An inspection of the matches seems to suggest that others have previously employed this approach as well. The detailed report also contained the text with the invisible formatting removed revealing the cheating attempt. Despite the high plagiarism score, the tool did not manage to identify the original source. The accessibility tool successfully identified the invisible text with 1240 instances of insufficient contrast (WCAG criterion 1.4.3).

3.6. Case 6: Invisible spaces

To avoid the suspicious looking dots in the plagiarism report and the detection of missing contrast by the accessibility tool a script was written that inserted a space at a random position in all words with more than 6 characters (long words). The inserted space changes the original word to two new non-words thereby sabotaging the pattern matching.

These spaces were made invisible with 1pt text size. The script is available at https://frode-sandnes.github.io/textObfuscator/. Hence, the text was first copied into the form and the result pasted back into Word. Word did not report any accessibility issues.

The plagiarism tool reported 0% plagiarism with no warnings. However, if inspecting the detailed report, one may notice the odd spaces at various positions in the text. The accessibility tool did not report any issues besides the missing title. Hence, size formatting passes undetected although they represent a noteworthy accessibility problem.

4. Discussion

4.1. Can we rely on plagiarism and accessibility tools?

Results confirm that it is relatively easy to bypass plagiarism checks with simple means. Splitting words with invisible spaces was probably the approach least likely to draw attention from educators. The plagiarism tool seemed to perform approximate text matching well but with less attention to the overall context of use.

The accessibility checks did uncover some of the irregularities introduced by the visual trickery, but not all. In sum, the tool was successful in identifying text disguised using color formatting (insufficient contrast). The accessibility checker would thus also likely detect the invisible character attacks reported by Elkhatat et al. [9]. However, the tool was unsuccessful in detecting text disguised using tiny text formatting. Such texts are probably illegible to most readers, not just readers with reduced visual acuity. On the other hand, this result appears correct as WCAG does not give absolute font size recommendations (besides for color contrast limits). The gist is that a (web) document should be resizable allowing readers to choose the text size. Clearly, a pdf document is generally zoomable. For instance, the Acrobat reader allows a document to be magnified by 6400%. Note that only space characters will appear invisible if color formatting is not used, as all other symbols (such as alphabetic letters) will be visible to the readers after closer inspection even if these are given a small font size.

The plagiarism tool successfully warned about the homoglyphs, while these passed undetected by the accessibility tool. It seems the accessibility tool did not check for language specifications, or lack thereof. Leaning on WCAG 3.1.1 one could argue that such tools should flag the use of symbols from scripts not matching the current language.

The tests revealed that text-as-images passed undetected by both the plagiarism detection tool and the accessibility checking tool. The latter was due to the authoring tool (Word) inserting placeholder alt texts that resulted in a pass for the alternative text checks. This could suggest a larger problem as Word is commonly used for generating pdf-documents, in that it will generate pdf-documents that pass automatic WCAG alternative text checks, while not containing alternative texts that provide any useful information for screen readers. Functionality that was intended to help authors create accessible documents indeed becomes an accessibility problem.

However, the inserted images resulted in other accessibility issues. A trained evaluator may learn to read such signs. On the other hand, a student report with many illustrations may overwhelm the evaluator with violations making it hard to separate accessibility issues from cheating attempts.

The accessibility tool was unable to detect the occlusion issues where the decoy text was hidden behind an image. The lack of occlusion accessibility checks has been pointed out by others [20], and several approaches for detecting occlusions in the context of

rendering failure detection have been proposed [21]. In sum, it seems we cannot fully rely on either plagiarism detection tools or accessibility tools. Combined, the tools can uncover more cheating attempts.

4.2. Limitations of this study

This study is based on the technology available in 2024. Plagiarism and accessibility technologies are continuously being developed and improved and it is likely that one will get different results if repeating this study as the technologies evolve. Next, a handful of attack vectors were explored. This is not an exhaustive list of cheating approaches.

Although the visual cheating attempts explored herein are relatively straightforward to execute, they also require some technical insight. Hence, the explored scenarios are hypothetical as we, and others [9], do not know the extent to which such techniques are exploited in practice. It would be relevant to uncover if such techniques are utilized, and if so, to what degree. Such insights could be obtained by analyzing past coursework.

4.3. Recommendations and future directions

Besides using accessibility tools, how can educators detect such cheating attempts? And, if detected, how can one identify the plagiarized sources? A practical approach is to open a pdf document in Acrobat reader and save the result as text. The resulting file will reveal visual tricks such as invisible characters since the text is stripped of formatting. Moreover, this text file will also include all the alternative texts in the document. Automatically generated placeholders can then be detected through manual inspections.

To locate the plagiarized source the plagiarism tool needs to be fed the text as perceived by the readers. Elkhatat et al. [9] suggest that this can be achieved by rendering the documents as images and then extracting the text using optical character recognition (OCR). Theoretically, OCR software will not respond to invisible characters, will treat homoglyphs as the most typical characters with a particular appearance, and extract text from images. A simple test was conducted to validate this claim by feeding each test case into a Tesseract OCR demo (https://tools.simonwillison.net/ocr). The results confirmed that each extracted text gave close to 100% similarity with the source.

If students could only submit coursework that adheres to accessibility guidelines, students attempting to use certain visual cheating attempts would be stopped due to the accessibility violations. Hence, in addition to promoting universal design, the requirement may have a preventive effect on cheating.

Future work includes shedding light on the underlying reasons and rationale for why students were exempt from the UD requirements. Moreover, it would be relevant to probe different (technical and non-technical) student cohorts' perceptions towards coursework UD requirements, as well as how this would align with student organizations' work on promoting equal access to education for all.

5. Conclusions

This study explored the simplicity with which a plagiarism tool can be bypassed using visual trickery, and to what degree an accessibility tool can help detect such cheating attempts. The results show that the accessibility tool could identify attempts at making text invisible through color manipulations but was unable to detect text size

manipulations. Also, it failed to detect text-as-images, homoglyphs, and visually obstructed text but gave indirect clues to manipulations manifested in bounding box violations which require experience to interpret successfully. We argue for requiring students to provide universally designed documents to raise their awareness of accessibility and to prevent cheating.

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The Use of Card-Game Design to Teach Universal Design Theory

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Abstract. This paper discusses the use of a card-game design task to teach the implementation of Universal Design (UD) principles to undergraduate students. The underlying assumption is that in order to implement UD methods, designers need to select the right tools to gather information and they need to understand the theoretical basis of the tools chosen. The aim is to bridge the theory/practice gap by getting students to actively consider how each aspect of their design research contribute to the implementation of the theory. Work by Herriott (2023) shows that design researchers are not consistent in explaining or making transparent the underlying reasons for why a UD tool was chosen. UD theory is also somewhat weak on the topic of implementation, a necessary element of design theory according to Jones & Gregor (2007). The didactic purpose of the card-game design was to encourage students to become conscious of the reason they chose the design tools eventually used in their course project. It was also to examine how, from a UD theory standpoint, implementation of UD could be enhanced since this aspect of UD theory appears to be in need of reinforcement. The students developed in class a card-game which could be used to create and advance their designs and also to retrospectively analyse them upon completion. The in-class discussion of what was required for a game also focused students´ attention to the elements of UD and their possible implementation. The work shows that more time is needed to explain game design; mapping of UD concept to game affordances is necessary; the course learning outcomes require addition of demonstration of theory-to-implementation

Keywords. Universal Design, design theory, tools of inquiry, design process.

1. Introduction

This paper is a preliminary report on part of on-going research into improving UD practice. The intention here is to provide a preliminary description of a means to explore ways to make the link from theory to practice stronger. Vavik notes that "to become a professional designer one has to have theoretical knowledge, practical skills and professional experience" [1, p.1]. Wilson et al. [2, p.619] note that "uptake of inclusive design in industry is limited, with designer awareness of the approach and its associated methods and tools noted as barriers to its uptake". Wilson et al. [2, p. 626) also write that there is "scope for improvement surrounding the communication of basic ID theory". This paper may go some way to help communicate UD ideas in class.

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The basis of the research was a study into the use of theory, defined by Jones & Gregor [3], which found that "that design researchers working on design for disability and universal access need to explicitly identify the structure of their theoretical content" [4, p.139]. Theory related to implementation was the under-emphasised element. Implementation means putting the theory into effect, using design methods and tools [3]. This resulted in a follow-up study [5] into the link between implementation and design tools. The link from theory to tool selection was found not to be very strong. The next phase led to an (ongoing) series of class-room based teaching experiments for design students in Denmark (3 classes at bachelor level) and Turkey (1 bachelor and 1 master´s) classes. The focus on the link between theory and practice led to a decision to use game design, argued for by Majuri et al. [6] as means to strengthen the link between design "tools of inquiry" [7] and the supporting theory. The work represents an attempt to make explicit that there is a link from UD theory to the tools used and on to the type of data gathered (quantitative, qualitative, mixed methods). See Figure 1, below:

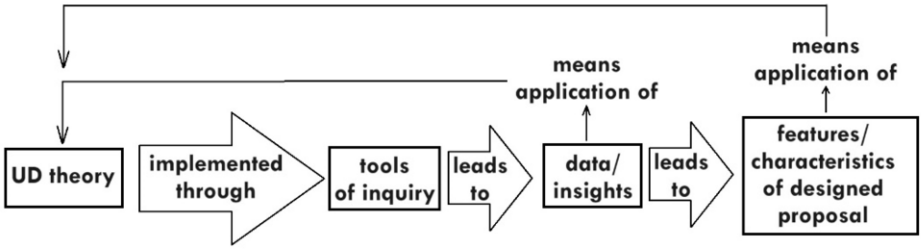


Figure 1. Mapping UD theory to game design features/principles.

This paper reports on teaching with the 2nd year BA industrial design students of the UD course. The class size was 17 students (which is in line with Dong´s [8] recommendation that smaller classes are better for teaching ID.

2. Literature review

This section consists of a short review of 1) UD, 2) UD in education, 3) gamification and 4) gamification in relation to teaching accessibility. Defined many ways, UD is design to accommodate a wide a range of cognitive and physical capabilities, the user´s wish for autonomy and self-actualisation. The terms Inclusive Design (ID), Universal Design (UD) and Design For All are viewed as being synonymous in much design research literature [9; 10, p.3; 11, p.93; 12, p.2; 13, p.2]. The term UD will be used here.

2.1. Universal Design, teaching of

Some research into teaching UD addresses what are called frameworks [1, 8, 14] or strategies [15, 16] while others look at the use of design tools [16, 17]. Some papers such as [8, 2, 14, 16] consider both. None cover the link from theory to tool use. Frameworks and strategies refer to high-level structures to help conduct teaching. Dong [8] describes how to position UD in courses (separately or integrated), how to get students to relate to disability and how imagine realistic situations. Vavik [1] presents the essential

elements of the inclusive design process but doesn´t go into much detail about the pedagogic methods. Watchhorn [15] discusses how to integrate UD teaching into interdisciplinary courses for building design ("architecture") and occupational therapy students. The strategic aspect of this work lay in the use of a variety of methods of teaching: in-class lectures, on-line resources (narrated slide shows), links to external resources and "interactive interviews with key stakeholders" [15, p. 482]. There was also a full-day class on virtual and real-life simulation of wheelchair use and vision impairment. Students also used a virtual-world simulation with common barriers found in real life. To be noted here is that to evaluate the teaching, the students were asked to report on their own change in awareness of UD. Scott et al. [16] inquire into how effectively UD is taught. Unusually for a building design course, there was clearly stated an assumption about inquiring into user groups by "engaging with them" (15, p.1). Participatory design is cited for one project and for another, a series of workshops with feedback from local citizens on the design proposals. One of the projects did not involve users, and was concerned with designing inside the framework of regulatory compliance. Rieger and Rolfe [14] describe a learning framework for teaching inside the context of building design. The means used in the coursework, involved users of various capabilities, student journals, qualitative and quantitative questionnaires, and studio project work. The article´s premise is that UD teaching is mostly limited to "fake personas, building codes and anthropometric data" [14, p.359] . The relevant part of this research is the structure for what is terms "authentic learning". Those feature are summarized as collaborative a real application, complexity, a broad range of data sources, supportive tutors and a chance to reflect on the work (14, p 360).

Turning to ways to teach inclusive design research tools, Dong [8] reports on the use of personas and scenarios to teach larger classes and the use of people with disabilities in smaller classes. The strategies are focused on UD as a general concept and a general approach. Rieger & Rolfe [14] listed different teaching methods for doing inclusive design: lectures, questionnaires, anthropometrics, sensory activities (e.g. simulating blindness), site analysis with a blind person, modelling, readings and reflective journals. Oleson et al. [17] focused their work on a design tool rather than the theory of Universal or Inclusive Design itself. The paper reports on pedagogical content knowledge (PCK) and identified the main approaches relevant for this. This work was conducted in relation to human-computer interaction (HCI) with a focus on software design looking specifically at implementation of the GenderMag inclusive design inspection method. Wilson et al, [2] investigate inclusive design education on a general level. Based on a survey of UK design courses, Wilson et al. found the tools used for teaching were simulation tools, ethnography, user-participation, "on-line resources", personas and observation methods. Note the dual use: tools of inquiry used *for* teaching and *to* gather design data.

2.2. Gamification, general points about

Gamification is an approach that uses rules-based or free play behaviours in various settings to encourage different mental approaches and actions [18,19]. Majuri *et al*. [6] note the effectiveness of gamification for human engagement and write that "it is not surprising that gamification has been especially addressed and implemented in the realm of education where supporting and retaining engagement is a constant challenge." Huotari & Hamari [18] are among the earliest to try defining gamification [19, p.9).

Huotari & Hamari [18, p.25] proposed a definition of this, though one related to service design: "Gamification refers to a process of enhancing a service with affordances for gameful experiences in order to support users' overall value creation.". Deterding *et al* [19, p.9] suggest it is the "use of game design elements in non-game contexts". Majuri *et al*. [6], write that the interest of studies has been on quantifiable factors such as course and assignment grades (rather than, say, content or non-quantitative objectives.

2.3. Gamification, use in teaching

A survey of the use of gamification in teaching is presented in Majuri *et al*. [6, p.11]. Only one of the measured behavioral and psychological changes in [6] involved something akin to learning, namely knowledge transfer. That doesn´t quite describe the change in mental state one might be aiming for (in this paper, the understanding of theory in relation to UD).

Finally, gamification for teaching UD (or accessibility). Earlier work on gamification and for communicating UD includes [20] and [21]. This relates to digital accessibility and the game design is screen-based as are Buratti *et al*. [22] and Buratti *et al.* [23] Lorgat *et al.* [24] report on using gamification in teaching accessibility for software design students, "a gamified quiz composed of situations or questions". This work then deals with UD-type material but is primarily about delivering factual material.

An important concept in gamification is that of motivational affordances [6]. These are the aspects of the game that encourage play: accumulating points, for example, to signal progression and achievement. The other point to note is that much work in gamification involves quantifiable outcomes e.g. grades and assignment completion. In this paper, the interest is not on quantifiable outcomes but how a game can be used to explain theory´s relation to tools of inquiry, data and design outcomes.

From this background, the question is whether one can use a game design with appropriate motivational affordances to help convey ideas of UD (theory, tool use and data gathering). Another aspect of this is that the students are asked to develop the game structure rather than the structure being provided by the teacher.

3. Experiment with game design - method

Prior to any instruction on UD, the students were asked to draw a design process. These diagrams were collected and stored. About 20 days into the course, the students had begun their design work and to consider the data they needed to gather in relation to their project. The instruction to the class began with a refresher on the main points of UD. Some principles of game design were explained. Games are primarily about making strategic choices. Game designer Sid Meier [25] said that "a game is a series of interesting decisions". A game needs to have options which are not clearly superior such that there are several pathways to a good result. A game needs to be balanced such that there is a reasonable chance for all players to achieve a win. Finally, skill must be balanced with luck – enough skill to make the game challenging, and enough luck to add some random interest so as to lead to varied outcomes [26, 27, 28].

The instruction was for the class to act as a group to design a game that could communicate the application of UD principles. The class were asked to consider the mechanism by which the a game could embody aspects of the design process. The students were supplied with sheets of Canson card in ten colours, coloured markers, glues, craft blades, a radius cutter (for rounding the cards´ corners), pencils, and marker paper. While the class worked, the author made a prototype game using the same guidance. At the end of the class, the students´ proposal was explained and tested. The game was compared to the teacher´s attempt. One the last day of course, students were again asked to draw a design process. The diagrams were collected and stored. The initial design process diagram was compared to the one done at the end of the course, focusing on instances of design tool use. The students´ 10-slide visual presentations were checked for instances of design tool use.

4. Data and Analysis

The process diagrams from the first and final day of the course were compared. Any design tools e.g. user-interview, sketching, prototyping, were counted. For the first set of diagrams, the average number of design tools named was 4.13. In the second diagram, the average number of design tools named was 8.6. Only one student did a second diagram with fewer named design tools on it than on their first diagram. In the first round of process diagrams there were more outcomes (e.g. "the model", "data". "sketches" and "information") rather than design tools e.g. sketch, model-making, mind-mapping. In the second set the tools used occupy more of the project description (e.g. mood board, make prototype, interview, observe etc). This implies the students are thinking more about what design tools they had been engaging with. The project presentations (10 slides per student) were analysed. The average number of design tools used was 7. In the presentations there was a less emphasis on the design tools than in the diagrams. Perhaps students wished to avoid repetition.

Turning to the card games from the classroom exercise: the student card design consisted of a conversation game intended to spur design discussion. It had cards for:

1) UD design characteristics (e.g. equitable use, flexible use, simple to use, low physical effort, etc.)
2) Capability/Constraints (e.g. memory, social skills, technical knowledge, speech, mobility, vision, etc.)
3) Situation/task (e.g. put on clothes, taking a shower, cleaning the home, send a text, etc.)
4) Design tools (e.g. focus groups, concept mapping, K/J method, interviews, design ethnography, prototyping, personas, etc.).

Additional cards consisted of design challenges e.g. design a stairlift, a coffee canister, or reacher grips. UD theory was communicated in the product challenge discussions prompted by the cards taken e.g. was there UD principle at stake in the design challenge? Which capabilities were relevant or which kind of design tool was needed to get information to solve the design challenge? The play approach of the students didn´t

include the kinds of game affordances one might expect, such as accumulating points or progression. It was a game in the sense of a conversational aid or discussion prompt. It followed the pattern of other card sets used in design e.g. the 6C model [29]) or the Design Guide to User Ecosystem Thinking [30]. The design created by the teacher (the author) consisted of a set of seven UD principles cards (see Fig. 2 below).

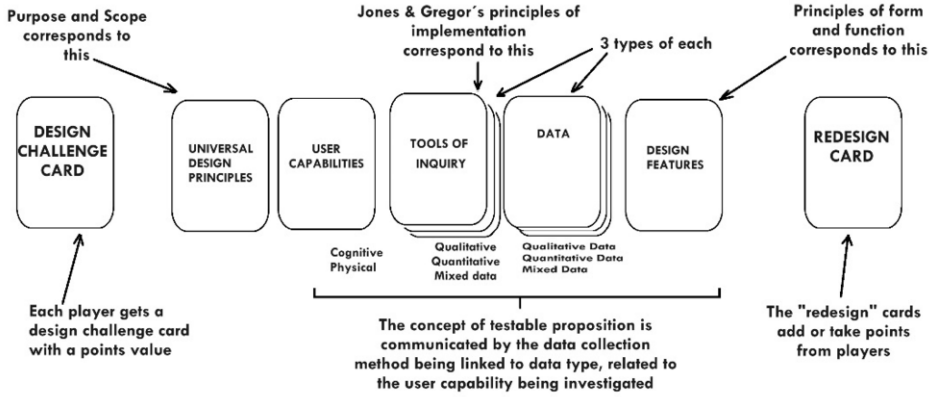


Figure 2. Teacher´s design card set. The middle five cards have assigned points. The points must match the value on the design challenge card. The "redesign" cards (right) allow the players to confiscate points from other and/or add points to their own set.

The aim of the game was for each player to acquire the points required by the design challenge card. This was done by picking up, putting down from the deck or taking cards from other players. The game afforded gaining points towards a winning quantity; it also allowed competitive play element in that players could add to others´ points requirements (simulating adding features) or take points from them (simulating unsuccessful research). The first player to have the correct total of points, right type of data and matching UD principle card wins the round. The other value of the card sets (both students' and teacher's) was the use as diagnostic tool in project discussions. Following the morning class, students had project feedback. Both the card sets structured the conversations about what design research tool was needed to solve the existing design problems. It was also possible to analyse the elements of the projects, using either set. That way the students could understand what elements worked in their project up to that point.

5. Conclusion and discussion

This paper should be taken as merely a brief glimpse into approaches to UD pedagogy. The research was dealt with strengthening the relationship between students´ understanding of the link between UD theory, UD implementation and the outcome of their design projects. Further work on this approach should make the theory-tools-data-feature chain more explicit. As it is, it is at best circumstantial. The citing of more instances of design tools (from about 4 to about 8) shows greater awareness of the tools; it only implicitly supports the notion the tools were chosen with theoretical reasoning in mind. A less interesting way to direct attention to this is to create a tabulated document to structure the theory-data-tools-feature chain. The designer would list the features and

then supply the corresponding meso-theory, design tool, data type (quantitative/qualitative/mixed) that led to that feature.

One of the peer reviewers asked about the relation of the teaching experiment to the learning outcomes. Space doesn´t allow a full analysis of the demonstration of the learning outcomes in the course description; however, the student responses indicated the achieving this outcome: "to have knowledge about universal design methods and principles", corresponding to the students using an average of 8.6 design tools to achieve a universally designed proposal. The examiner and censor who assessed this course work reported a high level of satisfaction with the work presented. They reported (informally) that in the exam presentations the students focused on UD design principles, user capability and data gathering.

The following points emerge from this brief initial experiment. One, since designing a game to explain abstract theoretical content requires the mapping of two sets of rules together [20] this has to be explained more clearly; neither sets of rules are directly equivalent so this requires judgement. Two, that more time is needed for students to understand the concepts of game design if they are to map them onto the concepts of UD. Further experimentation with this teaching will set aside more time to allow a second iteration of the game and more time for testing. Three, even if the student game design does not produce a concept as good as expected, it still provides an avenue for discussion. This could be questions such what is it that is not working in the game in relation to the learning outcome? How can the game be made more realistic and given a rule to drive it forward?

Finally, the aim of the exercise is not to teach game design – the aim is to find a game-based mechanism that can capture elements of the chain of concepts leading to application of UD ideas via UD design tools from the theory they are grounded in. This preliminary work will be followed up with a more elaborated method and teaching plan.

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The Digital School – Can Everyone Participate on Equal Terms?

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Abstract. This paper examines the accessibility of digital learning tools in Norwegian schools, highlighting significant deficiencies that hinder equitable participation, especially for students with disabilities. Through inspections, surveys, and stakeholder consultations, critical gaps in compliance and competence are identified. Recommendations are provided to strengthen regulatory enforcement, enhance teacher training, and support the procurement of accessible learning resources, aiming to ensure all students can equally benefit from digital advancements in education.

Keywords. education, equal participation, digital learning tools, universal design of ict, digital inclusion, accessibility, inclusive technology, students with disabilities, technology in education.

1. Introduction

In Norway, all children have the right to equitable education [1, 2]. Education is directly linked to other fundamental rights, including the right to work, freedom of expression and full participation in society. Schools therefore play a critical role in inclusion, for every student to develop their skills and receive education tailored to their individual needs and circumstances.

Norwegian educational authorities have long prioritized the integration of technology and digital skills. The COVID-19 pandemic and homeschooling accelerated this. While digital tools can enhance learning outcomes and promote inclusion through accessibility features, their effective implementation demands careful adaptation of teaching practices and integration of universal design into the solutions themselves. However, investigations have revealed a widespread lack of accessibility in digital learning materials, and both Norwegian media, civil society organisations and students reported several cases where students were shut out due to lack of accessibility.

The Strategy for Digital Competence and Infrastructure in Kindergartens and Schools 2023-2030 [3] sets forth goals for inclusive learning and equal access to education. It emphasizes the use of inclusive technology and customized digital accessibility aids to support all students, including those with disabilities, in regular teaching.

Since 2014, Norway has mandated universal design in ICT solutions [4, 5]. The regulations, enforced by the Authority for Universal Design of ICT, apply to both the private and public sectors and aim to promote equal societal participation, dismantle and

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prevent new digital barriers, and prevent discrimination. Since 2018, the regulations have been extended to include digital learning materials and digital solutions used in education.

The Government's *Action Plan for Increased Inclusion in a Digital Society (2023-25)* [6] includes several measures to ensure universal design in the education sector. The enforcement of compliance with the regulations for universal design of ICT shall be strengthened, with particular emphasis on digital solutions used by children in education.

Despite these efforts, challenges persist. The number of discrimination complaints reported by the Norwegian Anti-Discrimination Tribunal related to digital learning materials has increased significantly, and universal design deficiencies have been identified in all digital education solutions tested by the Authority for Universal Design of ICT [7].

To address these issues, the Authority for Universal Design of ICT conducted a comprehensive inspection of digital solutions in primary schools in 2023. We have conducted accessibility testing of digital solutions, mapped the most used digital learning resources and surveyed parents and students' experiences with the use of digital learning materials, with particular emphasis on students with disabilities. We have reviewed relevant research, policy guidelines, and strategies. In addition, we have had dialogue with civil society organizations, suppliers and authorities.

This paper presents a summary of our report, *The Digital School – Can Everyone Participate on Equal Terms* [7]. It aims to provide new insights into the opportunities and challenges of digitalisation in the education sector, while providing recommendations on how to ensure an inclusive digital school for all.

2. Methodology

To compile a broad knowledge base on the status of digitalisation in Norwegian schools, the Authority for Universal Design of ICT used a multi-faceted approach combining document analysis, literature review, and qualitative and quantitative research.

A thorough review was conducted of political goals, strategies, laws, international conventions, and regulations pertinent to universal design of ICT. This included examining enforcement procedures and comparing overarching goals, rights, and requirements with current data on the status of digitalization in primary schools. Emphasis was placed on the utilization of digital devices, digital learning materials, learning platforms, and collaboration solutions.

A review of secondary sources was also conducted. This included examining public committee reports and research articles that discuss the potential and challenges of digital competency, technology, and digital solutions in educational settings. This review aimed to contextualize the findings within broader educational and technological discourses.

A nationwide survey was administered to collect user experiences with digital learning materials and digital solutions among students with and without disabilities. The survey explored the balance between digital and analogue learning materials, user-friendliness, comprehensibility, and the degree to which teaching methods were adapted to individual needs. Special focus was given to the experiences of students with disabilities, to ensure their perspectives were adequately represented.

Collected data from the survey, alongside statistics from educational authorities and assessments of enforcement procedures, were analysed. This analysis included data from inspections and other surveys on universal design. Key areas of focus were compliance with regulations, the identification of violations, and the assessment of their impacts on

students with various disabilities. The aim was to derive insights that could inform knowledge-based recommendations for the education sector, suppliers, and authorities.

3. Main Findings

3.1. Extensive Digitalization of Primary Schools but Minimal Focus on Universal Design

A significant majority (93%) of primary school students have access to a tablet, PC, or Mac [8]. Older students have the greatest access. Specifically, 20% of first graders do not have their own digital device, while this figure drops to just 1% among tenth graders.

The vast majority (98%) of primary schools use digital learning materials in teaching [10]. The proportion of total sales attributed to digital learning materials increased from 12 percent in 2017 to 41 percent in 2021 [11]. Three out of four primary schools wish to further increase the use of digital learning materials [12].

A survey conducted by Oslo Economics [13] for the Authority for Universal Design of ICT identified the most used digital solutions. Over 70% of schools use NRK School and YouTube for teaching purposes. Other popular tools include Book Creator, Salaby, and Geogebra, used by between 50% and 70% of schools. Microsoft products are widely used, indicating Microsoft's significant presence in Norwegian primary schools.

Key factors influencing the choice of learning materials include time and budget constraints. For example, 57% of primary school leaders consider price important, while 42% prioritize content quality. Privacy, information security and universal design are less emphasized, as 20% of school leaders stated these as important criteria [12].

Both schools and suppliers recognize the importance of universal design but face challenges in complying with regulations. Very few schools consider that they have sufficient competence. Although 86 percent of schools participating in the Oslo Economics survey consider that they lack competence, fewer than half have planned or have carried out training in universal design of ICT [13]. The Norwegian Directorate for Education and Training's guide for assessing learning materials in connection with procurement is intended to ensure that materials support effective learning, engage, and are relevant. Less than half of school owners have adopted the guide [14].

3.2. Many Positive User Experiences but Challenges Identified

Proba Research conducted a nationwide survey on behalf of the Authority for Universal Design of ICT, involving 2750 parents of primary school children [15]. Approximately 25 percent of parents responded to the survey together with their child.

3.2.1. Parental Opinions on Digital Learning Materials

Overall, 47 percent of parents believe the use of digital learning materials is appropriate, while 44 percent think there is too much, and 4 percent feel there is too little. Parents who answered together with their children, were generally more positive about digital learning materials.

Digital learning materials offer unique advantages over printed materials, such as individual adaptation, quicker feedback, increased motivation, and enjoyment. However,

criticisms include their effectiveness in teaching basic skills like writing, arithmetic, and reading, potential distractions, and concerns over the extent of their use.

Between 49 and 60 percent of parents agree that digital learning materials enhance mastery and learning outcomes, are user-friendly and understandable. However, only 34 to 40 percent believe that teaching is adequately adapted to each student.

3.2.2. Experiences of Students with Disabilities

The survey included 537 students with disabilities, learning difficulties, chronic illnesses, or other diagnoses affecting learning and schoolwork. These students tend to use digital learning materials more extensively than their peers without disabilities. 56 percent of students with disabilities prefer digital solutions over analogue materials, compared to 45 percent of students without disabilities.

While many students with disabilities find digital solutions more effective than analogue materials, those with learning or concentration difficulties often face distractions and unclear instructions, indicating a lack of universal design in digital solutions.

About 36 percent of students with disabilities use aids to benefit from digital learning materials. Aids for hearing and alternative and augmentative communication (AAC) are highly rated but used by few students. The most common aids, such as braille displays and text-to-speech programs, are frequently considered ineffective by parents, which is serious given that many students depend on them to function.

3.2.3. Parental Involvement

Many students facing difficulties with digital solutions rely on parental assistance. But about 25 percent of parents find it challenging to assist their children with digital learning materials. For the most vulnerable students lacking such support, digital solutions may exacerbate educational disparities.

3.3. Status of Universal Design of Digital Learning Materials and Enforcement Practices

Inspections conducted by the Authority for Universal Design of ICT revealed that lack of universal design in digital learning materials is widespread. Regulatory breaches were found in all the 11 digital learning platforms tested by the Authority in 2023 [17].

The most common breaches affected students with dyslexia, those who are blind or have severe visual impairments. Additionally, most learning materials violated keyboard navigation requirements, impacting not only visually impaired students but also those with motor disabilities. Violations regarding the captioning of audio and video content were also noted, which are crucial for students who are deaf or have hearing impairments. Furthermore, weak contrast and the lack of text enlargement options pose significant challenges for students with moderate visual impairments. Similar issues were found in surveys conducted by Oslo Economics and UseIT Consulting on the universal design of digital learning materials [17].

Breaches of universal design regulations in education are particularly serious. The Authority for Universal Design of ICT addresses these violations through corrective orders with non-compliance subject to fines. Of the 11 digital platforms inspected in

2023, four were given corrective orders and fines proposed for seven. In all cases, the issues were resolved before the conclusion of the sectoral inspection.

The Authority for Universal Design of ICT issues ICT-related opinions in discrimination complaints received via the Norwegian Equality and Anti-Discrimination Tribunal. In 2022-2023, all 21 digital learning materials tested failed to meet universal design requirements [9]. This is concerning due to the comprehensive and often lengthy process of handling discrimination complaints, which can result in students missing significant portions of educational objectives if the complaints are not resolved promptly.

3.4. Research Reaches Contrasting Conclusions

Research shows that there is significant but unrealized potential in the digitalization of schools. For students, technology is a given [2]. The combination of personal PCs and other mobile tools, learning platforms, and the internet has opened new possibilities for active participation in teaching and learning processes. However, students are also aware of the challenges and negative aspects of technology.

The government-appointed Screen Use Committee [19] conclude that reading comprehension is better when reading continuous informational texts on paper compared to a screen. But in writing instruction, both handwriting and keyboards are useful. A large international meta-analysis of research shows a positive correlation between screen use and learning outcomes, provided it is used for educational purposes. Mobile use in schools is a tool for learning but can also be disruptive. Digital technology in classrooms changes the learning context and poses new demands on schools. The Screen Use Committee emphasizes that more knowledge is needed about good digital teaching practices, varied work methods in digital classrooms, and the fundamental conditions for learning.

The Knowledge Centre for Education (KSU) at the University of Stavanger, in collaboration with researchers at the University of Oslo and Volda University College, has prepared a research-based summary on digitalization in basic education [20]. They point out that the integration of digital tools, resources, and learning materials has potential for students' learning and development of skills. Most teachers are positive to digitalization. The teacher's role is very important in all phases of learning processes with digital technology, but there are few concrete plans for developing digital competence among teachers and students. There is also little attention to learning goals for students' using digital resources. They point out challenges related to integrating digital technology in teaching and emphasize that realizing the potential does not happen automatically. More research-based knowledge is needed.

Systematic use of learning analytics is one of several measures that can ensure a more knowledge-based approach [21].

4. Conclusion and Recommendations

Digitalization in the education sector offers significant opportunities for enhancing learning and mastery for students. However, realizing this potential requires substantial groundwork to ensure that all students can participate on equal terms. This is especially critical given the political goals and legal frameworks that uphold the right to education and the rights of people with disabilities.

Currently, the primary challenge is the lack of a comprehensive and systematic approach to ensure that individual students do not bear the burden of their own learning when digital solutions fail. This situation threatens the right to equitable education. A series of interconnected factors contribute to these challenges, creating a complex barrier to achieving truly inclusive and effective education.

4.1. Lack of Compliance with Regulations Requires More Inspections of Universal Design of ICT

Despite legal requirements, strategies and action plans, compliance with the regulations remains very low. Suppliers recognize the importance of universal design, but many express concern that universal design could hinder innovation. However, the inspections reveal that suppliers often fail to use the flexibility within the regulations to address different user needs.

Inspections have proven effective. But the number of inspections is currently too low. Increasing the number of inspections is one of the measures outlined in the Action Plan for Increased Inclusion in a Digital Society [6] and is also recommended by Oslo Economics and UseIT Consulting [17].

4.2. More Targeted Guidance on Interpreting Requirements for Universal Design and Digital Learning Materials

The Authority for Universal Design of ICT provides guidance on interpreting regulations and solution proposals for universal design of ICT. There is a need for more guidance that addresses regulatory interpretation questions and doubts that arise, particularly in connection with digital learning materials, making it easier for businesses and suppliers to comply with the requirements.

4.3. Strengthening Competence on Inclusive Digital Teaching Practice amongst Teachers

Digital skills are one of the fundamental skills in the new curricula [22]. But there are few concrete plans for developing digital competence among teachers and students.

There is a need for a national competency boost in universal design of ICT and inclusive digital teaching practices in education. Guidance on inclusive digital learning should be a highly prioritized task, and suppliers must also contribute to the competence boost on inclusive use of technology.

4.4. Joint Service to Support the Municipalities When Procuring Digital Learning Materiales

Schools find it challenging to ensure that learning materials comply with regulations for universal design of ICT. School owners ask for the responsibility to be elevated to a national level.

There is a need for a joint support service for coordinating procurement and a publicly managed national service catalogue for digital learning materials. The Ministry of Education and Research should consider the need for a national approval body for digital solutions used in schools.

4.5. Ensure Financial Support for Learning Materials and Assistive Aids with Limited Market Potential

There is a need to strengthen funding for the development of necessary learning materials that do not have significant commercial potential. Learning materials and aids for blind, severely visually impaired, deaf, and sign language students, students with cognitive disabilities, and students needing alternative and augmentative communication (AAC) are particularly important to prioritize.

4.6. Prioritize Standardization to Safeguard Requirements for Universal Design and Educational Considerations

Standardization is an effective tool that should be used more to address specific challenges in the sector. Ongoing standardization initiatives [23] should be given high priority, and the need for more standardization initiatives should be considered.

4.7. More efficient Process for Handling Complaints to Strengthen Students' Protection Against Discrimination

The process for handling complaints from students on discrimination is fragmented and inefficient. Clarifications of violations must be made quickly to be useful for the student. Responsible ministries should take the initiative to investigate the need to adapt the handling of complaints on discrimination in the ICT area so that students' protection against discrimination is safeguarded.

4.8. National research program to Realize the Full Potential of Technology in Education

Several reports conclude that the potential of digitalization is not being realized. There is a need for a national research program. The potential for systematic use of learning analytics should be considered, also with a view to safeguarding students with disabilities that affect participation in teaching and learning.

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Universal Design in the Built Environment

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Empowering a Universal Design Course for the Built Environment: Exploring Learning Experiences Through an Interdisciplinary, Multicultural and Civic Approach

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Abstract. Promoting inclusion and diversity is essential for creating an inclusive built environment. Next to building knowledge and understanding on the topic, it is also crucial to foster inclusive attitudes and awareness for both personal and professional growth. In developing a new architectural course 'Designing with People', our goal was to elevate knowledge and understanding of an inclusive built environment as well as to create more awareness on inclusion and diversity, guided by the Universal Design paradigm.

To achieve this, the authors established a civic approach and facilitated interdisciplinary, intercultural collaborations to create a symbiotic learning environment among international students Interior Architecture and Architecture, students Occupational Therapy, clients and user/experts. This paper explores the strategy for advancing universal design through collaboration and examines if and how a network of stakeholders can mutually benefit from shared learning experiences. To understand stakeholders' perspectives, the study utilizes reflection reports, surveys with open-ended questions, and self-assessment questionnaires.

Results point to notable positive learning experiences in knowledge-sharing, way of working and thinking, a more nuanced view on people with disabilities and the synergistic combination of diverse perspectives, indicating that 1+1=3. While enhanced awareness among students on diversity and disability topics was less noticeable throughout the course, the intensive collaboration with international students from diverse geographical and cultural backgrounds seemed to increase awareness of other cultures and identities. The outcomes suggest that promoting mutual learning experiences among students from diverse disciplines together with other stakeholders, can not only enhance educational settings but also holds the potential to inform and improve universal design practices in various professional contexts. This opens up opportunities to significantly enrich the discourse on inclusion and universal design.

Keywords. universal design, inclusive design, architecture, occupational therapy, symbiotic learning, interdisciplinary collaboration, civic approach, higher education

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1. Pushing the boundaries of Universal design education

Promoting inclusion and diversity is essential for creating an inclusive built environment. As a design paradigm, Universal Design (UD) can be considered a crucial element in this ambition, but what ingredients are essential for teaching UD to higher education design students? Drawing from the literature, several critical elements emerge: cultivating knowledge about a broad spectrum of users, integrating insights from diverse user perspectives throughout the design process, applying relevant research methods and tools to help students grasp user needs and fostering empathy between students and the diverse communities they serve [1-4].

However, can we push the boundaries even further to expand learning experiences and foster a more inclusive mindset and awareness for personal and professional growth? This aspect is important for everyone, regardless of their profession. Therefore, the authors aimed to look beyond the 'standard' ingredients of UD education in the development of a new design course, 'Designing with People'. A symbiotic learning environment was created involving a network of stakeholders, including students from occupational therapy (OT), architecture, and interior architecture, user/experts, clients, and the teaching staff. The concept of symbiotic learning, where all participants benefit mutually from shared learning experiences [5, 6] seems interesting to advancing UD through collaboration. In this way, there is not one direction in transferring knowledge – from tutors, clients and user/experts to students– but all involved stakeholders can learn from one another. In order to create a symbiotic learning environment, several strategies were explored to stimulate this.

Research demonstrates that an interdisciplinary collaboration between designers and Occupational Therapists has the potential of being an enriching collaboration benefitting both designers and Occupational Therapist [7]. Various studies have examined this collaboration in different design domains, such as product design [1, 8], visual communication design [9], industrial design and architecture [7, 10-12]. The main driver for such a partnership between OT and design students is the need for collaborative efforts within the design process to become richer and better serve the needs of diverse users [10]. This aligns with and can enrich the goal of teaching UD as discussed above.

To further strengthen this symbiotic learning environment, user/experts and clients are involved. Applying a UD process implies that diverse users are central in the design process. User/experts, a term coined by Ostroff [13], support this bottom-up approach [14] to learn from "developed natural experience in dealing with the challenges of our built environment" [13]. In addition, both clients and user/experts not only provide students with real-world insights but they can also ensure that the designs are more responsive to the needs of those who will use them [13]. This civic aspect may deepen students' learning experience, fostering a more comprehensive understanding of UD and its impact on diverse users. However, is it also possible for clients and user/experts to learn from each other or from the students in symbiosis? Little is known about their learning experiences. Some studies discuss user/experts' perceptions and experiences in architectural co-design processes [e.g., 15], but they do not address their mutual learning experiences. With this in mind, this study explored the two-way learning experiences of all involved stakeholders within a symbiotic learning environment.

2. Method

The course "Designing with People" (3 ECTS credits) took place from January to June 2024 (involving 11 weekly 3-hour sessions with supervisors). In order to examine participants' learning experiences, a combination of different research methods was used tailored for each group of stakeholders.

For this study, 19 master students Occupational Therapy and 18international (bachelor and master) exchange students interior architecture (n=4) and architecture (n=14) participated, coming from Brazil, Ecuador, France, Hong Kong, Italy, South Africa, Spain, Poland, and Portugal. Each student was asked to fill in a questionnaire at the start and the end of the course. We adapted the Self-Assessment Inclusion Scale (SAIS) to measure students' awareness towards disability and inclusion [16]. In addition, students wrote a reflection report at the end of the course, including responding to probing questions on what they have learned from different stakeholders during the process.

Both the user/experts with physical (n=3) and visual (n=5) disabilities and the clients (n=2) involved in this year's design assignments completed seperate surveys with open-ended questions after their final course intervention. Finally, the teaching team (n=4) from both faculties were asked to reflect on their learning experiences with regard to all involved stakeholders. The data from the reports and surveys were analyzed using thematic analysis to identify common themes and insights.

3. Set-up of a Universal Design course aiming to foster symbiotic learning

Given the fairly limited time available for students in a 3 ECTS course, prior to the start of the course 'Designing with People', external students already gathered extensive data on two design assignments of real cases through interviews, observations, and focus groups during a preliminary phase. Insights from this initial stage were shared with the 'Designing with People'-students in the third session of the course. This year, both cases focused on designing 'a garden for all': one near a cohousing project for people with vision impairments that was publicly accessible, and one private garden for patients in a psychiatric care home. Students were encouraged to follow accessibility norms, but specific accessibility regulations were not integrated.

The course began with an introduction to Universal Design (UD), Human-centered Design, and relevant research methods and tools (e.g., personas). Additionally, various user (re)sources were integrated throughout the course, utilizing both direct and indirect user information. Resources included context-independent and context-dependent knowledge on UD [17, 18]. *Figure 1* shows the actions and activities initiated by the tutors to enhance knowledge and awareness about UD. In addition to these resources, the student teams gathered information themselves throughout the design process.

In this specific context, two strategies were implemented to foster a symbiotic learning environment. First, an interdisciplinary collaboration was set up between two faculties: at least two students from the international exchange design programs worked together in design teams with at least two master's students in OT. In addition to this interdisciplinary approach, it is important to note that the design students came from various countries and cultural backgrounds (see section 2). Both aspects contributed to the diversity of the design teams bringing different perspectives on design and user experience, without making this explicit to the students.

Second, a civic perspective was incorporated by involving actual clients and user/experts with disabilities in real-life cases within the built environment. The objective was to establish an ongoing network where the same group of user/experts and clients would engage on a structural level annually, thereby fostering collective knowledge on UD [19]. This had three primary goals: (1) to enhance familiarity among stakeholders, (2) to create an efficient and effective structure, and (3) to facilitate mutual learning and inspiration over the years.

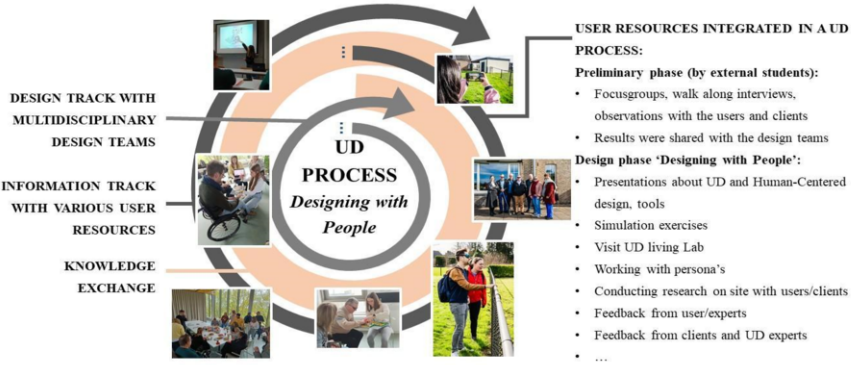


Figure 1. Overview of the UD course 'Designing with People' and examples of integrated user resources.

4. Analyzing stakeholders' learning experiences

When analyzing the gathered data, we identified various learning experiences for the different stakeholders. First, we focus on the interdisciplinary student collaboration and their diverse learning experiences. Second, we examine the results from students' self-assessment evaluations. Finally, we elaborate on the learning experiences from a civic perspective, involving all involved stakeholders.

4.1. Students' learning experiences from an interdisciplinary approach

When comparing what design and OT students learned from each other, some parallels are noticeable. Although it was not clear to everyone at the start of the course how their design process would benefit from interdisciplinary collaboration, both groups highlighted the value of this approach by the end of the course. They recognized that collaboration brought diverse perspectives that enriched the project outcomes in several ways. Three themes were identified in the analysis:

4.1.1. Learning from each other's way of working and thinking

The working and thinking styles of both groups clearly differed, leading to distinct knowledge outcomes. OT students learned from the technical design skills, visualization capabilities, and creative problem-solving approaches of the design students. They valued their creative approach to creating comprehensive visual representations: "*The creativity with a design, although I came with ideas and a simple visualization. They could actually put it into a design and visualize it with little adjustments to make it prettier, etc. Very intriguing*" (OT student).

Design students' learning experiences focused more on enriching the design by listening to other perspectives: "*The mix of ideas […] makes me understand that I have to keep in mind to listen to various points of view. It feels logical but it's not always easy to have different opinions on design and actions*" (design student). Additionally, some design students gained insights into organizing work differently and learned about tools and devices that can support the design process: "*Their way of organizing work is very different, even though not all of their habits are suitable for me, [...] I took some notes for myself and probably I'm going to use some of the tools they use*" (design student).

Some challenges were mentioned as well. Although both groups clearly valued the interdisciplinary and multicultural approach, it challenged them to understand each other's roles and mutual understanding at the start of the process. One OT student suggested to the tutors to establish an "*early and ongoing dialogue to bridge disciplinary gaps, fostering mutual understanding of each other's roles and contributions, and implementing collaborative workshops or joint training sessions to enhance interdisciplinary teamwork skills*". It was initially unclear for some design students what the contributions of OT students to an architectural design process could be: it "*took a while to understand that the role of the occupational therapists were different*". OT students were more challenged by practical aspects, such as (mis)communication issues.

4.1.2. Awareness towards inclusion and diversity

Design students particularly appreciated the OT students' focus on mental health, daily life impacts, and user-centered thinking: "*I learned how much mental health could impact daily life and small actions, in how we move, speak, and act*" (design student). This interdisciplinary collaboration further helped them focus on the needs of various people throughout the design process, influencing "*every decision, every curve of the path, and every choice of plant was scrutinized through the lens of therapeutic benefit*" (design student). Interestingly, OT students did not elaborate on learning explicitly about inclusion from their colleagues, but they were inspired by the diverse cultural backgrounds of the design students. For example, one student noted: "*The collaboration with the (interior) architecture students with diverse cultural backgrounds was very interesting and allowed me to look at a range of perspectives*" (OT student). Findings indicate that the students' prior experiences and cultural contexts contributed to richer discussions and alternative approaches to problem-solving in Universal Design.

4.1.3. 1+1=3

Both groups valued combining different visions to enhance the overall design in ways they could not achieve without this interdisciplinary approach: "*I really was surprised how we could improve our creativity together and get to even better solutions together*" (OT student). OT students were appreciated for improving the design by truly understanding the needs of different users, while design students could "*put values or numbers on it*" and excelled in balancing usability and inclusion with aesthetics and attractiveness. OT students learned to consider more elements in their projects, such as material choices and spatial aesthetics, broadening their understanding beyond functionality. They highly valued seeing their concepts visualized and enhanced by the design students, reinforcing the importance of aesthetics in functional design: "*I won't soon forget the power of drawing out ideas. Previously, ideas remained purely in my head. By making them visual, it immediately becomes clear what strengths and weaknesses the idea has. It is easier to ask for feedback from others and make*

adjustments" (OT student). Thus, the strengths and knowledge of both groups enabled a synergistic combination that enhanced the design outcomes.

4.2. Assessing students' awareness throughout the course

Students filled out a self-assessment questionnaire (SAIS) at the start and end of the course. Although the sample was limited and there was no control group, it is interesting to elaborate on how students (subjectively) assessed their awareness towards disability and inclusion. A statement that scored high, but without much change between the first and second assessment, was 'accepting people with a disability [...] equally in their work': seven out of 10 students indicated to 'always' do this.

For approximately half of the questions, we observed little difference in the number of students who applied this 'always,' but we did see a reduction in the number of students who indicated they 'never' or 'rarely' apply it. Although there was generally little noticeable change between the first and second assessments across different topics, a distinct positive evolution was observed in statements concerning various cultural backgrounds and identities, both one's own as well as other people's background:

- I learn about specialized cross-cultural topics that are necessary for my work ('always' evolved from 16% to 28%)
- I am aware of how my own cultural identity influences my judgment of what is considered normal, mainstream, appropriate or acceptable ('always' evolved from 28% to 41%)
- I am aware of assumptions I make about people with a different cultural background ('always' together evolved from 12% to 24%)

As the design teams comprised at least two international students, this dynamic may indicate to subtly enhance awareness of cultural diversity. Collaborating with peers from different geographic and cultural backgrounds likely fostered a deeper understanding of cultural nuances. This exchange not only enriched the design process but also promoted a more inclusive approach to addressing cultural identity and diversity.

4.3. Learning experiences from a civic approach

In this section, we delve into the learning experiences of all stakeholders involved, including students, clients, user/experts, and tutors.

4.3.1. A more nuanced view on people with disabilities

Students emphasized the importance of involving user/experts in the design process. Both groups found interactions with these experts enlightening, deepening their understanding of user needs and influencing their design approach. "*I learned that architecture is not just about creating spaces; it's about understanding the people who inhabit them*" (design student). Insights gained included diverse challenges faced by individuals with disabilities, unique needs of each person, and sometimes conflicting requirements among different users. OT students highlighted the importance of avoiding stigmatizing solutions: "*They want to be treated like everyone else and not be seen as different from others*."

This seemed eye-opening to several design and OT students, comprehending the complexity of satisfying everyone and emphasizing the importance of thoughtful design decisions to balance competing needs. This heightened awareness prompted students to

delve deeper into the 'why' behind design decisions and to strive to avoid making assumptions.

User/experts also appreciated learning from their peers, acknowledging shared challenges despite individual limitations. During the co-creation day, these user/experts were paired with others having different disabilities, enhancing their understanding of varied needs. Both tutors and user/experts highlighted how direct contact with diverse user/experts significantly enriched their understanding. "*You learn to look beyond your own limitations*," remarked one user/expert.

4.3.2. Resonating beyond academia

The application of a real case with actual clients and users was generally seen as enriching the design process: "*The fact that the assignment was linked to a concrete case made it even more interesting*" (OT student). This approach significantly broadened students' ideas, underscoring the significance of UD principles. It helped them grasp the profound impact their designs could have on someone's daily life. Clients indicated how students' ideas -sometimes showing fresh or out-of-the-box thinking- opened their mindsets towards new possibilities for their case. Clients also referred to ideas from the other case that could be interesting for them as well. Both clients and user/experts commended the students' enthusiasm and collaborative engagement. Some user/experts highlighted their satisfaction in contributing their expertise to make a positive impact. This was very important for several user/experts.

On a more practical and organizational level, the tutors also valued how collaborating with user/experts kept them vigilant in making the course itself, along with its materials and communication, as inclusive as possible for everyone. Clients stressed the importance of maintaining ongoing contact to understand how different design proposals influence and endure in real-world applications. Establishing a structured learning network was therefore appreciated to benefit this objective.

5. Discussion and conclusion

This study explores a strategy for advancing UD by creating a symbiotic learning environment that fosters mutual learning among all stakeholders. Results indicate that students' learning experiences extended beyond explicit knowledge sharing, encompassing tacit learning that positively influenced their understanding of UD and inclusion [20]. User/experts and clients mainly mentioned explicit learning experiences, possibly due to the lower intensity of collaboration between these stakeholders compared to that between the two student groups.

Although both groups valued interdisciplinary collaboration, it initially challenged them to understand each other's roles, which has also been experienced in other studies [7, 10]. Enhanced awareness among students on diversity and disability topics was less noticeable from their self-assessment evaluations at the start and end of the course; however, an increase in awareness for other cultures and identities was noticed. Intensive collaboration with peers from diverse cultural backgrounds seemed to influence students' awareness and contributed to richer discussions on the topic of UD. These findings support the importance of creating sustained interactions among diverse stakeholders to enhance understanding and implementation of UD principles [11], but more research is necessary to confirm this. The civic approach, involving clients with real cases and

user/experts, was highly appreciated by all stakeholders. This collaboration provided a nuanced view of people with disabilities, highlighting the value of learning directly from those with lived experiences [21]. It facilitated a deeper understanding, awareness of diverse needs and the impact of designs on users' experiences, among students as well as user/experts, clients, and the teaching team.

Given the limited sample size, caution is needed when drawing conclusions. A larger sample size and longitudinal study would both provide more robust data to validate this approach. The latter could also provide insights into shifts in stakeholders' attitudes over time. Additionally, a continuous focus on diversity and inclusion awareness and UD methods from earlier educational stages, including bachelor's, may support enhancing students' awareness for both personal and professional growth. Future research could therefore investigate how to integrate these topics into curricula (including hidden curricula) earlier and more structurally. While challenges remain, the findings underscore the importance of creating symbiotic learning environments that facilitate mutual learning and understanding among diverse stakeholders.

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Future-Proof Homes. Design Support System for Selecting Age-Adaptive Building Elements and Finishes

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Abstract. The paper illustrates the definition of a home adaptation design support tool for selecting interior finishes and partition systems based on multicriteria evaluations. In line with Universal Design principles, the selection criteria promote the creation of homes that respond to the changing needs of people over their life course, allowing for aging in place. Based on a literature review on the design of age-friendly living spaces, optimal requirements for safety, comfort, usability, management, environmental protection and integrability related to partitioning elements and interior finishes were identified. Then, through the multicriteria analysis technique of the Analytic Hierarchy Process, selection criteria were established, and weights were assigned to classify market-available products according to performance, thereby informing the choices of designers and end users.

Keywords. aging in place, lifespan housing, universal design, multicriteria analysis, finishes and partitions

1. Introduction

In the current context characterized by an aging population, the design of housing that can adapt to people's needs throughout their lifetimes is crucial for promoting aging in place and optimizing resource use by extending the operational life of buildings.

In response to these needs, living spaces, furnishings, and technological equipment must be designed according to Universal Design principles in order to support various levels of autonomy and be compatible with home care activities, a key node of the long-term care services network [1].

This paper aims to re-evaluate domestic spaces based on the performances of elements such as walls, floors, and ceilings, also considering the biopsychosocial ICF model [2], which emphasizes the active role of the physical environment in improving the quality of life through spatial, technological, and material features that can support functional limitations and facilitate caregiving activities.

Specifically, this study presents findings from research funded by Sapienza University of Rome, aimed at developing a multicriteria evaluation tool for selecting partition systems and interior finishes suitable for aging and varying abilities, from a life-course perspective.

First results of the same research have already focused on a multicriteria selection system of aging-friendly furnishings, including when home care is needed [3]. In order

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to consider other spatial and technological features, the study presented here addresses the selection of internal partitions and related finishes as key physical interfaces between the space and users.

Starting with a literature review, optimal requirements were identified, diversifying between those related to finishes and those related to interior partitions, and considering sustainability and the possibility of integrating "smart" Ambient Assisted Living (AAL) devices as necessary cross-cutting features.

Subsequently, through the multicriteria analysis technique of Analytic Hierarchy Process (AHP) [4], such requirements were transformed into selection criteria to which weights were assigned to classify market-available products based on performance, thereby informing the choices of designers and end users.

2. Methods

To study the characteristics of housing suitable for meeting people's changing needs across the lifespan, the first phase of the research involved a review of the gray and scientific literature within databases such as Google Scholar, PubMed and in specialized repositories such as The Centre for Health and Design.

From the review, optimal characteristics of age-friendly housing were identified, with a focus on requirements for interior finishes and partitions.

For the two different areas of observation (walls and ceilings; floors, wall finishes, and ceiling finishes), from the technical requirements identified in the first phase of the research, specific evaluation sub-criteria were defined, grouped into the following macro-categories of criteria: Safety; Comfort; Usability; Easy Management; Environmental protection; Integrability and installation/disassembly impact.

Then, in the second phase, referring to the AHP multicriteria evaluation technique, the following steps were performed: definition of markers for each evaluation sub-criterion; assignment of a weight to each sub-criterion and criterion; implementation of the evaluation tool through spreadsheets.

The third phase involved the application of the tool for the evaluation of commercially available products sourced through desk research.

3. Technical selection criteria

Selecting indoor finishing materials/products and flexible construction solutions is crucial in designing inclusive and supportive age-adaptive environments. Therefore, it is necessary to identify spatial, technological and material features that can compensate/support any functional limitations and facilitate future care activities within the home environment.

3.1. Floorings, Wall and ceiling finishes

Flooring features greatly affect the safety of users, even more so if they have mobility or cognitive difficulties. In this case, technical choices should favour non-slip materials in dry and wet conditions [5, 6].

For fire safety, flooring should have a low reaction to fire and limit smoke emission in case of burning. Also considering the health implications, choosing coatings that do not release pollutants or toxic substances is important.

Concerning visual comfort, reflective or highly shiny surfaces can cause glare and hide the presence of liquids on the floor, increasing the risk of slipping. Excessive contrast between two adjacent floors can also be mistaken for a step by people with visual or cognitive disabilities [7, 8]. Similarly, high-contrast patterns should be avoided because they can cause disorientation and prevent recognition of objects on the floor [9].

To ensure good usability by all, the flooring components should be firmly fixed, flat, with minimum joints and projections.

Regarding acoustic comfort, soft coverings with high sound-absorbing power should be preferred. However, opting for carpeting, for example, would prevent easy use of movement aids [8] and cause difficulties in cleaning operations. In fact, flooring characteristics also affect the ease of space management. Floors must be stain-resistant and allow easy cleaning [10] by choosing nonporous and nonabsorbent materials. They must also be resistant to wear and tear and hard enough not to be nicked or marked by the passage of carts, removable furniture or wheelchairs.

Wall and ceiling finishings also play an essential role in facilitating aging in place.

To maximize natural and diffuse lighting, it is preferable to use light colors with a high reflection coefficient [11], reducing reflections so as not to cause visual discomfort.

Regarding aesthetic-perceptual characteristics, it has been shown in the literature that bold and repetitive patterns can cause illusions, restlessness and confusion in people with dementia [8]. Therefore, soft or pastel-colored upholstery is recommended [12].

In addition, combining user- and environment-focused design approaches and adhering to circular economy principles, using natural, non-toxic, and recyclable materials and systems that allow replacement parts to improve performance potential and reusability while maintaining aesthetic and sensory quality is a priority.

The aforementioned has been systematized in Table 1, which shows the set of technical criteria categories, sub-criteria and related indicators of success.

For each sub-criterion, a specific marker expressing the degree of satisfaction of the performance requirement was defined. Therefore, a scale of discrete values that allows for a score of 0 in the case of an unmet requirement, 0.5 in the case of a partially met requirement, and 1 in the case of a fully met requirement was defined.

Table 1. Criteria, sub-criteria, marker and score ranges for coating materials

Criteria	Sub-criteria	Applicability	Marker	Low score (0)	Medium score (0.5)	High score (1)
1. Safety	1a. Low reaction to fire	Fc/Wc/Cc	Reaction to fire	Highly flammable	/	incombustible
	1b. Low VOC emission	Fc/Wc/Cc	VOC certificate	High emission	/	Low emission
	1c. Non-slip surface	Fc	Friction coefficient (μ) (or equivalent)	μ<0.4	μ 0.4-0.6	μ >0.6
	1d. Visual uniformity	Fc/Wc/Cc	Presence of pattern/textures	Surface with patterns	/	Monochromatic surface
2. Comfort	2a.Sound absorption	Fc/Wc/Cc	Sound absorption coefficient (α)	α <0.4	α 0.4-0.8	α >0.8

3. Usability	2b. Pleasant to touch	Fc	Thermal conductivity (W/mK)	>1	0.1-1.0	<0.1
	2c. Light reflectance and contrast	Fc Wc Cc	Light reflectance value (LRV)	<0.3 <0.6 <0.8	/ / /	0.3-0.5 0.6-0.8 0.8-0.9
	2d. No shiny/ no glare	Fc/Wc/Cc	Sheen/ Glossiness	Sheen >70%	Sheen 25-70%	Sheen <25%
	3. Flat without joints	Fc	Installation without joints or projections	Joints > 5mm projections > 2mm	/	Joints < 5mm and projections <2 mm
4. Easy Management	4a. Resistance to scratch and wear	Fc	Resistance to wear / Hardness	Prone to wear	Medium resistant	Hard / Resistant
	4b. Easy to clean	Fc/Wc	Stain resistance / Low porosity	High porosity	/	ceramic tiles >ClassIV; low porosity
5. Env. Protection	5a. Recyclability	Fc/Wc/Cc	Recyclability certification	Without certification	/	With certification
	5b. Recycled content	Fc/Wc/Cc	Certified recycled content	<10%	10-50%	>50%
	5c. Sustainable manufacturing	Fc/Wc/Cc	Sustainability certifications	Without certification	/	With certification
	5d. low transportation impact	Fc/Wc/Cc	Distance	>500km	150-500km	<150km
6. Integrability	6a. Ease of replacement	Fc/Wc/Cc	Separability	Non-separable	Partially separable	Separable
	6b. Removability	Fc/Wc/Cc	Dry installation	Wet installation	/	Dry installation
	6c. Impact construction work for installation	Fc/Wc/Cc	Installation	Work involves building elements	work involves only finishings	No work required

Cc= ceiling coating material; Fc= floor coating material; Wc= wall coating material.

3.2. Internal Walls and Ceilings

Adopting solutions for interior partitioning from a perspective that anticipates future needs will save time and costs due to subsequent home modifications.

To promote interior flexibility, it is advisable to use movable partitions consisting of sliding panels that are preferably soundproof, lightweight, easily maneuverable, and have no floor rails so that they do not constitute an obstacle and avoid dirt accumulation.

As an alternative to movable partitions, drywall solutions should be favored, organizing structural frames to facilitate strategically placed openings, expand existing rooms, or allow the removal of the portion of the wall above the doors for the passage of a ceiling hoist. Another preventive approach is to choose partition walls with adequate mechanical properties to allow the installation of grab bars. [13].

To encourage flexible use of space and increase its potential to accommodate different functions, it is essential to provide walls and ceilings for the passage of cables and to facilitate the incorporation of assistive ICT devices [5]. To this end, the choice of

drywall systems with adequately sized cavities is a preferable solution also to facilitate their inspectability, taking care, however, to ensure adequate sound insulation to benefit from a quiet environment [13].

In accordance with circular economy instances, it is preferable that products result from recycled processes or are highly recyclable and come from factories near the construction site. The construction system chosen should also favor disassemblability of components to facilitate their replacement and/or removal.

The set of technical criteria categories, sub-criteria and related success indicators for internal partitions are shown in Table 2.

Table 2. Criteria, sub-criteria, marker and score ranges for walls and ceilings

Criteria	Sub-criteria	Applicability	Marker	Low score (0)	Medium score (0.5)	High score (1)
1. Safety	1a. Low reaction to fire	W/C	Reaction to fire	Highly flammable	/	Incombustible
	1b. High resistance to fire	W	Fire resistance	<EI30	/	>EI60
2. Comfort	2a. Sound insulation	W/C	Sound insulation (Rw)	<25	30-50	>50
3. Easy Management	3a. Mechanical strength	W/C	Load resistance	<50kg	50-250kg	>250kg
	3b. Impact resistance	W	Impact resistance	Not compliant	/	Compliant with impact from a hard and soft body
	3c. Flexibility	W	Movability	fixed	/	Easy to move
4. Environmental Protection	4a. Recyclability	W/C	Recyclability certification	Without certification	/	With certification
	4b. Recycled content	W/C	Certified recycled content	<10%	10-50%	>50%
	4c. Sustainable manufacturing	W/C	Sustainability certifications	Without certification	/	With certification
	4d. low transportation impact	Fc/Wc/Cc	Distance	>500km	150-500km	<150km
5. Integrability	5a. easy plant integration	W/C	Presence of cavities	Wall without cavity	/	Wall providing cavity
	5b. Removability	W/C	Dry installation	Wet installation	/	Dry installation
	5c. Impact construction work for installation	W/C	Installation	Work involves building elements	Work involves only finishings	No work required

C= ceilings; W= internal walls

The assignment of weights for both criterion categories and sub-criteria was done using the value scale proposed by Saaty [14]. The final score given to a product (finishing

or partition) is obtained from the weighted sum of the partial scores for each criterion, which are obtained from the weighted sum of the scores for each sub-criterion.

Due to a lack of space, Tables with weights are available in Appendix A.

4. Results

The proposed multicriteria evaluation tool was tested for selecting a new flooring and inserting a new interior partition, simulating the renovation of an apartment in Rome, Italy.

The technical information about a flooring was retrieved from the data sheets provided by the manufacturer (Figure 1a) and, through the indicators defined in Table 1, discrete scores were assigned and entered into the prepared spreadsheet. The spreadsheet returns within two polar graphs the partial scores related to the satisfaction of each sub-criterion, the partial scores for each criterion, and an overall score (Figure 1 b).

a)

Technical data sheet

Material: Porcelain Stoneware
Tickness: 9mm ≤ ± 5% (± 0.5mm)
Surface: Glossy
Slip resistance: > 0,40
Stain resistance (UNI EN 10545-14): 3
Impact resistance: (UNI EN 10545-5) 0,8
Resistance to abrasion: (UNI EN 10545-7) 5



Installation

Installation can take place by either using cement dust or glue, with the use of specific high-performance adhesives for fine porcelain.

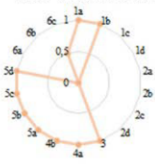
Certifications



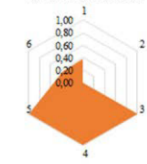
b)

sub-criteria	score	weights	categories	score	weights
1a. Low reaction to fire	1	0,28	1. Safety	0,38	0,33
1b. Low VOC emission	1	0,10			
1c. Non-slip surface	0	0,47			
1d. Visual uniformity	0	0,16			
2a. Sound absorption	0	0,30	2. Comfort	0,00	0,17
2b. Pleasant to touch	0	0,23			
2c. Light reflectance and contrast	0	0,33			
2d. No shiny/ no glare	0	0,67			
3 Usability	1	1,00	3. Usability	1,00	0,21
4a. Resistance to scratch and wear	1	0,33	4. Easy Management	1,00	0,09
4b. Easy to clean	1	0,67			
5a. Recyclability	1	0,19	5. Env.Protection	0,77	0,17
5b. Recycled content	1	0,35			
5c. Sustainable manufacturing	1	0,23			
5d. Distance	1	0,23			
6a. Ease of replacement	0	0,07	6. Integrability	0,36	0,02
6b. Removability	0	0,20			
6c. Impact construction work	0,5	0,73			

Sub-criteria Scores



Criteria scores



Final score: **0,61**

Figure 1. a) data retrieval from the technical sheets provided by the flooring manufacturer.; b) outcome of multicriteria evaluation

Likewise, a solution for the construction of an internal partition was evaluated (Figure 2). By repeating the evaluation for other finishes and partitions, the tool allows the comparison of different alternatives, making objective conformity of their performance with the fulfillment of Universal Design principles translated into selection criteria. The tool is intended to be used by the designer, as it requires technical expertise in interpreting product data sheets and using spreadsheets. However, by highlighting the objective conformity of different alternatives to predetermined requirements, the user participates more consciously in the decision-making process.

Using the proposed tool, the designer can also consider, along with the results, other factors that determine the final choice, such as possible user preferences, costs, and other technical constraints determined by the specific context of intervention.

a)

Technical data sheet

Materials: wood, rockwool and gypsum
Reaction to Fire: A2-s1,d0
Resistance to fire REI 60
Sound insulation R_w: = 43 dB
Impact resistance: no damage
Recycled content of slabs certified by ICMQ (UNI EN ISO 14021:2016)



Installation

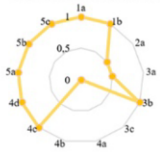
Dry installation by screws. Joints between slabs, horizontal and vertical, and finish are treated with fillers and reinforcing tapes

Certifications

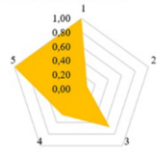
b)

sub-criteria	score	weights	categories	score	weights
1a. Low reaction to fire	1	0,25	1. Safety	1,00	0,43
1b. High resistance to fire	1	0,75			
2a. Sound insulation	0,5	0,17	2. Comfort	0,09	0,17
3a. Mechanical strength	0,5	0,45	3. Easy Management	0,68	0,13
3b. Impact resitance	1	0,45			
3c. Flexibility	0	0,09			
4a. Recyclability	0	0,19	4. Env.Protection	0,46	0,24
4b. Recycled content	0	0,35			
4c. Sustainable manufacturing	1	0,23			
4d. Low transportation impact	1	0,23			
5a. Easy plant integration	1	0,07	5. Integrablity	1	0,02
5b. Removability	1	0,20			
5c. Impact construction work	1	0,73			

Sub-criteria scores



Criteria scores



Final score: **0,67**

Figure 2. a) data retrieval from the technical sheets provided by the manufacturer; b) outcome of multicriteria evaluation

Currently, the tool supports the evaluation and comparison of isolated products. However, future research developments intend to include in the evaluation system the mutual compatibility of multiple compliant solutions, as well as their compatibility with respect to other contextual constraints.

Furthermore, in future advancements of the study the observed aspects will be considered along with the spatial configuration and other building elements (doors, windows, lighting, etc.) by taking advantage of the digitization of technical information using Building Information Modeling methodologies .

5. Conclusions

To meet people's living needs, it is necessary to promote an approach to design that moves from a dogmatic attitude built on regulations and standards to one focused on the selection of materials and components based on their performance. According to these assumptions, the paper outlines a multicriteria evaluation system to support the designer in selecting interior partitioning elements and related finishes that comply with Universal Design principles [15].

Such principles, when considered as one of the filters for selection, along with eco-friendly features, can help achieve full social and environmental sustainability of housing adaptation interventions for aging in place.

Considering the principle of *Equitable use*, the selection criteria promote finishing products according to the logic of inclusion and design for all.

Preferable solutions for partitions adapt to how people use them according to their different conditions, meeting the principle of *Low physical effort* and *Flexibility in use* of spaces, ensuring through the facilitation of different configurations the appropriate *Size and Space for Approach and Use*. Moreover, by allowing the harmonious integration of systems and any assistive technologies, they promote *Simple and intuitive use* of spaces, leaving the routine of daily life unaffected. The joint control of finishes' technical and sensory performance makes the home more communicative, in line with the principle of *Perceptible information*.

Finally, in terms of *Error Tolerance*, the system rewards solutions that minimize the risks and negative consequences of installation errors, assembly of drywall components and their connections.

Through tools that facilitate the identification and choice of such solutions, an adaptive pathway that pursues the concept of progressive accessibility can be promoted. Therefore, it is important to know the optimal performance for the user's preventive choices and lifelong planning. It is equally useful to have tools, such as the one proposed, that facilitate this anticipatory approach to incorporate universally designed age-friendly features, which can then save costs of tailored interventions when needed. By guiding choices and controlling costs, this could also provide useful input to the housing construction industry and direct market innovations toward more inclusive solutions.

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Universal Designed Homes: Social Value and Economic Benefits

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Abstract. This paper examines the social value and economic benefits of Universal Design (UD) Homes, with a focus on assessing the potential financial savings arising in various areas of expenditure due to investment in UD Homes. Investment in the provision of UD Homes can result in a win-win outcome, leading to improved quality of life and more cost-effective forms of investment. UD Homes are found to be particularly cost-effective in the context of age friendly housing due to the potential to reduce the need for costlier forms of long-term residential care and the avoidance of injurious falls.

Keywords. Universal Design Homes, Economic Value of Universal Design, Cost Benefit Analysis

1. Introduction

The Irish Disability Act 2005 defines Universal Design (UD) as the design and composition of an environment so that it can be accessed, understood and used to the greatest practicable extent by all people, regardless of their age, size, ability or disability [1]. By creating a fully accessible home environment, investment in the provision of UD Homes benefits a wide range of user groups, including persons with disabilities, older people living independently, people with a temporary or permanent injury, and families with young children [2]. Adopting UD in the construction of homes benefits all people, but in particular enables persons with disabilities and older persons to live independently, comfortably and safely at home. This paper provides a focussed examination of the social value and economic benefits of investment in UD Homes.[4]

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[4] This research on the social value and economic benefits of UD Homes underpins a forthcoming cost benefit analysis (CBA) under development by the Irish National Disability Authority (NDA). This paper and the associated CBA research have been informed by a comprehensive stakeholder consultation process including persons with disabilities and older persons, Disabled Persons' Organisations (DPOs), Approved Housing Bodies, Irish Local Authority representatives, officials of housing and disability policy focussed Government departments and other public bodies, academics and industry representatives.

2. Universal Design Homes

UD Homes are designed to be accessible and usable by everyone. UD Home features such as ramps, wide doorways and grab rails make it easier for people with mobility impairments to enter and move around the home [3]. Importantly, UD features make a home more easily and affordably adaptable to the changing needs of its occupants over time, allowing people to age in place and potentially avoid the need to move either to long-term residential care or to a more accessible home.

2.1. The Benefits of Purpose-Built Accessible Housing

While retrofit-based home modifications play an important role in supporting individuals to continue living in their home as their needs and abilities change, the construction of *purpose-built* highly accessible UD Homes presents several distinct advantages and benefits as compared to reliance upon a system of retrofitting accessibility-supportive adaptations to standard dwellings. Research by Wiesel has found that individuals with additional accessibility requirements often experience challenges living in a home with retrofit-based adaptations [4]. These are summarised in Table 1 below.

Table 1. Limitations of home modifications in addressing user accessibility needs

Accessibility	Post-construction modifications more likely to only partly meet peoples' accessibility requirements
Affordability	Cost of modifications are partly shared by households that are unable to afford it
Funding Ineligibility	Individuals are ineligible for funding due to assessment of need or means testing
Structural Restrictions	Homes and rooms that are too small, or doorframes and hallways that are too narrow, preclude home modifications or limit efficacy
	Modifications are cost prohibitive or have limited efficacy in addressing barriers
Private Renters	Difficulty getting landlord approval, modifications and tenancy may be viewed unfavourably by landlords, funding restrictions for renters, precarious lease

Source: Wiesel [4]

3. Research on the Economic Value of Universal Design

There is a substantial body of extant research examining the economic benefits of UD in areas such as housing, the built environment, the public realm and the labour market. Alonso uses a contingent valuation approach to estimate the willingness to pay for accessibility features in housing [5]. The results suggest that the benefits of barrier-free housing are substantial and that people are willing to pay an average of 12.5% more for housing with accessible features.[5] The study concludes that the benefits of building barrier-free housing outweigh the costs and that policy interventions to encourage the construction of accessible housing are justified.

[5] When comparing two similar dwellings, with the only difference being their accessibility conditions, a sample of 1,007 randomly selected households that responded to a survey would pay an average of 12.5% more for barrier-free housing.

Aslaksen applies Cost Benefit Analysis (CBA) to the upgrading of existing buildings to achieve UD [6].[6] The results indicate that the costs of retrofitting the building are relatively low when compared to the long-term benefits associated with improved accessibility, which include increased independence, reduced healthcare costs, and increased economic participation. This study concludes that CBA can provide valuable insights into the economic feasibility of upgrading existing buildings to achieve UD and that policy interventions to promote UD can be justified based on their economic benefits.

Fuglerud et al. undertook a review of the literature on the application of CBA to UD [7]. The authors discuss the utility of CBA as an approach to determining the economic viability of UD, and suggest areas for future research, including the need for more longitudinal studies on the impacts and potential benefits of UD.

4. The Benefits of Universal Design Homes

If UD Homes are made available to those who require more accessible housing, this can result in substantial improvements in physical health, mental health and other important quality of life indicators for older persons and persons with disabilities. These benefits stem from improvements in areas such as personal autonomy, privacy, safety, comfort, dignity, inclusion in the community and reduced social isolation due to the enhanced visitability and liveability of homes.

In addition to these non-monetizable benefits, extant research indicates that the provision of UD housing can result in benefits in the form of avoided costs, i.e. cost savings through prevention of outlay costs that would otherwise have arisen in the absence of the construction of UD Homes [8-10]. Hill identifies several cost savings stemming from the provision of UD housing [11-12]. These include savings in adaptation costs by providing for such changes in the up-front design of the property, reduced need to move into residential care, reduced cost of rehousing, reduced government administration costs, savings in home care costs for older persons and persons with disabilities, savings in health care costs, and savings due to reduced falls at home. In cases where accessibility enhancing features are "an alternative to residential care or prevent hip fractures or speed-up hospital discharge … they will save money, sometimes on a massive scale" [13].

4.1. Accessible Housing and Health-related Quality of Life Outcomes

A study by Carnemolla & Bridge explores the relationship between accessible housing and health-related quality of life by measuring wellbeing and quality of life outcomes following home modifications [14]. The study involved 157 participants whose homes were modified to improve accessibility. The authors used a variety of instruments to measure health-related quality of life, including the WHO Quality of Life-BREF and the Health Utilities Index Mark 3. Measurements were taken both before and

[6] The study examines the cost and benefits associated with retrofitting an old building to make it universally accessible for people with disabilities and employed 18 commonly used measures of accessibility and the average costs associated with achieving accessibility. The benefits associated with each measure were then analysed in a stated preference study.

after home modifications and revealed that home modifications were associated with an average 40% increase in Health-Related Quality of Life levels.[7]

Heywood undertook an analysis of the effects of home adaptations on the health and well-being of elderly and disabled people [9]. The study found that housing adaptations such as grab bars, wheelchair ramps and bathroom modifications have a significant positive impact on the health and well-being of those who use them.[8]

An analysis by Garrett et al. aimed to evaluate the economic benefits of housing adaptation as preventative housing interventions for the National Health Service (NHS) in the United Kingdom [15]. The study focusses on home adaptation as interventions to prevent falls, cold-related illnesses, and accidents in the home. They authors find that preventative housing interventions in the form of housing adaptations can result in significant cost savings, with an average payback period of 15 years while mitigating the avoidable costs associated with various types of harm. The analysis was based upon a large-scale preventative programme of such interventions targeting three million homes, with an average cost of works per household of £2,130.[9]

4.2. The Avoidance of Retrofitting Adaptation Costs

The provision of purpose-built highly accessible housing presents distinct advantages as compared to reliance upon a system of retrofitting, both in terms of achieving higher accessibility standards and better use of financial resources [16]. As purpose-built UD housing entails barrier-free access, enhanced accessibility and adaptability, and many safety-supportive features, the design of a UD Home can reduce or fully obviate the need for the types of adaptations that are generally introduced through the retrofitting of standard homes. In this sense, the cost uplift associated with the provision of UD features during the design and construction phase ought to be viewed as a front-loading of likely future adaptation costs.

In cases where individuals have accessibility requirements which necessitate further adaptations to a purpose-built UD Home, these can be achieved cost effectively due to the inclusion of low-cost adaptation features during initial design and construction. Moreover, the standard of accessibility achieved with purpose-built UD housing significantly exceeds what can affordably be achieved through retrofitting of accessibility enhancing features in the case of a standard home [4].

5. Accessible Housing and Ageing in Place

The construction of UD homes has the potential to deliver cost savings by allowing individuals that acquire age related conditions to continue to live independently and securely in their home in the community for longer. This can result in reduced costs by

[7] The greatest improvements were in the domains of physical health, psychological health and social relationships.

[8] Specifically, the paper highlights several benefits of housing adaptations, including increased independence, improved mobility, reduced falls, and decreased hospitalisations. In addition, housing adaptations were found to have a positive impact on mental health outcomes, including reduced depression and anxiety, and improved social interaction.

[9] The authors used data from existing secondary resources and extant studies to estimate potential savings for the NHS arising from the avoidance of illness. The authors also considered the impact of the interventions on the quality of life of older adults and their caregivers.

minimising the period that older persons are required to live in costly residential care service facilities. In addition to being more cost effective in the long term, supporting individuals to remain living within their own homes and communities for longer is also preferable on a wide range of health, wellbeing and quality-of-life criteria.

5.1. Cost Effectiveness of Independent Living

According to the National Nursing Home Survey from Nursing Homes Ireland (NHI), the average annual cost per bed of a nursing home place in Ireland is €54,089, €33,514 (62%) of which is accounted for by staffing costs [17]. Such costs can be significantly offset if older persons are given the option to live at home in accessible housing in the community for longer. Research conducted by the Irish Housing Agency has found that the annual running costs of community-based supported housing services for older persons can be lower than that of a nursing home placement and can be substantially lower as compared to other service settings such as hospitals [18].

Table 2. Annual Running Costs to the State by Tenure Type or Service Setting

Tenure or Service Setting	Annual Running Costs
Independent Living	€2,000
Assisted Living	€5,200
Specialised Living	€33,020
Nursing home	€45,883
Hospital	€365,000
Social home	€14,220

Source: Housing Agency [18]

This Housing Agency research highlights the fact that enabling "people to live independently for longer and thus avoid, or delay, moving into long term residential care, such as nursing homes" is made possible by "purpose-built, accessible building design that promotes independent living." The adoption of UD principles is described by the Housing Agency as a "typical feature" and "core ingredient" in the design of homes for older persons [18].

Several studies have been undertaken to investigate the effectiveness of providing accessible housing as a means of deferring or avoiding transfer of older persons or persons with disabilities to residential care. Research by Ratzka documented a study undertaken in Sweden which found that up to 30% of transitions to nursing homes or other forms of residential care could have been avoided by accessible housing alone [19]. A study by Dunn found that 50% of applicants to a residential care centre for older persons in Boston were in fact capable of living in the community with appropriate supports and accessible housing [20]. In terms of the likely period of deferral of transition of older persons to residential care, research by Cobbold undertaken in Great Britain suggests that "living in a Lifetime Home (adaptable house) can delay moving into residential care by three years" [21].

Other studies have sought to evaluate the cost effectiveness of investment in accessible housing through comparison with the cost of providing residential care over a given time horizon. The Housing Agency study on the financial benefits of investing in supported housing for older persons found that the savings from investment in community-based supported housing are substantial in the longer term, and outweigh the additional costs associated with the construction of accessible housing [18]. Table 3

provides a breakdown of the annual savings associated with different home support models as compared to more costly forms of long-term residential care.

Table 3. Benefit by funding type and accommodation

Funding Mechanism	Model	Annual Benefit	30YR Benefit
Social	Independent Living	€4,700	€106,000
	Assisted Living	€5,200	€117,100
	Specialised Living	€2,200	€48,900
Private	Independent Living	€4,000	€89,800
	Assisted Living	€9,200	€207,000
	Specialised Living	€20,000	€451,800

Source: Housing Agency [18]

5.2. Avoiding the cost of injuries in the home environment

As individuals reach old age their abilities change, often resulting in the need to make modifications to the home environment to enhance the safety of the home environment and reduce the risk of falls. Reductions in housing-related injuries can lead to substantial cost savings by avoiding the need for costly health service provision. According to the Irish Health Service Executive (HSE), every year 10% of all older people in Ireland require treatment following an injury, with falls causing 75% of all such injuries [22]. Other studies suggest an even higher frequency of falls among older persons [23-24]. Such falls are often associated with the use of steps and transitions between floor levels, the use of baths and showers, and falls on stairs.[10]

Table 4: Range of estimates of annual frequency of falls in older persons (65+)

	HSE [22]	**O'Connell et al.** [23]	**Gannon et al.** [24]
Annual rate of injurious falls requiring medical care (65+)	7.5%	18.4%	20%

Several studies have sought to measure the reduction in the frequency of falls that can be achieved through the greater availability of accessible housing. Plautz et al. examined the effects of accessibility enhancing home modifications in preventing falls and other accidents among older residents [26].[11] Following the introduction of accessible home modifications which mitigate the risk of injurious falls, the number of falls reduced from 59 in the 6 months before the intervention to 26 over the same period after the intervention. In a more broad-based study Gillespie et al. found that home modification interventions among older people (65+) living in the community were effective in reducing the rate and risk of falls [27].[12]

[10] A study by Blick & Davies found that typical safety hazards that can lead to home injury include uneven bathroom and kitchen floors, stairs without hand-railing, uneven stair surfaces, stairs with excessive nosing or insufficient tread size, external steps with uneven risers, external steps with no handrails, poorly defined step edges and missing step treads [25]. In some cases, such falls can occur while older persons are waiting for adaptations to be made to their home [13].

[11] The study included a sample of 141 research participants which were either; (a) aged 60+ who already had one fall or; (b) aged 75+ (whether they had already had a fall or not).

[12] This study found that "home safety assessment and modification interventions were effective in reducing rate of falls (RR 0.81, 95% CI 0.68 to 0.97; six trials; 4,208 participants) and risk of falling (RR 0.88, 95% CI 0.80 to 0.96; seven trials; 4,051 participants)".

A study by Keall et al. examined the effectiveness of home modifications in reducing injurious falls by testing the safety benefits of features such as handrails for outside steps and internal stairs, grab rails for bathrooms, outside lighting, edging for outside steps, and slip-resistant surfacing for outside areas such as decks and porches [28]. This study involved a single-blind, cluster-randomised controlled trial with a sample size of 842 households. The results showed a 26% reduction in the rate of injuries caused by falls at home per year for those households exposed to the intervention after adjustment for age, previous falls, sex, and ethnic origin. A follow-on study focussed on the Māori population found an even larger reduction of 31% [29].[13]

A paper by Saez et al. brought together a team of researchers including architects, geriatric doctors and health economists to examine the cost-effectiveness of accessible housing for older adults in Argentina, specifically in relation to the cost of falls [31]. The study involved a cost effectiveness analysis comparing accessible and non-accessible housing, taking into account the costs of modifying existing housing, medical costs associated with falls, and the potential savings from reducing the incidence of falls among older adults. The study found that the cost of modifying existing housing to make it accessible was lower than the potential cost savings from preventing falls. The authors suggest that making housing more accessible for older adults could result in significant cost savings for the healthcare system.

6. Conclusion

This paper has examined the social value and economic benefits of investing in UD Homes. It finds that there is a substantial body of evidence indicating that investment in the provision of UD Homes can result in savings in other areas of expenditure which can potentially offset the additional capital investment required to deliver UD Homes. Investment in UD Homes is found to be particularly cost effective in the context of age friendly housing due to its potential to reduce the need for costlier forms of long-term residential care and the avoidance of health service costs arising from injurious falls. These findings suggest that investment in the provision of UD Homes can result in a win-win outcome, leading to improved quality of life and more cost-effective forms of investment.

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[13] A separate study by Keall et al. examined the social and economic benefits of preventing falls through a programme of home modifications [30]. This study involved a single-blinded cluster randomised controlled trial and analysed insurance payments for medically treated home fall injuries as recorded by the New Zealand national injury insurer. Benefits were expressed in terms of the value of disability adjusted life years (DALYs) and the social costs of avoided injuries, which were then compared with the costs of the home modifications intervention. Injury costs per time exposed to the modified homes compared with the unmodified homes showed a reduction in the costs of home fall injuries of 33% (95% CI 5% to 49%). The social benefits of avoided injuries were estimated to be at least six times the costs of the interventions.

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Long-Term Residential Care and the Built Environment: Improving Quality of Life and Resilience Through a Universal Design Approach

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Abstract. This paper draws on a series of transdisciplinary research projects examining the role of the built environment in supporting quality of life in long-term residential care settings (LTRC) in Ireland. Acknowledging the impact of COVID-19, these projects include airborne infection control as a key theme. Moreover, considering the wide spectrum of needs, impairment, and health conditions experienced by people living in these settings, along with the diversity of residents, staff, and visitors who occupy LTRC buildings, the research is underpinned by a Universal Design (UD) approach. Finally, climate change is examined as emerging challenge, particularly for older people living in LTRC. Starting with these major concerns, this exploratory paper examines how UD can act as a bridging concept to bring together inclusion, quality of life, health and wellbeing, and climate resilience in the context of long-term residential care in Ireland and beyond.

Keywords. Universal Design (UD), long-term residential care (LTRC), ageing, built environment, urban design, quality of life, health, infection control, climate change, resilience

1. Introduction

This paper draws on a series of transdisciplinary research projects examining the role of the built environment in supporting quality of life (QOL) in long-term residential care (LTRC) settings in Ireland (1-3). Acknowledging the impact of COVID-19, these projects include airborne infection control (IC) as a key theme. Considering the wide spectrum of needs, impairment, and health conditions experienced by people living in these settings, along with the diversity of LTRC residents, staff, and visitors, the research is underpinned by a Universal Design (UD) approach (4). Finally, throughout this research, emerging challenges are identified, including climate change, which has the potential to significantly affect older people living in LTRC.

Starting with these major concerns and drawing on the research above, this exploratory paper examines how UD can act as a bridging concept to bring together inclusion, QOL, health and wellbeing, and climate action in the context of LTRC.

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2. Background

Key challenges for long-term residential care: Kane (5) argues that long-term care policies and programs tend to be associated with reduced QOL, while Villeneuve et al. (6) found that many older people experience a "significant drop in their quality of life when entering aged care institution". QOL is the subjective rating of a person's physical, emotional, and social well-being (7), and is therefore impacted by the built environment, particularly in LTRC where high levels of frailty, disability, and comorbidity (8) combine with increased time spent indoors (9).

COVID-19 negatively affects QOL in LTRC, illustrated by a Canadian study identifying how a range of COVID related factors such as a lack of access to specialist geriatric professionals and carer exhaustion led to poorer QOL during the pandemic. Irish research shows that LTRC settings were disproportionately affected by COVID-19 (Kennelly et al., 2021) with serious impacts on residents, staff, and family members. Anderson et al. (10) identify how the built environment can precipitate or exacerbate infection related measures such as quarantine, constrained social interaction, or restricted visiting. These interventions are particularly difficult in terms of cognitive impairment (CI) or a person that walks with purpose, formerly called "wandering" (11).

As discussed, people living in LTRC are particularly susceptible to COVID-19 due to comorbidity and frailty, and for similar reasons are also highly vulnerable to climate change. Considering the prevalence of CI and disability in LTRC, it is important to note that climate change disproportionately affects people with dementia (12) and disabilities due to impairment, exacerbation of symptoms, difficulties with thermal regulation, and activity limitations (13). Referring to LTRC, Wollschlaeger et al. (14) highlight the dangers of extreme heat, flooding, changes in infectious agents, and wildfires for settings in Canada. A UK study examining indoor temperatures in care settings during a heatwave recorded daily temperatures >34.3 °C, much higher than the 26 °C threshold suggested by Public Health England (CIBSE 2020). As discussed previously, the built environment plays a significant part in intensifying or mitigating the impacts of climate related events for people in LTRC.

Supporting QOL, achieving IC and pandemic resilience, and climate change mitigation are interconnected priority areas for LTRC design and retrofit. While UD is often linked to QOL (15) and sustainable design (16), it has only recently been connected to IC in LTRC settings (3). Considering the relevance of the above for LTRC, bearing in mind built environment implications, and links to UD, it is important to explore how these challenges can be addressed by UD in a holistic and integrated manner.

Universal Design and long-term care: The UN Convention on the Rights of Persons with Disabilities defines UD as "the design of products, environments, programmes and services to be usable by all people" (17). This approach is articulated by the seven principles of UD (18) which focus on accessibility, ease of understanding, and usability. Steinfeld and Maisel (19) propose UD as a "process that enables and empowers a diverse population" by improving the three key areas of "human performance, health and wellness and social participation". Following this, they set out eight UD goals including Body fit, Comfort, Awareness, and Understanding covering accessibly and usability, but also go further to include Wellness, Social integration, Personalisation, and Cultural

appropriateness. Mosca and Capolongo (20) refer to this three part approach and associated UD goals to develop criteria and indicators as part of their UD assessment framework, thereby reinforcing this holistic approach to UD.

Looking at LTRC, Grey et al. (3) adapt the four key UD principles in the Irish UD homes guidelines (21), which include: Integrated into the neighbourhood; Easy to approach, enter and move about in; Easy to understand, use and manage; Flexible, cost effective, safe, and adaptable over time. Like the UD goals, these principles refer to usability, health and safety, and social integration, however, while including flexibility, and adaptability over time. They also adopt a multi-spatial approach i.e. from location and site layout, down to building design and detailed architectural features.

Participatory design and co-creation are central to the UD approaches described above. Steinfeld and Maisel (18) advocate for 'design participation', while Grey et al. (3) argue that LTRC residents, family members, staff, and health and social care professionals should be involved in co-research and co-creation processes.

Bearing in mind QOL, and the impacts of airborne infection, and climate change, how can this multi-spatial and multisectoral approach to UD be used to interrogate the built environment in LTRC, and address these interconnected challenges?

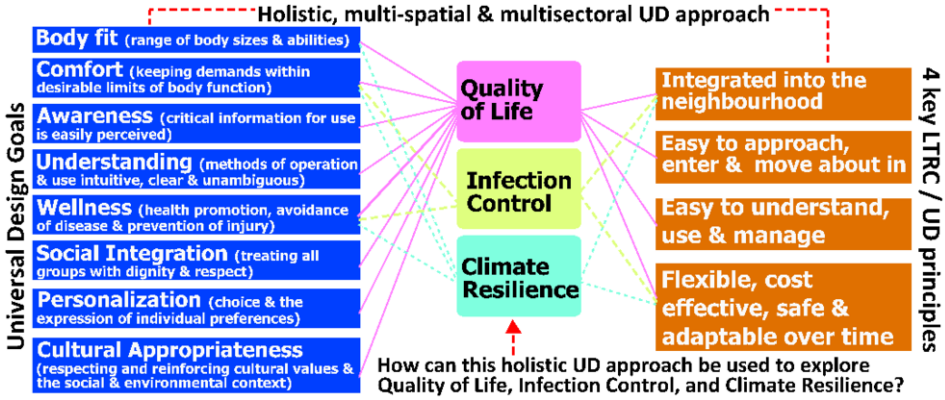


Figure 1. Holistic UD approach to explore QOL, IC, and Climate Resilience in LTRC

3. Methodology

As mentioned previously, this paper draws primarily on three research projects (1-3) involving Irish partners and international experts from the UK, the Netherlands, and Canada who formed a steering committee to direct the research and review key outputs. These projects share a common research methodology drawing on literature reviews, interviews, questionnaires, Irish case studies, and international best practice. An example of this methodology is illustrated by Grey et al. (1). The research findings are primarily structured according to Underpinning issues (e.g. QOL), Overarching design characteristics (e.g. models of care), Built environment issues across spatial scales (e.g. location, building layout etc.), Planning policy and guidance, and finally, Barriers, challenges, and opportunities. Reporting on all the findings is beyond the scope of this paper, therefore a sample of relevant findings are presented herein.

4. Key findings and discussion across key spatial scales

In broad terms, UD can be used to improve the accessibility and usability of any environment, product, or system, while UD based participatory design and co-creation is also beneficial. In this paper, both these aspects of UD are taken as given, and instead it focuses on how a holistic UD approach, at a more fundamental level, may influence QOL, IC, and climate resilience across five key spatial scales (see Figure 2 below). These five spatial scales emerged from the previously mentioned projects (1-3) as important spatial levels at which to explore the built environment of RLTC settings.

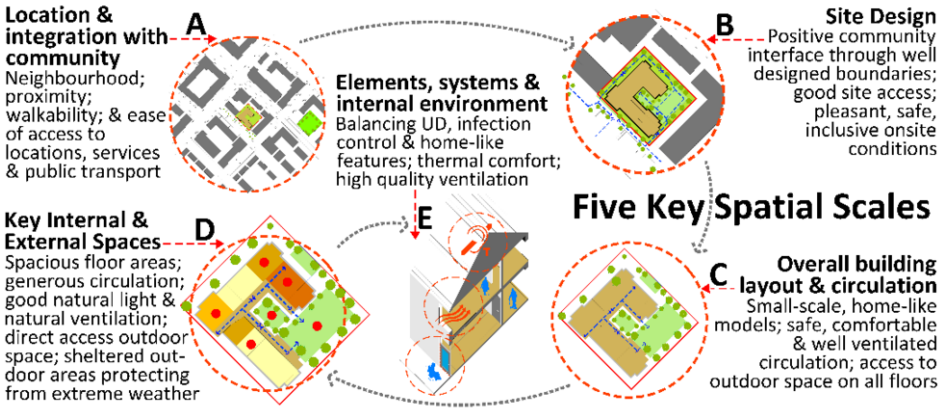


Figure 2. Five spatial scales to explore the intersection of UD, QOL, IC & climate resilience

A. Location and integration with community: Integration with community, proximity, walkability, and ease of access to locations, services, and public transport are all fundamental UD considerations (19). The first UD principle in the LTRC guidelines (3) calls for integration with the neighbourhood to avoid cutting "residents off from community life and social interaction…thereby lessening their quality of life." (22). Here QOL overlaps with UD to help embed LTRC settings into the community. Anderson et al. highlight the importance of maintaining a sense of self and connectedness through continuity with community (10), which according to Christie (23) is a protective factor in terms of adaptation to adversity. They argue that proximity to a person's home community may be a critical factor in supporting resilience. This may apply to a pandemic or indeed challenges arising from climate change.

Adlakha and Sallis (24) explore how walkable neighbourhoods may reduce the risk of diseases, for example by facilitating physical exercise to improve immune system and inflammation responses, or by supporting physical distancing through walking and cycling. In terms of climate change, diverse and walkable communities are linked to carbon reduction (25), while some walkability features such as green space, are found to support climate resilience by mitigating urban heat and managing storm water (26). Therefore, ensuring that LTRC are located and integrated within walkable communities may be important in terms of UD, QOL, and pandemic and climate resilience.

B. Site design: Site boundaries that create positive engagement between the setting and the community provide a range of benefits. In terms of UD, creating good visual

access is important for orientation and wayfinding (27). A visual connection from the setting to the community can create familiarity and recognisability, a sense of place and belonging, and engagement with the community (28). Connection to the outside world may be significant if LTRC residents need to quarantine or shelter in place during a pandemic to help alleviate loneliness and isolation (1).

Air quality on the site will often be dictated by external factors, but where relevant onsite conditions should be carefully considered. EN 17210: 2021- Accessibility and usability of the built environment, includes immunological functions and air quality as UD issues given their impact on human functioning and health. Furthermore, research shows links between poor air quality and higher rates of COVID-19 (29), making air quality at site layout level a UD, QOL, and a resilience issue.

The location and quality of a setting's outdoor space is influenced by the site design and overall building layout, among other factors. Good outdoor space that is accessible and usable for all residents is a crucial QOL (30) and UD consideration (1). Research also points to reduced transmission of respiratory viruses in outdoor spaces (31) making them an important part of pandemic resilience.

C. Overall building layout and circulation: Small-scale household models that contain less than 12 residents, have single rooms, and shared home-like sitting and dining areas, have been linked to improved QOL (32). More recently, research looking at small-scale settings found that COVID-19 infections and mortality were significantly lower. Overall, these smaller scale settings can improve QOL and reduce infection risk, while also supporting UD by providing smaller, more legible, and manageable settings (1).

Regarding circulation, the principles 'Easy to approach, enter and move about in' and 'Easy to understand, use and manage' are important UD considerations (1). While wide, spacious corridors are beneficial in terms of access, usability, and QOL, they also allow social distancing and lower occupant density during a pandemic (1). Well-ventilated circulation areas are important for comfort and air quality, and are critical for IC (33), as natural ventilation can dilute airborne pathogens and extract them outside.

D. Key internal and external spaces: A typical LTRC setting will include a range of key spaces such as bedrooms, bathrooms, living spaces, kitchens, etc. Spacious floor areas, generous circulation, good natural lighting and natural ventilation, and a range of other design issues are important for UD, QOL, and pandemic resilience (1).

Research indicates that private bedrooms and bathrooms are preferred by residents and families (34), are linked to QOL in nursing homes (35), and improved IC (1). The quality of these rooms is important and therefore size, good natural light, ventilation, and ideally access to a private outdoor space are important (3, 36).

The role of external spaces providing safer environments in terms of COVID-19 has already been discussed. This was reiterated in the Irish context, where stakeholders expressed being able to access nature and the outdoors as a contributor to positive health and well-being during the COVID restrictions. Lack of access to outdoor space for residents living on upper floors is a major concern for many stakeholders in the Irish context (1). Many larger settings contain multiple floors without direct access to outdoor

space on upper levels. Stakeholders referred to ground floor bedrooms allowing 'window visits' during COVID-19 restrictions, which was impossible for many people on upper floors. It was recommended that residents on all floors have access to usable outdoor space (e.g. roof terraces, balconies).

Ickert et al. (37) note the importance of sheltering residents from the elements when outside. Covered outdoor spaces also help moderate the impacts of extreme weather associated with climate change. Vecellio et al. (38) outline the risks of excess heat for older residents, and identify how vegetation, covered walkways, and shaded areas can help with the thermal comfort of older people in outdoor spaces during extreme heat.

E. Elements, systems, and internal environment: In line with UD, finishes, materials and fittings should be easy to understand, use and manage, but they must also support good IC practices without being too institutional in appearance. Allen and Marr (39) state that frequent cleaning and disinfection of surfaces and finishes may help reduce secondary airborne transmission. They highlight the role of technological controls such as ultraviolet C or UV-C germicidal irradiation, for deactivating virus replication.

Returning to the critical issue of air quality, Mendes emphasises how ventilation is critical to the wellbeing of older people in LTRC (43). For COVID-19, Allen and Marr (42) recommend increasing air ventilation rates above current minimums; using high-efficiency filtration for recirculated air (MERV 13 or greater); or managing air flow direction and speed to prevent spread of aerosols. Elsewhere (1) purge ventilation, or the rapid ventilation of a room, via an openable window or external door, is advised.

Thermal conditions are also an important LTRC consideration where comfortable temperatures are associated with QOL. SARS-CoV-2 survives longer in cold, dry conditions, therefore it is advisable to have warm indoor temperatures (18-21 °C) and an indoor relative humidity at approximately 50% (1).

High temperatures in LTRC reduce QOL (40) and disproportionately affect residents with disabilities and CI (12, 13). This is also an emerging climate concern as discussed earlier. Oikonomou et al. (41) looking at LTRC and heat waves, find that older buildings with higher heat loss and higher thermal mass capacities may benefit from the application of high albedo materials (high reflectance of sunlight), whereas newer, highly insulated buildings may benefit from higher ventilation rates and external shading systems. They found that nighttime window opening to purge heat was one of the most beneficial cooling measures. Returning to purge ventilation for COVID-19, it is interesting to see synergies between pandemic and climate measures.

5. Conclusion and next steps

The previous section follows the threads of UD, QOL, IC, and climate resilience as they appear and intersect across key spatial scales in LTRC. While much more research is required, it starts to illustrate how a holistic approach to UD can be used to explore and address various overlapping aspects of the built environment (19) in care settings. This

research also points to the synergies that may exist between different concerns which are often examined in isolation.

The findings from this research are being used to inform the planning and design of LTRC settings in Ireland. This sector is going through a period of change following COVID-19, and therefore it is important that the next stage of LTRC development in Ireland is underpinned by evidence-based policy and practice. While this research focusses on the Irish context, it is relevant to other locations with comparable LTRC systems, or who experience similar conditions related to aged-care, pandemic resilience, or the impacts of climate change.

This exploratory paper highlights a number of areas that require further research:

- Setting location and associated planning and urban design policy in terms of the intersection of UD, QOL, IC, and climate resilience.
- The role of the local neighbourhood and site design issues on the above.
- Research at a building level looking at space requirements, building materials, internal environment, technology, and other detailed building related issues.
- Explore the synergies that may exist at the nexus of these issues.
- Potential trade-offs that need to be balanced in resolving these challenges.

This exploratory paper presents UD as a bridging concept that brings together inclusion, QOL, health and wellbeing, and climate action in the context of LTRC. Individually these are complex issues, and this complexity vastly increases at their nexus. However, UD provides an important opportunity to create an integrated and synergistic approach to QOL, IC, and climate resilience so LTRC residents can thrive.

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Universal Design in University Environments. Are the New Buildings More Inclusive? A Tool for Equal Design Assessment

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Abstract.
This study explores the application of Universal Design (UD) principles to university environments, aiming to improve the experiences of students and staff by fostering inclusivity in educational and social spaces. The research began with a literature review and employed the 'Design for All A.U.D.I.T.' tool, developed by Politecnico di Milano. This tool was adapted to evaluate six buildings across two universities in Milan: Politecnico di Milano and Statale University. The buildings ranged from the most recent to medium-aged and the oldest on each campus. The assessment focused on three main categories—physical, social, and sensory-cognitive quality—across eight key areas, including outdoor environments, entrances, halls, horizontal and vertical circulation, restrooms, classrooms, and study/leisure spaces. A binary scoring system was used to calculate the satisfaction of requirements, previously weighted by experts. The evaluation revealed that newer buildings generally scored higher on average (77%) compared to those from the 1960s (62%) and historical ones (67%). Despite higher scores, newer constructions often prioritized educational spaces over social and leisure areas, resulting in a lack of student gathering spaces. Significant issues included poor entrance design, inadequate wayfinding strategies, and a lack of inclusive classroom features, although restroom facilities consistently demonstrated good accessibility. The most recent building at Politecnico di Milano scored highest overall but struggled in leisure and study rooms, as did the new building at Statale University. This research highlights both the current state and potential for improvement in university architecture through the lens of UD. The study underscores that innovative design does not always equate to user satisfaction and provides an objective tool to aid decision-makers in enhancing the accessibility and inclusivity of university spaces, ultimately improving the well-being of all users.

Keywords. Inclusive Design; Design for All; University; Built environment; Performance assessment; Case studies

1.Introduction

Inclusion, accessibility, and disability are increasingly important themes globally and in Europe, highlighted by initiatives like the Sustainable Development Goals (SDG) and the Recovery Fund, which emphasize creating inclusive spaces for everyone’s well-

being (mission 5 PNRR). Studies show that well-designed spaces positively impact quality of life and well-being [1,2].

Universal Design (UD) aims to create products, environments, and services usable by all without the need for adaptation, making spaces accessible and inclusive [3]. Similar to the Design for All strategy [4], UD addresses the needs of diverse people, regardless of abilities, age, gender, culture, or social background, improving quality of life for everyone [5,6].

It is crucial to define strategies and evaluation parameters to support the creation of UD-compliant spaces [7], especially in public buildings like schools, universities, healthcare facilities, and cultural sites, setting an example for physical and sensory accessibility [8].

Universities should embody educational and social advancement, providing equal opportunities for all. Inclusive teaching criteria must account for all possible difficulties, including socio-environmental, cultural, or familial challenges [9]. However, many universities still lack accessibility for students with disabilities. In Italy, only a third of universities are truly accessible. The National Agency for the Evaluation of the University and Research System (ANVUR) in a report on 90 universities highlighted ongoing accessibility improvements, but many still fall short in providing services like transportation (28%) and sign language translation (55.6%) [10].

The main issue is the lack of clear guidelines and tools to help designers and decision-makers create accessible and inclusive educational environments [11,12]. Current tools, like the Plans for the Elimination of Architectural Barriers (PEBA), often only meet minimum regulatory requirements and do not address all variables needed for truly equitable and salutogenic spaces [13,14].

This study aims to identify UD design and strategic actions to support the creation of accessible university spaces and to develop a tool for evaluating existing university buildings' inclusivity.

2. Method

The research methodology included three main phases: 1) analysis of the state of the art and identification of a method; 2) development of an analysis method appropriate for the university context; 3) application and testing of the method through empirical research to conduct a comparison of six universities in the city of Milan, Italy.

The analysis of the state of the art was conducted on the themes of UD in relation to university spaces and evaluation tools through a literature review [12]. The literature review identified three highly relevant tools: “Design for All A.U.D.I.T.” [15-16] from Politecnico di Milano, isUD Certification by IDeA Center [6], and Clear Code Architecture by PMMT Architecture. Unlike the latter two, which focus only on building areas, DfA AUDIT aligns with UD Principles and includes three macro categories to achieve inclusive environments, not only accessible. This comprehensive approach justified its selection as the most suitable tool for evaluating Inclusive Design. Therefore, this tool, originally designed for various public buildings like hospitals, was specifically adapted for university environments by simplifying it to three main categories, removing healthcare-specific indicators, and including those relevant to academic settings. The performance evaluation is carried out using qualitative and quantitative scientific indicators, providing a guide for decision-making and strategic processes, both for new projects and renovations. The Healthcare version of the tool is now available as an online

platform called Wideclusive® [1]. The inclusion analysis through this tool is based on three main categories: physical quality, sensory-cognitive quality, and social quality [17].

The second phase of the research involved adapting the tool to analyze each of these aspects in relation to eight typical university building environments: external environment, entrances, atrium, horizontal and vertical circulation, restrooms, classrooms, and study/leisure spaces. For each of these environments, checklists of indicators (design actions and/or strategies) were developed, considering the three main categories: physical accessibility, wayfinding, and social inclusion and well-being.

In the final phase, the new version of "DfA AUDIT for University" was tested on six case study buildings from two of Milan's most prestigious universities, Politecnico di Milano and the University of Milan (Statale). For each university, three buildings were considered: one recent (built within the last 5 years), one from the mid-20th century (1960s), and one historic, to understand if there is a correlation between the construction year and the quality of the spaces, given the increasing focus on accessibility and inclusion and the related funding.

3. Results

The DfA AUDIT for University tool was structured and organized to facilitate an objective analysis and identify effective design strategies to enhance the accessibility and inclusivity of university environments. This tool evaluates not only the individual building but also the surrounding area and associated services, providing a comprehensive overview of the services offered.

For the pilot case studies, the tool involved on-site inspections with detailed analysis sheets, including photos and graphics. Each building was assessed using indicators across three categories, highlighting strengths and weaknesses. Data collection was carried out by a Master's student in architecture and a UD researcher from the Architecture Department, ensuring objectivity and usability of the indicators. An associate professor reviewed the process, when doubts occurred and data analysis was performed in Excel, with verification by a senior UD professor.

3.1 Design for All AUDIT Tool for University Inclusion

DfA AUDIT is an evaluation system designed to analyze university spaces in line with Universal Design principles [15,16]. It is based on objective and quantifiable indicators to assess environments, focusing on three fundamental categories: physical quality, sensory-cognitive quality, and social quality. These categories are detailed as follows:

- **Physical-Spatial Quality**: Refers to the environment's ability to promote easy, comfortable, functional, and safe use of space for every user.
- **Cognitive-Sensory Quality**: Relates to the environment's capacity to support orientation, understanding of services, and user comfort, influencing the senses and cognition.

[1] The tool is now available via a digital platform named Wideclusive ® (https://www.wideclusive.com/en/home), developed by the research group Design and Health Lab of Politecnico di Milano also registered trademark. The name "Design for All A.U.D.I.T." is used to refer to previous scientific articles.

- **Social Quality**: Focuses on the environment's ability to enhance well-being and inclusion, considering emotional stimuli and social interaction among users.

Rating	Categories	Hall [To be evaluated once per building]	Value	Scores
50%	Physical quality *Total score:* *3 out of 4*	Entrance and hall doors have a clear span of at least 85 cm, preferably 100 cm.	Yes	3
		There are seating areas, with seats of different sizes, some with armrests, some without, with backrests, without backrests.	No	0
	Sensorial - Cognitive quality *Total score:* *2 out of 7*	Lifts, stairs and toilets are visible from the entrance or indicated by signs visible from the entrance.	No	0
		The orientation system includes visual, tactile and/or acoustic directional signs at all main entrances, indicating the location of primary destinations.	No	0
		There is a map or signage indicating the main functions of the building (e.g. classrooms and offices on each floor).	Yes	2
	Social quality *Total score:* *3 out of 5*	The windows provide outward views accessible to all (e.g. sitting or standing).	Yes	1
		There are artistic elements such as images, exhibition spaces and installations, aimed at enhancing the perception of the space.	Yes	1
		There is a reception desk for students and external persons (e.g. teachers, guests, parents, etc.), with a desk accessible to all (e.g. height between 70cm and 110cm).	No	0
		The seating configuration allows for the creation of spaces of privacy for individuals or for small groups (e.g. by shifting seats, arrangement, soundproofing). (If seats are not present = value absent).	Yes	1

Figure 1. Example extracted checklist for the building hall.

The tool examines these aspects across different sections representing university building environments, from external to internal spaces, including: outdoor environment; entrance; hall; horizontal circulation; vertical circulation; restrooms; classrooms; study and leisure areas. Each environment is represented by a checklist (Fig.1), providing an objective analysis that goes beyond the minimum regulatory requirements for overcoming architectural barriers, offering design strategies aimed at improving the life of all university users, from students to staff. For numerous environments such as classrooms or restrooms, at least one environment per floor or at least three of the same environments within the building is evaluated.

The scoring system employs a binary method where the value of each indicator is derived from the presence or absence of various requirements (Yes, No, N/A). Quality assessment results from meeting the defined requirements for each environment, with scores ranging from 1 to 3 to reflect the impact on achieving the specific indicator. The overall score for each category is determined by a weighted sum of the scores obtained for each criterion. For instance, in figure 1, the percentage 50% is the sum of the scores of the achieved indicators divide by the sum of all the scores of the indicators. Once applied, the tool provides a percentage evaluation of criteria satisfaction. Scores are provided for the quality of the entire building, each building environment, and each of the three categories.

3.2 The application of the tool in university buildings: physical, social and sensory-cognitive quality.

Compared to University A, the **historic building** has a rectangular plan with three floors and achieved a total satisfaction rate of 77% thanks to its green surroundings, shaded seating, bike racks, reserved parking, and public transport within 300 meters. Its physical quality scored 73% due to limitations from the building's historic adaptation. Despite ramps and added accesses, vertical circulation is hindered by secondary staircases. Internal signage is good, but external signage is poor and hard to identify,

reducing the cognitive quality to 79%. Social quality scored 81% due to lockers, vending machines, green spaces, and study rooms, though it lacks designated waiting and meeting areas.

The **1960s building**, with nine floors, earned a total score of 67%, with numerous bike racks, wide sidewalks, accessible parking, and good public transport. However, the interior sensory quality scored 62% due to inadequate, often improvised signage. Social quality scored 81% thanks to a bar area and external seating, but internal meeting spaces are empty and neglected.

The most **recent building** at University A, with four floors, achieved an overall satisfaction score of 80%, driven by an excellent sensory-cognitive quality of 90%, thanks to well-designed signage, restrooms, and equipped classrooms. However, the social quality was lower at 76%, due to a lack of gathering and waiting spaces.

At University B, the **historic building**, with four floors and several inner courtyards, scored 59%, with penalties in all categories, especially in sensory-cognitive quality (52%) due to poor, often improvised signage. Social and physical quality also scored low (64% and 63%) due to a lack of seating and waiting spaces both indoors and outdoors. Despite this, the building is well-connected to transportation and offers parking and bike racks.

The **1960s building**, with three floors, scored the lowest at 57%, with significant penalties in all quality categories. Social quality was particularly low at 48% due to inadequate seating and waiting areas. The campus entrance opens onto a crowded, tree-lined sidewalk with no seating, and the atrium lacks seating. Signage for services like stairs, elevators, or classrooms is missing, with only improvised signs in corridors.

The **newest building** at University B, with nine floors, achieved a total score of 74%, excelling in physical quality (83%) and sensory quality (79%). It features ample signage, bike parking, excellent public transport, and well-organized horizontal circulation with map screens. However, social quality was penalized at 48% due to a lack of designed meeting spaces, limited to basic waiting area seating.

In addition to category evaluations, the tool also provides detailed analyses for each environment. The table below shows an example of percentage values for different areas within one of the buildings along with their corresponding overall averages (Table 1).

Table 1. Example of evaluation results in relation to different environments (historic building, University B).

Building areas	Scores for areas	Total score
Outdoor environment	60%	59%
Entrance	40%	
Hall	44%	
Horizontal circulation	78%	
Vertical circulation	65%	
Restrooms	85%	
Classrooms	41%	
Study and leisure areas	62%	

3.3 Comparison of case studies

It is interesting to note that more recent constructions scored higher on average (77%) compared to buildings from the 1960s (62%) and historic buildings (67%), challenging the notion that innovation always leads to better results. The comparison chart (Fig. 2) shows that the highest score was achieved by the newest building at

University A, inaugurated in 2021, where cutting-edge design strategies were implemented, resulting in high scores in almost all areas. However, the building scored one of the lowest in the study and leisure areas.

			Physical quality	Social quality	Sensory-Cognitive quality
University A	Historic building		73%	81%	79%
	1960s building		64%	81%	62%
	Recent building		76%	69%	90%
University B	Historic building		63%	64%	52%
	1960s building		55%	48%	64%
	Recent building		83%	48%	79%

Figure 2. Comparison matrix of evaluation results.

The more recent buildings have achieved higher performance levels, confirming that the progress of Universal Design is not only cultural and ideological but also practical. However, it is notable that buildings from the 1960s scored lower than even older structures.

Among the positive aspects identified in the analysis, the restrooms are increasingly designed to provide maximum accessibility, with attention to the height of fixtures and aids, allowing adequate space and sanitary conditions. Classrooms are positive for their amount of light and internal comfort, equipped with outlets and technological aids. However, they often lack accessible stations for students with motor, visual, or auditory disabilities.

Recent buildings tend to prioritize educational spaces at the expense of social and leisure areas, neglecting student gathering spaces. This issue is particularly evident in newly constructed buildings (scores of 11% and 8%), which are important for the social and psychological well-being of students and staff. Interestingly, this is one of the most well-tended aspects in less recent buildings, such as the historic building of University A and the 1960s building of University B.

Another important point to note is the lack of attention to signage, exemplified by the 1960s building at University A. Despite recent renovations, it has significant limitations in internal circulation due to the almost total absence of wayfinding systems. Additionally, building atriums are often bare and lack installations that would make them more livable spaces, such as seating in various configurations to allow small group gatherings or privacy.

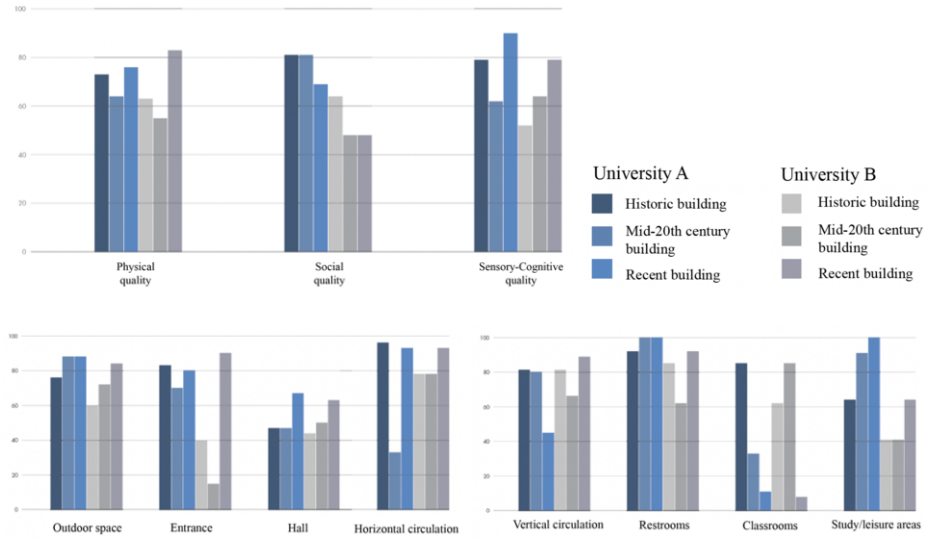


Figure 3. Graphs of the summary results and comparison of the evaluations of the 6 case studies.

4. Conclusions

The primary objective of this research was to examine the application of UD strategies in the university environment. The study applied a university accessibility and inclusion assessment tool based on UD to six case studies from two universities in Milan. The application demonstrated that the "DfA AUDIT for University" tool can empower decision-makers with effective design strategies, enhancing inclusivity in both external and internal campus spaces. This tool is proposed to improve inclusive university environments, increasing the number, proportion, and well-being of people with and without disabilities who can access and use university spaces, allowing them to participate in all activities inclusively. Additionally, it provides objective data on UD regarding physical, sensory, cognitive, and social quality, enhancing the social impact of usable and inclusive universities. Finally, it can serve as a benchmarking and decision-making support system to compare accessibility and inclusion across different international universities and offer design strategies to improve overall quality for everyone. The application's strength lies in its ability to provide a quick, cross-cutting evaluation of UD using objective data, with site audits taking just 2 hours per building after collecting drawings and permits. Weaknesses identified in the audits were primarily in the "outdoor spaces" and "entrance outside" sections, where many buildings lacked clear distinctions. The tool will be updated to combine these sections and include clearer indicators.

The limitations of this study primarily concern the number of case studies, which should be increased to validate results across various educational contexts. Therefore, the tool will be tested in future research concerning the following uses: both as a design support tool and an analysis tool to evaluate the degree of inclusion.

The next step in the research will be to assess all universities in Milan, then expand the evaluation nationally and internationally. This will further test the tool, comparing accessibility and inclusion among different universities and providing design strategies to enhance the quality of spaces for all. Later on, it would be interesting to analyze the

inclusion of university buildings in relation to inclusive pedagogy, such as the Universal Design for Learning (UDL) approach.

This research examines spatial inclusion in university environments through the lens of UD, shedding light on the current state of university architecture and its potential for improvement. By offering an objective mapping tool, this study aims to empower decision-makers and designers to enhance the accessibility and inclusivity of university spaces, ultimately improving the well-being of all users.

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Architecture, Sustainability and Design Tools

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Static Versus Dynamic Accessibility. Accessibility Management as a Tool to Enable Its Permanence over Time

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Abstract.
An accessibility monitoring or audit of an environment provides information at a given point in time (static view of accessibility). But accessibility, to be really effective, must be maintained over time. Therefore, it must be considered throughout all phases of the design process (different phases of the project) and construction (different phases of the work). But it is also essential that, once built, it is possible to maintain or even increase the level of accessibility initially achieved.
There are many cases in which, despite a good accessible project, during the life of the building the accessibility conditions worsen substantially because the need for a system that guarantees the permanence of accessibility over time is not contemplated.
This requires the adoption of a Universal Accessibility Management System (UAMS) which, as is done with other disciplines such as Quality or Sustainability, allows those responsible for the management of this environment to implement, prevent or correct the accessibility actions that correspond in each case.
For the development of a UAMS, the first thing to be defined is the scope to be considered and the scope. Furthermore, from the point of view of use, accessibility can be considered from the visitor's point of view (customer service; customer's perspective) or from the worker's point of view (workstation; employee's perspective).
In this article we will take as a reference two methodologies that have been widely used on numerous occasions, to analyse the strengths and weaknesses of each of them and their parts from a deep theoretical (processes and indicators) and practical (disruptors) knowledge.
The ultimate aim of this work is to identify the aspects to be considered in the definition of a UAMS, in order to be able to define and specify the keys to approach an accessibility audit from a dynamic perspective, that is to say. one that really guarantees the sustainability of the accessibility of that place over time.

Keywords.
Accessibility management. Dynamic accessibility. Built environment

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1. Introduction

Unfortunately, in many environments it is relatively common to find an accessibility situation that is not adequate, even though it was originally conceived correctly. This situation has often been motivated by a lack of maintenance, or a modification of use and where there has been no connection between the original accessibility and the one that exists today.

The consequence in all cases is the ineffectiveness of accessibility. This conception corresponds to a static vision of accessibility, a "still photo" coinciding only with accessibility at a given moment [1]

On the other hand, there is a concern, unfortunately still a minority, to try to guarantee accessibility over time (dynamic accessibility) for which a Universal Accessibility Management System (UAMS) is required. The structure and contents of this UAMS is what this study focuses on.

2. Approach / Method

The numerous complaints about the lack of accessibility in spaces where it previously existed, as well as the systematic evidence of audits carried out in different projects, show a reality in which a punctual consideration of accessibility in environments is not enough. An accessible toilet converted into a storeroom, a lowered counter used as a storage shelf, a TWSI (Tactile Walking Surface Indicators) strip blocked by furniture, or a grab bar in a toilet that no longer works properly, are just some of the common examples that can be found. Therefore, a rethinking is needed to consider the accessibility as a dynamic reality that requires a Universal Accessibility Management Plan (UAMP) to guarantee accessibility over time.

For this study, an analysis of two Universal Accessibility Management Systems (UAMS) is carried out. This documentary analysis is complemented with the direct experience of practical evaluation that the authors of this study have, in order to be able to assess their effectiveness from a more global and efficient perspective.

2.1. Accessibility Management in Smart Tourism Destinations (STD)

First of all, we will analyse the UAMS for Smart Tourism Destinations (STD) which Seggitur (an entity of the Secretariat of State of the Ministry of Tourism of the Government of Spain) has been developing for several years with studies carried out in more than 400 tourist destinations.

It is an accessibility evaluation system that forms one of the five axes that make up the destination evaluation method of this entity: Governance, Technology, Innovation, Sustainability and Accessibility [2].

This system takes UNE 178501 [3] and UNE 178502 [4] standards as a reference and bases this system on the following principles (aimed at a public management body that administers the tourist destination):

- Leadership: with a commitment from top management, defining an accessibility policy and objectives, providing the necessary means and resources, with participative, transversal and transparent management.

- Planning: with internal and external analysis in order to have an updated diagnosis of the current reality, actions to address risks and opportunities, mapping of threats, definition of actions to achieve objectives, etc.
- Support: through the provision of resources for the establishment, implementation, maintenance and improvement of the system. Including staffing, training, infrastructure and economic resources. Defining competences, raising awareness and communication as well as documenting all information.
- Operation: Continuous control of the different processes. Determine requirements and their services. Reviewing changes, determining the requirements to be considered and implementation of the Operational.
- Evaluation: monitoring through the established measurement criteria, having information on the point of view and opinions of tourists and citizens on the ITD, carrying out an evaluation with all the data and measurements obtained. In addition, an internal audit and management review should be considered to complete the performance evaluation.
- Improvement: Determine and select opportunities for improvement and implement the necessary actions to improve processes, products and services within the scope of UAMS.

Among the indicators that are established, the following stand out:

1. Commitment to accessibility: document stating the commitment to the continuous improvement of universal accessibility in the ITD.
2. Human and financial resources: quantification of the human and financial resources for the management of universal accessibility in the ITD.
3. Accessibility diagnosis: existence of a documented diagnosis of the ITD's universal accessibility, the scope of which covers the elements of the entire accessibility value chain.
4. Action Plan: document that includes the Universal accessibility improvement actions to be carried out in the ITD.
5. Training actions: number of training actions given and promoted by and in the ITD on Universal Accessibility and Design for All. In addition to the number of students trained.
6. Information on the accessibility of the destination: information publicly available on official destination websites.
7. Accessible information: existence of accessible information on the ITD in different media (physical and digital) and formats (visual, auditory and/or tactile).
8. Promotion of accessibility: percentage of the budget dedicated to initiatives to promote the accessible offer of the ITD.
9. Commitment to continuous improvement: Public document of commitment to the continuous improvement of universal accessibility in the ITD.
10. Degree of compliance with accessibility: percentage of universal accessibility measures of the ITD's Action Plan that have been complied with.
11. Accessibility in wayfinding: existence of accessible guidance, signposting and orientation systems in the ITD.
12. Accessible transport: accessible public transport vehicles (% taxis and buses) as well as accessible routes and itineraries (stops and vehicles).

2.2. Accessibility Management from the DALCO criteria

This system is based on the UNE-170001:2007 Certification standard, the first part of which defines the basic functional accessibility criteria DALCO (in Spanish an acronym for Moving, Grasping, Location and Communication) and the second part establishes a Universal Accessibility Management System, UAMS.

This standard and the system defined here has served as the basis for the implementation of a dynamic approach to accessibility in numerous entities in Spain. The accessibility certification developed from this document has led both certifiers such as AENOR [5] and consultancy firms such as CEIS [6] or ILUNION [7] to rely on specialists in the field to audit or assist in the implementation of this system.

It has been applied mainly to built environments (although also to products and services) of different types: urban public spaces, existing buildings, new buildings or others. And of different uses: offices, shopping centres, shops, hotels, museums, etc.

This accessibility management system is based on the following four sections:

- Responsibilities: management commitment, system review. Universal Accessibility Policy.
- Resource Management: Human resources (provision, qualification, training), materials, infrastructures and technical aids. Documentation
- Planning: Accessibility chains, compliance with DALCO criteria.
- Monitoring, Measurement, Analysis and Improvement: Corrective and preventive actions, data analysis. Accessibility Improvement Plan.

It is remarkable its similarity with the quality management system, since it was conceived in its design as a particular case of quality management, according to the contents of ISO [8].

2.3. Other cases

There are different accessibility evaluation methods, many in the form of checklists that can allow some comparison. For example, the NDA's Access Handbook Template [9] or as an accessibility consultancy methodology [10]. Particularly noteworthy is the European Commission's Technical Report on Conformity Assessment of Accessibility and Usability in the Built Environment UNE-CEN/TR 17622 IN [11].

Although beyond the scope of this study, it is also noteworthy to keep in mind the existence of accessibility management systems beyond the built environment, such as ICT, training, and others. [12].

These systems, although with significant differences in content, also guarantee a dynamic vision of accessibility as opposed to a one-off resolution of a problem (traditional vision of accessibility). Moreover, they are also a tool, through continuous improvement, to go beyond standards, and not to be limited to mandatory regulations [13]. The Universal Accessibility management system and its possible associated certification is conceived in other cases as an added value for the organisation [14].

3. Results

These two accessibility management systems are based on public methodologies endorsed by a standardisation body.

The scope in both cases is within the field of the built environment, although the first is more specialised for Tourist Destinations (municipalities, cities or regions) of a larger scale and which includes many elements (streets, buildings, products and services). However, the second one, although initially flexible for any scale, in practice has been found to be more effective for the implementation in entities where the built environment of one or several buildings is combined with the associated accessibility products and services provided there. (such as, for example, customer service or emergency evacuation assistance).

Both methodologies base some of their indicators on compliance with mandatory accessibility regulations. These are complemented by other indicators from guides, manuals or the experience of the designers of these methodologies. In turn, some of the indicators need to be broken down into sub-indicators, resulting in a nested structure of requirements. It is important to highlight that the result is not based on an arithmetic sum of scores, as not all the requirements have the same relevance and need to be weighted, as some of them are essential to complete the process.

The key aspects to be considered in a Universal Accessibility Management System (UAMS) are very similar in both cases, being the Involvement of all areas, Planning, resourcing, monitoring and continuous improvement, the key factors to be highlighted in common.

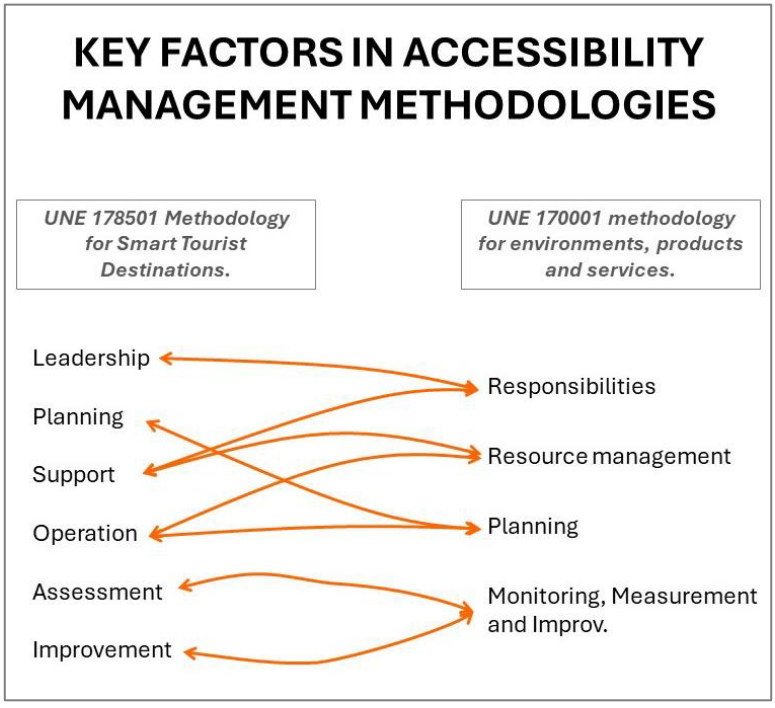


Figure 1. Comparative scheme that relates the key factors in the two accessibility management methodologies analyzed.

In both cases, the management system can be associated with a seal or certification that serves as a distinction for identification by the end user as an accessible environment. These distinctions are not of an indefinite nature but are limited in time, thus reinforcing the idea of the need to consider accessibility on an ongoing basis.

4. Conclusion

It is important to highlight the cross-cutting nature of this system, as it relocates accessibility not to a specific department (traditionally associated with Social Services or Works) but is now present in all areas of the entity: marketing, purchasing, product development, customer service, maintenance, etc. And involves the entire structure of the entity, from top management to the last technicians in each department. [15]

Some limitations are also evident. In the case of the DTI methodology, as it is centred on a public management body, the entire tourism part of the destination that depends on private management (and there is a lot of it) is relegated to the background, so that accessibility management is limited in scope. For example, the accessibility of privately managed accommodation, restaurants or even tourist attractions. This methodology, although it would require more effort, could be implemented perfectly well by including also privately managed settings and services.

In the DALCO methodology, some considerations are insufficiently developed, leaving them rather ambiguous and at the discretion of the assessing technician. Despite relying on the mandatory regulations, this is not a solution, as in most cases they are minimum requirements that fall far short of the excellence sought by a management system. The specification and development of many of the requirements that go beyond the minimum requirements established by legislation could be another aspect to be implemented in these methodologies.

In both cases, and as a final conclusion, it was found that the implementation of an accessibility management system has led to a reconsideration of accessibility, not as a one-off project to be carried out and that's all, but as a basic and permanent consideration to be kept in mind on an ongoing basis (Dynamic Accessibility).

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Unveiling Social Sustainability: A Mapping of Practices at an Architectural Studio

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Abstract Universal Design (UD) and social sustainability are closely related agendas in today's construction industry. This paper studies how social sustainability was implemented as a strategic asset at a company level in an architectural studio and how it was subsequently practiced by different parts of the organisation. The merging of two architectural studios into one involved strategic development and a new common strategy for future collaboration and innovation, entitled "Always Based on People" (ABoP). Based on interviews and document analysis, the architectural studio's strategic work on social sustainability is analysed using the conceptualisation of multiplicity. By following four roles and their practices in the organisation; head manager, communication officer, project manager, and sustainability auditor, this analysis look at their context, background, methods, understanding and end-products, reveals different versions of social sustainability in relation to different stages of the design process. The case illustrates how values are represented, negotiated, and established within the organisation, reflecting different types of values - espoused, shared, and aspirational. The paper argues that it would be relevant to assess and refine the feedback mechanisms and navigational skills of the organisation to include, distribute and coordinate, or even triangulate between, value-based concepts as social sustainability, UD, and accessibility. The result could be a situation where social sustainability functions as a lever for UD, and UD qualifies social sustainability counteracting social washing.

Keywords. Architectural practice, social sustainability, universal design

1. Introduction

Social sustainability has found its way to planning practices, as a value-based framework ensuring community and user involvement. In a questionnaire survey among architectural studios concerning social value creation in connection with public housing projects, mental well-being, inclusion, and ownership were the headings that most participants chose to describe their understanding of social value creation [1]. Mental well-being was understood as aesthetics, health, healing architecture, well-being, liveability, while inclusion was understood as equality, community, universal design (UD), accessibility, neighbourliness, and clear boundaries.

In literature, social sustainability is described as both the improvement of living conditions (for present and future generations) and the procedural aspects of how to govern development processes [2]. The social of sustainability span broad from social justice (equity, rights, access, participation); human and social capital: health and wellbeing of communities; and engaged governance [3]. On the individual scale, quality of life is a concept that unifies material needs, non-material conditions (relations, social,

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cultural, and environmental conditions), satisfaction, and happiness [4]. While the two other pillars of sustainability, environmental and economic, are easily assessed by short-term calculative practices, social outcomes are more difficult to empirically record [5], both due to the differences in scales and fields, and due to a more long-term scope [6]. In addition to objective measures, quality of life and other social outcomes also involve subjective measures, such as how people perceive and evaluate their surrounding conditions [7]. As a flexible and context-dependent concept, social sustainability is defined and translated to the specific situation [6].

Sustainability in construction is assessed by different methods. In Denmark, the certification scheme of Deutsche Gesellschaft für Nachhaltiges Bauen (DGNB) includes parameters for social sustainability found in the criteria of 'sociocultural and functional quality'. However, the criterium has different focuses regarding scale, physical and functional aspects in building scale (temperature, acoustics, visual comfort, indoor air quality, accessibility, safety, disposition, architectural quality, art, and outdoor areas) and on both social and functional diversity in the urban scale. Assessments of social sustainability have geographical and temporal delimitation; what is assessed as 'good' for the city is not necessarily good for the local area or a specific part of the population, and ideals for 'good' are changing [8]. Stakeholders use the abstract concept of social sustainability differently, often to support their agendas, sometimes reproducing the standard norm rather than addressing the specific perspectives at stake. To avoid false security and *social washing,* we need to acknowledge the geographical and temporal scales, and continuously sustain the critical dialogue about the role and function of social sustainability and its benefits: "Good according to whom? And at what expense?" [8. p. 608]. In addition to social sustainability, design professionals and their organisations continuously handle and position themselves within other societal agendas and value-based frameworks, such as UD. The relationship between UD and social sustainability has been emphasised [9]. UD's focus on social integration of people with disabilities, as well as ethnic minorities, low-income groups, LGBT+, parallels social sustainability. From this perspective UD is understood as a process that contributes to the improvement of human performance, health, well-being, and social participation [10]. However, when emphasising UD as a process, the organisational context is not elaborated in relation to the implementation and practice of UD values.

In recent years, UD and social sustainability have become closely related agendas in Danish construction industry, where UD pioneers consider UD a key to social sustainability [11] and a means to enhance the narrow understanding of accessibility with much more inclusive approaches and design solutions. In May 2024, the Danish Association of Construction Clients has integrated UD in their policy on social sustainability [12]. However, the prescriptive accessibility requirements of the buildings regulations and conservative clients have long defined and settled the level of rather unambitious design solutions [13], making it difficult for the architects to work with UD. Consequently, a change in mindset [10, 14] and a UD mindset [15] has been emphasised as an important aspect towards inclusivity.

The purpose of this paper is to study how social sustainability was implemented as a strategic asset at a company level in an architectural studio and how it was subsequently practiced (and understood) by different actors/parts of the organisation. The contribution is aimed at both academia and practice, as it adds to the existing body of knowledge on UD regarding mindset and approach when applied. Additionally, it explores the relationship and differences between social sustainability and UD that organisations in construction encounter in the contemporary value-based marked.

2. Theory

Organisational values are important for the identity and culture of an organisation [16]. These values can be espoused, attributed, shared, and aspirational. While the *espoused values* are sanctioned or managed by top managers, *attributed values* are those that core members feel represent the organisation. *Shared values* are those embedded in customs, norms, and practices, while *aspirational values* are the values that members believe the organisation ought to have. The presence of the different forms of values in an organisation change in a continually evolving composition, dependent on external or internal changes or interventions, such as a strategic reorientation in an organisation, which often includes disruption of the present equilibrium of values.

The related and changing forms of value, as well as the palette of different values in an organisation, hold parallels to Annemarie Mol's notion of the 'Body Multiple' [17]. The body multiple is used to describe the different versions of a phenomenon, atherosclerosis, and how these versions are enacted by different practices in a Dutch hospital. Informed by instruments, background knowledge, treatment regime etc. of each of the practices, the versions exist side by side, making the assessed and treated body a fragmented, yet at the same time versions of the same body. Mol shows how the versions are related to each other across the different sites and practices, and across the hospital. Described by *ignorance*, *inclusion*, *distribution*, and *coordination*, different relational modes can be more or less consciously and strategically used to manage and navigate between the different versions across the organisation.

3. Research design

This paper is based on a study of a Danish architectural studio merged from acquisition of two architectural studios in 2020 and 2021. The studio has offices in five Danish cities, with a total of 113 employees and partners. In a situation characterised by changes due to the merger, it was decided to articulate a set of values that could unite the studio and strengthen the identity. The mantra 'Always Based on People' (ABoP) was built from a bottom-up assessment of the existing values and practices of the two original studios and used in the strategical process of creating the new profile.

Inspired by Mol´s multiple enactment of a phenomenon [17], this paper explores how ABoP is enacted in the studio. The empirical material includes four qualitative interviews and a document analysis. The monthly internal newsletters 'Heard at the studio' issued from January 2021 until April 2022 and the new website launched after the merger in March 2022 were used to prepare the semi structured interview guide aimed at mapping what ABoP means for the informants in relation to their work at the studio. Thus, the interview guide was structured around the main questions: How do you understand ABoP? How do you use ABoP in your work?

The informants represented different professional roles and practices at the studio: Practice 1 (P1) a managing partner, Practice 2 (P2) a communication officer, Practice 3 (P3) a project manager, and Practice 4 (P4) a DGNB/sustainability auditor. Every interview lasted for approximately 30 minutes, two of the interviews were recorded and for the other two interviews notes were taken both during and after the conversation. All interviews were transcribed and, together with the notes and documents, used to describe

and thematically analyse the practices in relation to the different versions of ABoP, the values, and the different relational modes represented.

4. Findings

ABoP was launched as an innovative strategy for the consolidated company, aiming to embed in the organisation as a mindset representing values as courage, respect, engagement, and ambition. Examining how these values of ABoP were enacted across the four practices reveals differences regarding orientation, focus, and understandings of diversity and social sustainability.

4.1. Distribution and focus

The interviews show that focus was distributed across the trajectory of the design process and across different organisational orientations (internal and external). P1's main orientation was towards the external marked and the studio´s position in this regard, while P2's focus was on the final product. P3 concentrated on the design process, and P4 focused on the assessment or documentation of the final product, also involving later phases of the design process. Thus, the position and orientation of the individual practice influenced how social sustainability and diversity were understood and enacted. P1, P2, and P3 described diversity in relation to different work functions and different users of buildings. P3 and P4 also mentioned different family constellations, with P4 being the only one to describe physical impairment or abilities as a parameter of diversity. Regarding social sustainability, P1 stressed the involvement and engagement of local labour in the building processes, both externally and internally, stressing the importance of the organisation´s local satellites to the studio´s identity. The ambition of creating value for the client was seen in relation to employee engagement, which includes respect for people, as well as architectural and functional values. P1 also suggested that the diversity of the employees could drive this engagement.

P2 shared this focus within the organisation, linking the social sustainability in ABoP to the studio's identity, their type of tasks and local presence: "Our local commitment and presence bring community-supporting architecture to all parts of Denmark, and we continue to develop our professional skills, which we can put into play regardless of the size or segment of the task. …" (newsletter, P2)

P2 places a general emphasis on the societal aspects and impact of the built environments created by the studio, addressing user in broad terms: "Architecture that does not start from the users is not architecture at all for us", although primarily represented by the client: "That's what we do and have always done - we start from the users and the client who ordered the building." The aim was to provide buildings that meet the requirements of their clients, yet preferably in a way "which clients never could have imagined themselves" (P2). Diversity of users involved daily users, building service staff, and even steering groups.

For P3, social sustainability was by large related to the projects and particularly to user involvement to ensure cohesion, participation, and equal opportunities. Furthermore, social sustainability was never isolated from economic sustainability: "Social sustainability… and economic sustainability … it is all connected, and if you do not get the right processes running…Yet you need to know the time perspective… is it the budget for the here and now or in 40-50 years?" (P3)

4.2. Time and changes

Time was emphasised as a perspective of change, new practices of the organisation situated in the building (P2), new family structures (P3 and P4), and changes that the building should accommodate (P1): "We put great effort in creating buildings that can be developed over time so that they can meet many and changing needs."

For P4, who was more directly engaged in assessing the projects, the flexibility for future changes also included the studio's understanding and approach to user needs and profiles. P4 stressed that currently, social sustainability is something measured and quantified in the certification schemes. Even though DBGN has included UD with an expectation to support implementation of the concept, it is still, in this context, understood and practiced as mere 'traditional accessibility'. As long as it is seen as an add-on and not a design tool integrated into the design process, real evolution will be limited.

4.3. Navigating the human diversity issue

In other areas, such as the field of planning, the auditor describes a change of approach due to the sustainability parameters: "Social quality – for example the quality of the area... Previously, social quality didn't matter - now with social sustainability, including leisure and learning, and mobility infrastructure, social quality counts." (P4). P4 noted an increased focus on human diversity within this practice, primarily represented by users' physical abilities. Particularly, building regulations on accessibility have raised awareness regarding wheelchair users, blind and visually impaired people in the practices of P3 and P4. However, diversity was not understood in relation to social and cognitive/mental abilities, or other sensory or physical impairments. Despite ABoP´s strategy departing from a focus on people, the meaning remained ambiguous and posed a challenge for P4: "ABoP is, after all, individual and comprehensive". Human diversity was by large understood in relation to different architectural functions and functional groups – not as diversity within a group related to the human body, such as the abilities of service staff or occupants. This underlying recognition of the limited understanding of diversity was also illustrated by P3, who shared awareness of UD, noting it does not prescribe a one-size-fits-all solution: "Ultimately, we have to accommodate as many people as possible. Yet, we also seek a balance; we must design something specific but at the same time be as universal as possible. Nobody has the perfect formula."

4.4. Future coordination efforts?

P3 considered the articulation of social sustainability to be an opportunity 'to cater to as many people as possible'. However, it became evident that the course of the design process itself was a crucial role in the coordination between the different value-frameworks of UD, accessibility, and social sustainability. P4 experienced that the strategy for accessibility was only addressed towards the end because the prescriptive requirements of the Buildings Regulations were exclusion criterion in DGNB. Consequently, no one really worked with UD, and accessibility became an add-on in the design process. The auditor reflected on the potentials for coordination: if both aspects of UD - the prescriptive measurements as well as the good attitudes and intentions - were translated into a measurable parameter in the scheme, DGNB and social sustainability

could potentially help elevate UD. However, P4 also acknowledged the challenges in evaluating good attitudes and intentions.

5. Discussion

The findings illustrate multiple understandings [18] of ABoP and its associated values and concepts – embedded in the different phases, processes, and products within both the organisation and its specific projects. In the work of creating ABoP, there was a deliberate attempt to acknowledge the diversity represented among the colleagues, a task initiated by P1 and carried out by P2. However, it appears that the practical, hands-on understanding of the different concepts of UD, social sustainability, and accessibility, is primarily embedded in project work, which is mainly carried out by the two other practices represented, P3 and P4.

One of the key differences in these understandings lies in the very concepts themselves. For instance, regarding social sustainability, this involves both ensuring representation and involvement in the design process, as well as documenting and measuring the degree of social sustainability in the final product [4]. When evaluating the versions of social sustainability represented in the interviews or documents, the social aspects related to improvement or empowerment [12] are limited to the internal organisation and local labour (P1), rather than empowering of the future users of their architectural design. This could be a natural consequence of design processes, not knowing the future users, and therefore not having the possibility to involve them. However, this does not seem to be the case as they emphasise the role of the user in other ways in the empirical material. Similarly, their representation of users focuses on different users across an organisation or a lifecycle, without considering diversity in physical or mental abilities. In this regard, the studio's practices differ significantly from Steinfeld and Maisel's understanding of the UD process [10], or the mental health and inclusion identified in social value creation in public housing [1]. This limitation is addressed by P3 and P4 and acknowledged by P1 when confronted with this in the interview.

P4 describes an issue of the assessment of social sustainability, which occurs at the very end or even after the design process. While P1, P2, and P3 are involved from the early stages of a design process and stress the client as the primary force for setting the values in each project, including the degree of social sustainability, P4 is mainly involved in execution and documentation where key decisions and negotiations have already been made. P4 stresses the possible benefits, if the studio could embrace and visualise social sustainability from the initial phases and throughout the design process, thereby enhancing their support and potentially qualifying the overall sustainability agenda.

Negotiation and settlement of value-based agendas as social sustainability, also constitute conscious or unconscious methods of coordination or distribution. Consistent with Bourne and Jenkins [16], the different versions of diversity and social sustainability represent different values: P1 and P2 largely represent top-down *espoused values* derived from core members *attributed values* in ABoP. In contrast, the values embedded in the customs, norms, and practices described by P3 and P4 represent *shared values*. P4 also reflects on *aspirational values* regarding how the social sustainability and UD could be integrated into the organisation. The evolution and interplay between these types of values can be strategically employed in organisational change by realigning and disrupting the existing equilibrium of values [16].

The use of theoretical frameworks such as the body multiple [17] and its relevance to the analysis can, of course, be debated, as it may introduce a confusing element to the narrative of the paper. However, as it is precisely through this specific theoretical lens that the different yet corresponding versions were made visible to us, and for that reason, we find it necessary to share in an academic text such as this.

Boström [2] argues that though social sustainability is not the best concept for studying the complexities of the social-environment relationship, it can be effectively linked to other social scientific concepts. Although the study of ABoP is small in scale, we believe its intentions and strategical work reflect the current situation in many architectural studios and related practices of the construction industry, as well as others working with societal agendas in other marked-driven industries. The findings show that UD can support the users of the built environment in a gentler manner than social sustainability has demonstrated, in acknowledging and arranging for the needs of the caretaker with a hearing loss or mobility impairment. This means that practitioners working with value-based management need to nurture the awareness that UD and social sustainability work at different levels, and the important work in connecting, navigating, and coordinating between them. We also posit that enhancing the strategic implementation of value-based frameworks could benefit from better acknowledgment and coordination of knowledge and efforts dispersed across different organisational levels and positions in the design process. Moreover, there is a need for future research of UD and social sustainability, particularly on how they are or could be practiced and translated throughout the building process, from programs and user involvement to the use of the building.

Consequently, it would be pertinent to assess and refine the feedback mechanisms and navigational skills of the organisational system – to include, distribute, and coordinate, and even triangulate between the value-based concepts as social sustainability, UD, and accessibility. Furthermore, as both agendas and concepts continue to evolve, the integration of UD in the Danish Association of Construction Clients policy of social sustainability in May 2024 [12], two years after the interviews were conducted, may be a determining factor for the transition of the sector. This could potentially lead to a scenario where social sustainability functions as a lever for UD, and UD contributes to enhancing social sustainability while mitigating the risk of social washing.

6. Conclusion

The paper demonstrates that there are multiple understandings of ABoP and social sustainability within the architectural studio, depending on organisational roles and level of engagement in projects. Management and communication focus primarily on meeting client needs and the broader social aspect of social sustainability on an overall level. Conversely, those directly involved project design concentrate on the inclusion of as many users as possible. However, human diversity is predominantly understood in terms of various architectural functions and functional groups, rather than encompassing diversity within specific user groups related to the human body, such as the abilities of service staff or occupants.

These findings underscore the necessity for earlier and more comprehensive integration of social sustainability throughout the design process to enhance overall sustainability. Currently, DGNB primarily function as a late-stage reminder of building

regulation requirements on accessibility, rather than serving as a foundational approach for UD from the outset of the process. Looking ahead, future versions of DGNB could potentially evolve to initiate and promote UD from the beginning of architectural design.

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Gap-Trailing: Scaffolding and Exploring Situated Knowledge

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Abstract. User knowledge and lived experiences are pivotal in bridging the gaps between the environment and individuals causing disability. Examples of best practices help us refine and develop the theoretical groundings of UD in academia and the practical implementation in design practices. Yet best practices are also needed in our methodological approaches across research and practice concerning how to work with and in the intersection of people and environments. The approach of the researcher is pivotal when facing individuals with diverse physical or cognitive abilities, but also when exploring the role of the environment. Architectural anthropology is one way of combining tools and mindsets that could be useful when studying more complex or nuanced processes, e.g., aging or impairment. In this paper, we focus on the knowledge of people who are experiencing incipient vision loss and the mutual and dynamic interrelation of (dis)abilities between the individual and their (home) environment. In the project entitled "The Role of Lighting When Vision Changes" we explore the phenomenon of vision loss, and in this paper, we provide a critical-reflective perspective on how fieldworks can contribute to this exploration. During the winter season of 2023-24, walk-along interviews were conducted in the homes of 37 participants 55+, including 10 normally sighted and 27 visually impaired (still using their residual vision). Based on transcriptions and fieldnotes, as well as reflective notes from subsequent joint discussions among the researchers, this paper discusses the role of architectural anthropology in the project and how it can scaffold new socio-material explorations as well as critical reflections.

Keywords. Universal Design, Reflective Practitioner, Architectural Anthropology; Incipient vision loss; Domestic Lighting

1. Introduction

Universal Design (UD) holds ideological and strategical foundations to bridge the gaps causing exclusion and disability between individuals and the surrounding physical and social environment [1]. In the 40+ years of UD, the field has spread and cultivated, in functionalistic, pragmatic, positivistic, normative, and critical theoretical applications [2]. In a call to build a more robust theoretical foundation of UD Steinfeld and Maisel [3] stress the practical implementation and use by design practices: "…we need to start with an understanding of the type of information that designers find useful". User knowledge and - representation have been focal, by encouraging *participation* in and by empathetic design in design practices and design methodologies [4], or more specifically the way user-knowledge represented in narratives can provide insights into everyday life and the

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opportunities and barriers encountered by the users [5]. Moreover, this context-specific knowledge and episodic experiences with users in specific situations act as eye-openers or metaphors to guide and establish a UD mindset in a design process [5]. Yet, when situated user experiences are disseminated [6], knowledge of the physical environment is often underrepresented, and in the fields of design and architecture, there have often been an instrumentality associated to user knowledge, also seen in UD's origin in product design, physical ergonomics, and part of a technical rationality in a problem-solving regime [7]. The instrumentality is also seen in the general understanding of human vision in architecture, as static and neutral. However, this is far from the actual diversity of visual abilities among us: Current data from Denmark show that while only 1% are diagnosed with severe visual impairment or blindness [8], our vision changes through life and 50% use spectacles from the age of 12 years, increasing to 90% from the age of 60 [9]. Designs for the visually impaired have often been provided as special solutions and assistive technologies focusing on the diagnosis and lighting recommendation for the elderly to increase the levels [10, p. 438]. Moreover, the physical environment has been considered a neutral or rather passive parameter in the rehabilitation process of the visual impaired [11].

To scaffold the situated user knowledge so pivotal for the UD researcher, we introduce a method of gap trailing and discuss how to enhance exploration of the dynamic relations and gaps between individuals and their environments.

2. Theoretical framework

Studying both sides of the individual-environment-gap [1], requires input on the situated knowledge. Lived experiences are situated in the bodies of the individuals and in the given time and place [12], as an eye is situated in a specific body and mind, and in a specific social and physical context, the sociotechnical mesh of the everyday life. People are not passive receivers of comfort [7] nor passive receptacle for sensations, but engage in "active and interactive, conscious and unconscious processing" of their environments [12, p.47]. We need to "recognize the sensorial in a way that challenge the static understanding of the 'regular user' and rigid design standards" [13, p. 15]. Yet, as able-bodied people do not know the experiences of the disabled-bodied, the expert knowledge embodied in people of different abilities can enrich our knowledge and understanding regarding the built environment [14]. Tacit knowledge embedded in technologies and environments [15] and embodied in our bodies and everyday practices, can be explored, made explicit and be a source of expertise in social interactions, as seen in situated learning [16] and included in the process of scaffolding that involves what can be achieved by the help of others [17]. In the fieldwork, we also need to acknowledge the knowledge embodied in the researcher and embedded in his/her methods: to become aware of our implicit knowledge a priori, and our tacit knowledge enacted in and resumed to after the fieldwork, as *reflection in and on action* [7]. A re-positioning, not in the high ground problem-solving of technical rationality, but in an exploratory and reflective mode of framing the problems and unveiling the uncertainties of the "swampy lowlands" [7 p. 42]. The "art" of this practice is two-folded, involving both *knowing-in-practice*, "the intuitive judgement and skill, the feeling for phenomena and for action" and the *reflection-in-action*, when phenomena are perceived incongruent with the intuitive understandings of the practitioner, involving "surfacing, criticizing, restructuring, and testing" [7 p. 241]. Furthermore, the in-depth ethnographic trials of the researcher are

animated by the topographies, bodies and lives they cross: “Trials embed the movement which both constitutes them, and which provides a method for their investigation” [18], ethnographic fieldwork embeds and reveals the *navigational skills* of the researcher, allowing sensitivity and improvisation to "assess, position and re-direct its course" [19]. The verb *trailing* means to be drawn along behind someone or something, or to walk or move slowly or wearily [20], and in order to explore big issues it is often necessary to focus, in-depth, in particular and local conditions, “large issues explored in small places” [18]. The specific focus on the built environment in these inquiries can be supported by architectural anthropology, an approach grounded in a phenomenological understanding of space, reflecting a criticality of social relations and meanings materialized in our built environments [21], as well as a general focus on the different temporal and physical engagements enabled by architecture. Architects employing anthropology have been criticized to lack the reflexivity and critique embedded in AA [22], nevertheless, as a mode of inquiry, AA can be a tool to nurture exploratory and self-reflective approaches, conduct fieldwork and critical analysis of the empirical data [23]; a means to *understand* a complex phenomenon, as “a lens for zooming in and out across physical, social and temporal scales” in indoor environments [24]; or for developing rich descriptions as seen in studies of the everyday life of people living dementia [25].

3. Methodology

The project entitled “The Role of Light when Vision Changes” aims to implement elements from low vision rehabilitation, concerning involvement of users as experts in their everyday lives and a flexibility and elasticity of empirical methods, to housing research and lighting design. The first of three work packages (WP1), includes fieldwork exploring the phenomena of vision loss and the role of light, from conversations and observations with participants in their home environment. The findings will later inform the development of guiding principles and design parameters for more inclusive processes and lighting solutions.

A protocol for WP1 was developed and pilot-tested in the summer of 2023, including an interview guide, a model for mapping the spatial and illuminated environment, and rules of thumb for conducting the walk-along interviews as well as the measurements [26]. The ethnographic inquiry involved the observations and experiences from planning, executing, and resuming the field visits. Reflections in action [7] on how to navigate the interview between the individual, other family members, the overall scope and smaller themes occurring in the conversation - e.g. balancing the narrative of the informant, the observed practices, and the situations within the physical and social context. And reflections on action after the visit on how the elements of the protocol supported the inquiry and any anomalies related to the interview and field visit.

52 participants (22 male), 57-90 years (mean age 70), signed up for WP1. 12 were excluded due to overrepresentation of normal sighted, 2 were assessed to be in too poor a condition to participate, and 2 withdrew of personal reasons. 37 participants (13 male), 57-90 years (mean age 71), 10 reported normal vision and 27 visual impairments. The participants were visited in their homes by one of the researchers and a PhD scholar from October 2023 - March 2024, visits lasted for 1-2 hours. The project has been assessed by the ethical committee as non-invasive and not obliged for further validation. Informed consent has been obtained and the empirical material has been anonymized. The interviews are transcribed and categorized and have together with fieldnotes and

transcriptions from our subsequent shared reflections informed the analysis on the position and contribution from participants and researchers in the fieldwork.

4. Findings

The findings presented below include situations and narratives from the fieldwork representing knowing-in-practice, reflection-in-action, as well as elements identified as part of our posteriori shared reflection.

4.1. To be present and listening

"You need to be totally present in the situation, with full focus and all receptions tuned in at once… I guess that's why you're so tired afterwards." This reflection was shared by one of the researchers in a meeting discussing the fieldwork across our 37 cases. The fieldwork sometimes started before we had entered the home, with participants sharing their views on lighting or their eye condition already in the hallway. The participants had themselves signed up for the project, and therefore knew the theme of vision and light, and, in most cases, had thought of insights they wanted to share in the project. Prior to the visit, we learned about their self-reported visual function (as visual impairments or any issues regarding lighting), sex, age, and address. Before the first visit, they had talked to one of the researchers on the phone to clarify inclusion criteria for participation and to schedule the visit, and we had collected plan drawings from municipal archives or databases. Sometimes a Google maps street view was used to get an impression of the area, and building on these initial mappings, as well as observations from entering the housing area or street, first impressions were layered in the mind. Entering by car, bicycle, and /or public transportation, passing a parking lot, garden, or entering a hallway directly from the street. Yet, the moment the door was opened, another mode was activated. As the experiences of the participants were the main source of knowledge, already the first encounter was important, and we soon experienced that this researcher-role was mainly to follow along, keep all channels open, to observe and to listen.

4.2. Situatedness

In addition to the *semi-structured interview guide* - with questions on vision; lighting qualities; lighting practice and workarounds; and outdoor/common areas - the main *tool* for the interview was the physical context we were situated in together. The sensitivity to the physical context is part of the tacit knowledge that we, trained as architects and housing researchers, bring to the field visit. However, in this case it was used to scaffold the contextualized user knowledge, asking in on their visual and multisensorial experience of the environment: "What does your condition mean, in here for example?", "Do the lines of the floor wabble in here as well?", "How do you see my face/hand/this photo?", or "Are you still able to orientate, do you see the things in the adjacent room?"

When moving on to the questions on their domestic lighting, the interview often shifted into a walk-along interview. Prompted by descriptions of activities or encouraged by us to show the situations at stake, we walked around in the house or apartment, exploring the light and their vision further: Leaving the interview guide at the table, and instead using our bodies and a luxmeter to assess the situation. Re-enacting situations, e.g. of knitting or handicrafts, how they were seated, how the light was positioned in

relation to the fabric and their eyes, in order for us to conduct the lux measurement of this specific activity. These inquiries felt most convenient when the situation included or had included some problem-solving and adjustments to find 'the right setting', or if they had situations not working for them. Then they were able to describe the situation more in depth and with reflections on the embodied knowledge in the very demonstration. Some of the narratives regarded embodied ways of moving across rooms: "Of course I know my own house well, but I can also feel that there are certain places here... Like, if I go that way [into the living room], I always make a short stop on this doorstep. I don't know why I do it… but somehow, I feel… 'ok, here I am'", or demonstrated in the situation, as the same participant showing her problem-solving attempts gone wrong in front of the bathroom mirror: "When I put lipstick on, the light shines on the sides of my face and not on my mouth. It is the same with the magnifying lamp and the makeup light, it just adds more light on my ears, and it gets completely dark where I need it... So, I haven't found the solution".

4.3. Linking to different times and places

At times, a conversation starter was needed, and as the number of field visits conducted increased, there was also a range of reference scenarios that could be used to compare to the present field visit. This could also be asking on whether they had experienced something else in other settings or in other places. When they linked these kinds of experiences, the shared *exploration* 1:1 was not possible. However, the examples could illustrate the use and perception of different lamps throughout the day "that lamp provides better guidance of the space from the afternoon on, while during the day the light does not provide any guidance regarding my position in the room". In these cases the interviewer could try to ask in on the situation: "Because there is too much daylight that interferes?", where the participant replied: "Yes, then the light comes in from outside and from the lamps and then… [gestures the mix with her hands]… while in the evening I know that the lamp is hanging there, and then I can read the room in a different way" or later the describing the sunset: "When the sun is low and shines into the living room, I can suddenly *see* the colors of our paintings… I prefer to sit with my back to the sun, so the light comes from behind, so it lights up those objects and things that I want to see…". Other participants referred to public places, work environments, or to the school of the grandchildren, both regarding situations where the lighting situation disabled them, or the opposite where the light was working particularly well for the situation or activity taking place.

4.4. Navigating: Re-setting or finding the path when lost

The engagement of the participants varied a lot. Not all participants had reflections or experiences directly related to light and vision, and some needed some help to initiate their considerations on the subject. Our shared mid-way reflection meeting showed that the most challenging interviews where when the participant did not have any comments than "It's ok, it's fine with me" or "I have not thought about that" without any additional reflections. Furthermore, it turned out that we could not in advance know who was experiencing challenges regarding their lighting as there were participants with visual impairment coping well and participants with normal vision (corresponding to their age) that experienced huge frustrations.

In cases like this, snowballing and trying to ask in on things in the surroundings could often guide the conversation. Asking in on their everyday practices, of how they used or perceived their light, or their preferences regarding the specific lamps in the specific space and situation. Our shared mid-way reflection illustrated the episodic accumulation of knowledge that was enabled across the field visits, but also from previous experience: As one of the researchers had conducted more visits than the other two at the time of the meeting and had previous know-how of conducting narrative interviews with visual impaired participants. Sharing her reflections enabled discussions on researcher position and the use of her own perception in supporting the participant in sharing his/her embodied knowledge, e.g. in a situation, describing what she saw and relating it to the narrative of the participant "So, if I see it like this…, for you it is more blurry?"

5. Discussion

Knowing-in-practice and reflection-in-action are motivated by an urge to cultivate more divergent thinking skills and to match the complexity, uncertainty and uniqueness of the real-life situations [7] we are studying in fieldwork. Both in order to scaffold the situated knowledge of the participating individuals, but also to acknowledge and describe the use of our tacit practice knowledge as research practitioners of architectural groundings. One of the places that the incongruencies have been present has been our methodological framework and the tools. It turned out that due to the complexity of interests when positioned between the social and the physical and wanting to embrace the dynamic interaction of the two, we needed to reduce complexity of our methods. First reducing the interview guide to a more basic three question scheme [26], and later focusing in on the walk-along interview and navigating the conversation. In our research design for the fieldwork, we believed that taking the photos would be an important aspect of conducting the observations, but it turned out to be a relief just to be focused on the situatedness accompanying the participants as the experts of their life and attuning to their narratives and demonstration. Photos were taken by our Ph.D. scholar or assistant, and a small pilot conducted by one of the researchers of including a photo-elicitation-element in the interview did not support the trajectory of the sensory and spatial exploration. Even though the photo could potentially have provided a more focused conversation of elements in the space, it felt contrived to make them conduct this limitation, as we were situated in the setting with them and the conversation was developing naturally from a spatial and multisensory interaction, where the photo would reduce this to only the visual.

The overall objective to understand the complex phenomena of the GAP [1], yet in this paper to assess what methods to be used to do this, resemble Knowles' notion of exploring large issues in small places [18]. All in all, the small and safe character of the home turned out to be a good site for exploring the large issue of vision changes. An impairment or problem was in many cases a key to explore situational knowledge, yet a causal relationship between visual impairment and lighting issues was partly disproved, as needs and preferences varied, and some of the visual impaired experienced much less frustrations and challenges regarding light than some of the normal-sighted participants. These insights would not have been discovered had we only involved one of the groups. In collaboration with the participants, we are interested in the situated knowledge of their social and sensory everyday lives. Beyond being situated in a specific body with specific abilities, the participants personal narratives show that the relation between the

individual and their environments, are dynamic and changing, they are much more than passive receivers of indoor comfort and their environments are more than neutral backgrounds to their lives. Thus, for many, it is only when the changes and issues arise that they notice the actual role of light.

One could argue that we are not very precise instruments for measuring the social nor the physical environment, as we are shifting focus from the one to the other. On the contrary, as we are not in the problem-solving technical-rationality-mode, but trying to understand a more complex phenomena, we are reflective instruments attuned at scaffolding the embedded and embodied knowledge, measuring the interaction, and to critically assess and discuss what could be understood situationally regarding vision and light. In this situatedness, the informants are key to parts of our own sensory knowledge that we have not yet experienced bodily or developed a vocabulary to describe. Their narratives enrich our understanding of more complex workings of our vision and different versions and roles of lighting in people's everyday lives. Eye-opening narratives that become part of our knowledge [5] – in our case on the multiple and dynamic visual perception. An eye-opening shared with some of the normal sighted participants, where the sensory perception of their vision and its relation to lighting, task, and use, until this project participation was a more or less unarticulated and unconscious mechanism. Accordingly, we are still novices in combining methods for studying both the social and the material aspects of the field. We are not anthropologists, and we are re-positioning as architects, yet architectural anthropology has helped us navigate in our field visits and critically assess the empirical investigations [24] individually in each of our cases, as well as across the experiences of the three individual practices. As the output of the inquiry is dependent on the engagement and openness of the participant, the fieldwork requires attention and navigational skills on positioning, scaffolding, listening, and navigating – trailing the trajectory of the field visit.

The issues and complex socio-material phenomena situated in the GAP between individuals and their environments, require small-place studies [18] that allow critically assessment and adjustment of the methods for scaffolding situated knowledge. The situated knowledge will in the further analysis be combined with quantitative data of light measurements, luminaire mappings, and vision assessments, that can enable comparison across cases and results that can be translated to other studies, but we will keep insisting on the important situated learning and knowledge. For this specific project, we hope that we can help qualify and challenge existing design parameters with a more diverse understanding of vision and light and be an eye-opener for other practitioners across the traditional building process, from clients, designers, and manufacturers.

6. Conclusion

In this paper we have introduced the method of gap trailing, as a way to scaffold situated user knowledge and to enhance exploration of the dynamic relations and gaps between individuals and their environments. The phenomena of vision loss and following changing preferences and demands for lighting have proved to be a fruitful case for gap trailing, where issues regarding light or vision enabled participants to explore and unfold their abilities and experiences in relation to their everyday environment. Also, the researcher's tacit embodied knowledge is engaged in these inquiries, and the shared reflections posteriori accumulated knowledge across the cases and across the researchers. Articulating one's own experiences and reflections as well as tuning in on the other

colleague's narratives adds to the lens of investigation. As we move from novel to more experienced gap-trailers, we slowly build a practice knowledge that we hope to be cultivated and shared across the field of UD researchers.

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Spatial Justice: A Shifting Perspective to Reframe Universal Design

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Abstract. This paper considers the social, cultural, and structural processes and practices, that are manifested in the built environment and mediated spatially, that create and maintain experiences of exclusion, otherwise known as spatial injustice. Expanding on two decades of case study research and empirical data collected in spatial justice across Canada and Australia, this paper interrogates perspectives of power and spatial injustices that still exist today. These case studies are based in institutions like malls, museums, urban precincts, and universities to usher in a new understanding of universal design through the lens of spatial justice and include creative practice (films), (dis)-audits, co-design processes, and disability allyship. This paper expands on the first comprehensive set of studies across spatial typologies, and how power and spatial justice are manifested and designed into architecture and interior environments—and their fields of knowledge. Key takeaways are new ways of *knowing*, *teaching*, and *doing* in architecture and design to create spatial justice and cultures of inclusion.

Keywords. ableism, built environment, social justice, spatial justice, universal design

1. Introduction

Reframing universal design through spatial justice goes beyond building codes, guidelines, and standards, and demands new kinds of universal design approaches. This paper critically reflects on the past, current and future of spatial justice, its relationship to critical access approaches, allyship, creative practice, and the implications of this justice-based lens for current practice and research in and around universal design. This research was inspired by the lack of research in spatial justice, and to challenge and expand our understanding of power in architecture and design, particularly by examining power from an interior's perspective (architecture/interior design/interior architecture). While Dovey (2008) argues that the built forms of architecture and urban design act as mediators of social practices of power, it is the tangible examples of how this is manifested in environments that are presented here [1]. For example, Dovey contends that the nature of architecture and design, their silent framings of everyday life, lend them to practices of coercion and seduction, thus legitimising authority and control over people (2008) [1].

2. Spatial Justice

In my book, *Design, Disability and Embodiment: Spatial Justice and Perspectives of Power,* I ask, what is spatial justice? Is it the same as social justice? Is it social justice that is manifested into the built environment? Who defines what spatial justice is and, who can affect change towards more universally designed and just environments? [2] Justice is not a new concept, as we have been embedding justice into the spatiality of civil society from as early as Greek city states - *polis* 600BC [2]. When scholars like Soja (2009) for example who claim that "until these ideas are widely understood and accepted, it is essential to make the spatiality of justice as explicit and actively causal as possible. To redefine it as something else is to miss the point and the new opportunities it opens up" (p. 2). [3] Thinking this way about space and justice, not only reminds us that space itself is socially produced but that space and the built environment is not neutral "When we look, we can see how the built environment reflects the identities, differences and struggles of gender, class, race, culture and age" (p.1) [1]. The difference here is that most spatial justice theories look at spatiality (and mostly cities and urban design) from a more macro lens, whereas this paper focuses in one architecture and interiors and on universal design. My research and studies in how spatial justice is taught, understood and practiced also incorporates theories of power and how power is manifested in universal design. Lefebvre et al argued that space "it is a product literally filled with ideologies" (p.31), that these processes underpinning everyday life generate unequal power relations which manifest in inequitable and unjust distributions of social resources, across the space of the city and beyond [4].

Power disparities that are mediated by the built environment are important considerations within a spatial justice theoretical lens, because "justice is more oriented to present day conditions, and imbued with symbolic force that works effectively across cleavages of class, race, gender to foster a collective political consciousness and a sense of solidarity based on widely shared experiences" (p. 4) [3]. Justice has re-emerged as an important field of study for various disciplines. A social justice framework is underpinned by principles of fairness, democracy, rights and responsibilities attached to being a member of a particular social group. It extends beyond the court of law, to the everyday life context. Spatial justice seeks to rebalance the understanding of justice not just as a social and temporal concern, but very much spatial [2]. What is valuable about the justice-based theories and concepts is that it facilitates an opportunity to build a new theory and practice for spatial justice—a praxis that is inclusive and looks towards architecture, interior design/architecture and design. It is crucial in theory and in practice to emphasise explicitly the spatiality of justice and in turn injustice. My research and practice in spatial justice builds upon Soja's definition of spatial justice, in that it extends the definition of spatial justice to contribute new spatial justice theories and practice. Soja explains:

> The specific term "spatial justice" has not been commonly used until very recently, and even today there are tendencies among geographers and planners to avoid the explicit use of the adjective "spatial" in describing the search for justice and democracy in contemporary societies. Either the spatiality of justice is ignored, or it is absorbed (and often drained of its specificity) into such related concepts as territorial justice, environmental justice, the urbanization of injustice, the reduction of regional inequalities, or even more broadly in the generic search for a just city and a just society. All of these variations on the central theme are important and relevant,

> but often tend to draw attention away from the specific qualities and meaning of an explicitly spatialized concept of justice and, more importantly, the many new opportunities it is providing not just for theory building and empirical analysis but for spatially informed social and political action (p. 1) [3].

It is also important to situate our understanding of spatial justice beyond theorists, and to look towards its understanding for practitioners, as spatial justice is not just a theory but a part of our architectural and design practice. The quotes below are from a survey of future practitioners (for the detailed study please refer to *Design, Disability and Embodiment: Spatial Justice and Perspectives of Power*) [2]. Here, understanding how injustices are manifested in the built environment which then can lead to exclusionary practices and social injustices is an important concept for future practitioners to understand. Future practitioners stated: "Who has access to spaces and control over what spaces are like has implications for justice. Public spaces with hostile architectural features to deter certain members of society would be an example."; "Spatial Justice I believe relates to places of power and where we see just or unjust actions through the design of space. This could be racial segregation we saw years ago in America where different colours were separated by physical space. This would be an example of spatial injustice."; "Spatial justice is a tie between social justice and space. It refers to the fairness of land distribution and use and is largely used across society as a show of hierarchical power." What is interesting to note from these comments is how many of them identify spatial justice and its relationship to power as something of the past, or of a particular place and not an understanding necessarily that power is manifested in all spaces. This is where a reframing of universal design through spatial justice could have profound impact, not only on future practice but also on how users speak to their rights, access and needs in the built environment and design.

3. Case Studies

This paper expands on the first comprehensive set of studies across spatial typologies in *Design, Disability and Embodiment: Spatial Justice and Perspectives of Power*, 2023, and how power and spatial justice are manifested and designed into architecture and interior environments. In this paper several case studies are introduced to usher in a new understanding of universal design through the lens of spatial justice and include creative practice (films), (dis)audits, co-design processes, post-occupancy evaluations (POE's), and disability allyship.

3.1 Universities

Issues of access and audits are often not brought to public awareness. Access audits are often created 'out of sight.' Instead, the process and practice of access audits can and should be understood through a spatial justice lens, and go beyond codes, checklists and guidelines, to look at access more holistically. I created *(dis)audits* [2], which permit designers and architects to undertake access audits differently—to intervene in the physical environment through the words and embodied experiences of people with disability. It was through the process of bringing the lived experience and embodied know-how of users into sight, which brought about a new awareness of the environment—an awareness, informed by the nuances of disability to reimagine

universal design. The first (dis)audit was conceptualised and co-designed with a colleague who is blind, as a design intervention on a university campus in Canada. The (dis)audit asked users to 'rethink design' by placing signs all over campus that communicated the lived experience of the user/expert and the experiences of trying to negotiate the campus environment as a user who is blind. This audit was a kind of design activism that focused on the inaccessibility of the university campus environment, where we examined all entries, exits, corners, wayfinding and spaces on the campus together and noted the most hazardous and inaccessible aspects 'tagging' the campus through signs that asked the public to rethink design through the lived experience of a user who is blind. In Figure 1, the open staircase in a large communal campus space created serious risks and overhead hazards to all users. This design issue went unnoticed until we conducted (dis)audits with people with lived experience. (dis)-audits can also inform how we rethink post-occupancy evaluations (POEs) more generally through a spatial justice lens and the importance of embodied know-how of all users.

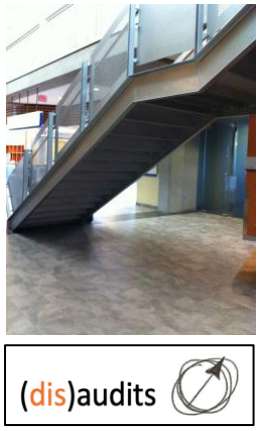


Figure 1. Identifying obstacles and barriers through doing (dis)audits on a university campus in Canada.

3.2 Museums and Galleries

Through detailed case study research across Canadian museums and galleries (see Figure 2) spatial justices and injustices were analysed across national institutions [5]. Many of the exhibitions in these national institutions were designed to be multisensorial and accessible but the bricks, beams and mortar of the buildings either created spatial justice or major barriers and injustices. For example, in Figure 2, the primary circulation in the museum is not stairs, or an elevator but an accessible ramp that takes visitors from floor to floor, side by side whether walking or in a wheelchair. This universal design allows for spatial justice, allowing most visitors to move throughout the building together and enjoy the same views and experiences, which is rare in most museum architecture.



Figure 2. Spatial justice and injustice manifested in Canadian museums.

At Canada's Sports Hall of Fame (CSHF), the beams, bricks and mortar impede the access and spatial justice for visitors. While doing an evaluation of the spatial justice of this museum, my colleague who uses a wheelchair was not able to access some of the spaces and exhibitions of the museum because of the interior architecture and engineering. The building was designed with large metal I-beams crossing through the main exhibition spaces, from floor to ceiling, creating major overhead risks but also spatial injustice for people in wheelchairs, parents with strollers and others with mobility aids [5]. Interestingly, this research was done prior to 2020 when CSHF closed due to COVID-19. The building never reopened, and in 2023 CSHF went from brick-and-mortar to a hybrid model involving digital storytelling [6].

3.3 Urban Malls and Precincts

My research across the last decade has also focused on evaluating the spatial injustices in urban spaces. It has seen a rise in 'hostile architecture', otherwise known as defensive architecture (like homeless spikes) throughout many nations in the world. But there are still some examples of urban spaces and cities trying to create a 'just city'. In Vancouver, Canada the non-profit *Raincity Housing* designed benches that unfold into shelters and read "This is a bench" during the day, but light up to reveal "This is a bedroom" at night (see Figure 3) [7]. Perhaps a small step on what Harvey refers to as the path from an urbanism grounded in exploitation, to an urbanism for the human species" [8].



Figure 3. Design interventions against 'hostile architecture' in the city.

4. Findings and Discussion

Spatial Justice (and in turn Universal/Inclusive Design) is still not well understood or prioritised amongst architects, designers and planners even though users are asking and

have been asking for decades. In Canada, for example, only 10% of Canadians believe their communities are doing a really good job of including diverse voices in planning, and that accessibility (96%) should be prioritised in new buildings in their community [9]. In Australia the statistics are not much better, for example, in a recent study only 51% of respondents said that the architectural profession values diversity and inclusion [10]. In a way this paper is a call to action—that we cannot continue to allow injustices to be built into our environments, and that the potential of spatial justice to shift our perspective to reframe universal design through a social justice lens is paramount. Presented here are three 'reframes', as new ways of *knowing*, *teaching*, and *doing* in architecture and design to create spatial justice and cultures of inclusion for all.

4.1 Knowing

Knowing differently is to be done through an unknowing. Like Butler, "[We] must recognize that ethics requires us to risk ourselves precisely at moments of unknowingness, when what forms us diverges from what lies before us, when our willingness to become undone in relation to others constitutes our chance of becoming human" [11]. The only way we can reframe universal design through spatial justice is to embrace an unknowingness and this can lead to safety, dignity, respect, and trust—a precursor to good disability allyship in architecture and design. By this I mean, an unknowingness, where architects and designers acknowledge the limits of their embodied knowledge and co-design/co-constitute knowledge with others. Creating spatial justice is more than just the bricks and mortar of the building, creating ramps and accessible toilets, it is about co-creating dignity and cultural safety. Many access protocols promote *transactional* understandings of the ally, as the altruistic supporter or advocate who assists disabled people for example, to obtain reasonable accommodations, or logistical adjustments to education or employment practice, or general access to public buildings [12]. What I am more strongly arguing for here is for us to move towards disability allyship in architecture and design and a new knowingness—a co-constitutional knowing (beyond the often taken from granted participatory design methods or reference groups) where allyship develops long lasting and sustainable relationships to create spatial justice and reframe universal design [13]. The fact an unconscious bias exists and many people who are invited to be a part of an 'inclusive or universal design' process are often just tolerated and accommodated, and then their corporeal and cognitive differences are assimilated the into codes, guidelines and dominant industry practices, is not just [12, 2]. I do believe it is time for a shift towards *un*knowing through allyship, because only then can we really create spatial justice.

4.2 Teaching

Spatial Justice has the ability to reframe how and what we teach into our architecture and design education, after all this is where our new practitioners are coming from, and it is critical for them to understand social and spatial justice. From 2006-2021, I embedded theories and practices of spatial justice into my studio, theory and history course across universities in Canada and Australia. I collected data across these courses, and most recently I collected a large data set with 4 surveys and 210 students in the course, Spatial Histories (a large first-year history course with ~550 students) [2]. Here are some of the student responses when asked, "Do you think justice is manifested in the built environment? How?":

> *I think architecture can be the apparatus that can incite justice, utilising architecture's ability to reflect society and communities, it can be the medium in which these justices can be examined in, and possible solutions occur in*. (Spatial Histories Student, 2021).

> *I think social justice is manifested within spatial justice. Buildings and spaces have the ability to manipulate our behaviours and attitudes and therefore can manipulate our beliefs towards others or issues (i.e., the spatial justice issue of segregated black and white entrances perpetuates the social justice issue of racism)* (Spatial Histories Student, 2021).

Through reframing architectural/spatial history through spatial justice, students surveyed reported that 93.55% of them (architecture, interior design/architecture and landscape architecture students) were challenged by this course to think about architecture/design in new ways [2].

4.3 Doing

Doing in relation to the design of the built environment can also assist clients, developers, policy makers, etc., to reconsider universal design through spatial justice. As has been presented, spatial justice is not just a theory but a way of doing in our practices. How do we begin to think about doing spatial justice? One of the ways we can start to do spatial justice (and in turn universal design) is to consider new methods for practice. One of these new methods is what I call *Dialoguing while wandering,* an embodied method often used in post occupancy evaluations (POE's) and through creative practice like film to uncover a world perceived from different angles and viewed through diverse vantage points (often with participants who are d/Deaf, blind, have low vision, use a wheelchair or other mobility aid, and those that identify as neurodiverse) [14]. Figure 4 shows Sarah, Megan and I dialoguing while wandering in an urban mall in Brisbane, Australia and us evaluating the universal design of the downtown urban mall and its Braille trail, as Sarah is blind and uses a white cane.



Figure 4. *Dialoguing while wandering* on the Braille trail in an urban mall.

The Braille trail goes unnoticed to most using this urban mall but for Sarah and other users who are blind or have low vision, it starts to create spatial justice. As researchers and designers, we would never have been able to understand the use and need of a Braille trail but through the method of dialoguing while wandering with Sarah we mapped out the encounters with one another, and it brought forth phenomena that may often escape

awareness in people who inhabit a particular environment [15].These wanderings, created through film, foster insights into the doing of spatial justice, and new ways to evaluate universal design. My research has shown spatial justice is not a well understood concept in relation to architecture and design even though it has been around for at least fifteen years. It is important to share diverse voices, from leading scholars, case studies inclusive of people with differing abilities, and the voices of practitioners and students in order to create just spaces and equal access for all [2]. Shifting our understanding of universal design, which is most often codified and understood through guidelines, to one of spatial justice means we can begin to cultivate a praxis of spatial justice. The challenge here is for us all to start thinking differently, to use spatial justice and creative practice as a lens to critique and deconstruct ableism, and in turn ableist architecture and design.

5. Conclusion

This paper takes a more holistic approach to shifting our perspectives towards spatial justice in universal design by not only looking at praxis but also education. In order to understand how power and injustices are designed into the built environment and to be critical of our roles in this injustice, we need to embed this criticality into architecture and design education. This research has presented new ways of *knowing*, *teaching*, and *doing* across architecture and design to create spatial justice and cultures of inclusion.

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Adapting Cities for Older Adults Through Universal Design

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Abstract. In the coming decades, population ageing will shape our cities and communities. In Finland, and in the other Nordic countries, the cohort of population 75 years old and older is increasing fastest in the urban areas. This demographic development will have impact on design of urban environment and housing, as well as on local services and transport. The WHO has recognized this challenge and launched the global network of Age Friendly Cities and Communities. The WHO proposes eight factors supporting older population that are interlinked. This paper focus on the three of the eight factors of age-friendliness directly related to the built environment: housing, access to outdoor environments and transport. The objective is to assess through case studies how has the Age-friendly cities framework promoted inclusive design of the cities. The research question is: How have the qualitative factors for age-friendliness been implemented in the urban environment? and How does the Age-friendly Cities framework shape the urban environment in the case study cities? The project uses qualitative case study methods involving users. The assessment of the quality of the environment is carried out with mixed methods: through city age-friendly policies, observations on site, and user participation. The analyses are based on Universal Design principals and the WHO framework. The objective is to provide further information on the practical measures to enhance age-friendliness through urban design and universally designed living environments. The overall aim is to promote sustainable and age-friendly urban environments through user knowledge and best practice examples.

Keywords. Age-friendly, Housing, Urban design, Universal Design

1. Introduction

The world is facing a population ageing. In Europe in the next decades, the oldest population cohorts, people 85 years old and older, will increase sharply. We need to anticipate this demographic change and make the urban areas and cities inclusive, safe, resilient, and sustainable [1, p. 37]. Planning age-friendly cities will enable to provide a good living environment for older adults and across all generations. WHO has launched a network for Age-friendly cities and communities to share the best practices and enhance peer learning related to urban transformations [2]. According to the WHO Global Age-friendly Cities Guide, the planning for older adults is related to eight interconnected domains: housing, transportation, outdoor spaces and buildings, social participation, community and heath care, respect and social inclusion, communication and information, civic participation, and employment [3]. Many of these domains are

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directly or indirectly related to the built environment. Universal Design (UD) of environments is considered to benefit all people at some stage of life as ageing is related to changing sensory and physical abilities [4, p. 46]. The seven UD principals adapted to housing design and planning "*creates homes that are usable by and marketable to people of all ages and abilities"* [5]. Application of the principals in the built environment can remove barriers for social participation and enhance inclusion.

Older adults are individuals with different lifestyles and housing preferences. They live in ordinary housing in different parts of the city. Buffel et al. (2019) point out, that consideration must be given to develop age-friendly interventions at a neighborhood level and build environments that support the diversity of older people [6]. The development process should be carried out together with the older population. McCall et al. (2024) found that ageism and 'othering' are prevalent in current approaches to delivering housing, health, and social care services for older adults. They found that both professionals and older adults have difficulties to see ageing affecting themselves. This makes planning age-friendly solutions a challenge [7].

There are seven cities in Finland that are officially part of the WHO Global Age friendly cities and communities' network. The objective of this ongoing study is to assess how have the WHO age-friendly guidelines affected the urban environment in these cities that are part of the global network. Two of them were chosen for the study. The research questions are: How have the qualitative factors for age-friendliness been implemented in the urban environment? and How does the Age-friendly Cities framework shape the urban environment in the case study cities? This paper describes the preliminary results of two case studies.

2. Background

2.1. National programs for older adults

In Finland, since the 2000's the need for age-friendly housing has been on the agenda. The national program for housing for older adults emphasizes peoples' own preparedness for ageing, the need for variety of housing choices, accessible housing construction and age-friendly urban environments [8]. The age cohort 75 years old and older is the fastest growing group of people in the cities and in the next decades, and it is estimated to grow sharply [9 p. 48]. According to the Ministry of the Environment, only 23 percent of existing dwellings are accessible [8]. New apartment buildings are built according to current building regulations, but many areas in the cities have old building stock with an ageing population. According to a national survey in 2020, 73% of Finnish municipalities reported to have made plans for age-friendly environment, but less than half had made decisions about actions in this area [10]. The Finnish Local Government Act states that each municipality must have a Senior Citizens Council that assess and comments on issues affecting the services and living conditions of older adults in their area. The aim is to give older population possibility to influence decision concerning them at local level. Older adults' participation is often lacking in the early phase of urban development and the Senior Citizen Council has possibility to comment on plans only at the final stage of the planning process. One of the objectives of the study is to engage older adults in the assessment and use their experiences to improve the living environments.

Two of the Finnish cities in the global network were chosen for the case study. In 2022, the share of people 65 years old and older in them varied from 25,4 % (Lahti) to

16 % (Vantaa) [11]. This ongoing study (2024 – 2025) aims at assessing the effectiveness of the membership in the global network in developing age-friendly urban environment. One area in both cities with high share of older adults was chosen for the case study. The case study area in Vantaa is a transport node and has approximately 18 000 inhabitants. In 2022, the share of population in the age cohort 65 years old and older in the area was higher (23.4 %) compared to the average of city of Vantaa [12]. The case study area in Lahti is located at the proximity of city center. In 2022, there were some 15 400 inhabitants of which 35% were seniors, 65 years old and older [12]. The preliminary results focus on assessing Universal Design and walkability of the living environment in the two cities. The observational walks with residents in case study areas were carried out in spring and autumn 2024. Workshops and discussions with older adults were carried out in Lahti in autumn 2024. This paper gives preliminary descriptive analyses of the age-friendliness.

3. Methods

This study uses qualitative and mixed methods. In this research two case study areas were chosen for qualitative and more detailed analyses. The evaluation of age-friendliness was done together with older adults and other local stakeholders. The study used purposeful sampling focusing on older adults who have personal experience on the topic [13]. This included observations on site, workshops and walking tours with local residents and other relevant stakeholders. This paper focus on the preliminary results of a workshops and walking tour in Lahti and two walking tours in Vantaa (approximately 1,5 km each). One of the walking tours was carried out with an international delegation from WHO Age-friendly cities global network. The assessment of the data was carried out using Universal Design principles as bases of the evaluation.

Table 1. Older resident participants in the case study

	Male	Female	Participants all
Workshop Lahti		8	8
Walking tour Lahti	2	9	11
Walking tour WHO delegation Vantaa	4	5	9
Walking tour 2. Vantaa	3	3	6

The results are based on UD principles and the framework of WHO Age-friendly cities age-friendliness three of the domains related to the built environment: housing, outdoor spaces and public buildings, and transport. These factors among others, influence the possibilities of social participation and inclusiveness of the living environment. UD principles are a tool to evaluate potentials of the built environment to support older adults in their daily activity.

4. Results

4.1. Population and housing

Approximately 93 % of Finnish population 75 years old and older live at home [14]. The case study neighborhood in Vantaa is undergoing a significant renewal and densification process with new housing construction. Many of the new apartments are targeted to seniors and older adults with similar layouts providing little choices or variations. The increase of accessible dwellings and housing for older adults is likely to further increase the concentration of the oldest age cohorts in this area. At the same, new housing construction may not be affordable to older adults with low income. Similarly, the housing unaffordability affects younger population. This may reduce the equitable access to housing and increase residential segregation. In Vantaa case study area there are many vacant newly built accessible apartments (Fig. 1)



Figure 1. Only a few of the new apartments had been sold (Image: author)

In Lahti case study area, many of the apartment buildings and a Wellbeing center for seniors are from the 1980's. The apartments targeted to seniors are government subsidized, affordable and originally built to satisfy the needs of older adults. This has led to a high share of older adults living in the area. The availability of affordable housing suitable for older adults is one of the criteria for age-friendliness. Older adults remain living in their familiar living area more often than younger age groups. Old dwellings may be more spacious and have a more flexible layout than recently built apartments. This allows flexibility in use with various furnishing options and space for assistive devices. The old housing stock may need accessibility renovations and many buildings lack lifts. The renovations that focus on Universal Design of the existing apartment buildings will enable people to remain ageing in their familiar neighborhoods.

Currently, 45 percent of people 75 + live in one person households. New forms of communal housing are planned to support older adults. It is an alternative especially for those living alone and feeling lonely or insecure. Even though people mainly mix with people in the same age groups, most older adults self-report that they want to meet people in all ages, and not to be segregated. Community building can be enhanced in existing housing areas improving access to current spatial resources: libraries, cafes, and other communal spaces. In Lahti case study area, the Wellbeing center for seniors acts as a communal space.

Mix of people will reduce age segregation. Frail older adults should be integrated in the city. In the case study area in Vantaa, a new residential service housing for older adults has been built next to an existing school building. A stone wall around the building creates a physical and visual barrier between the school yard and the courtyard for older adults. The target for safety has led to segregation of the two resident groups. Living environments planned for older adults, young people and families enhance equitable use of urban space and provide possibilities for cross-generational encounters.

4.2. Outdoor spaces

Walkability and access to local services and green environment are major factors of age-friendliness that support active and healthy ageing promoting social activity. The city of Vantaa has a municipal program for making the urban environment safe and attractive for walking. Through planning the city aims at providing easily accessible green environment near housing. The city is currently defining urban areas and routes that need special level of accessibility. These areas include among others public services, public transport nodes, health care services, and housing for older adults. This will enable to prioritize the renovations.

According to a recent survey, almost half (46 %) of the daily mobility of women and 25 % of men in the age cohort 75 + is done walking [15, p. 70]. Versatile and attractive walking routes may encourage walking. The lack of benches and resting places along the walking routes is one of the main concerns reported by older adults (Fig. 2). The resting places would encourage those with challenges in mobility to make longer walks. They are also potential places for social encounters. Sheltered sitting benches in the shadow of the trees create attractive meeting places in urban spaces. Observation in Lahti showed that existing benches may also not be suitable for older adults. Low seat or placement of the bench may hinder the use of it.



Figure 2. A hierarchy of streets and car free walking zone makes walking safe. (Image, Author)

A major topic during the walking tour was the maintenance and even surface of the walking routes. Older adults self-reported uneven surfaces and walking paths with cobblestones as hindrances for mobility aids. The challenge in both case study areas was also the topography and steep streets. Considerable physical effort was needed to access some of the services. The observation showed that in practice the responsibility of maintenance and ownership of urban environment is not always clear: municipality,

private housing companies or transport agency etc. In the Nordic countries the winter maintenance of walking routes is a challenge. Snow on the pavements may hinder walking with a walking aid and slippery icy streets are a risk for falls. Older people proposed adding handrails in some places with steep slopes to increase the safety.

In Vantaa, due to urban densification there are currently many construction sites. It has led to the lack of grass and green. Urban renewal is a long process, and it will take a decade to restore some of the natural environment in the area. The car traffic has been rerouted and in several places pedestrians and car traffic meet causing safety issues. An effort should be made to minimize hazards and accidents, restrict car access, and provide visible warnings and guidance to safe walking. Perceptible information in accurate place may enhances wayfinding safety. In general, distinctive local image, visible guidance, landmarks, and car free pedestrian zones improve the wayfinding and perception.

4.3. Public Transport

Public transport enhances the access to services. The case study area in Vantaa is a public transport node. A train station and a bus station are located near the local shopping mall. Older adults felt convenient to find all services in this service hub and it was an attractive place for them to live in. Good transport connections have generated also social and cultural activities within the area: an open meeting and activity space "living room" for residents as well a library, art exhibition and cinema located in an existing building next to train station.

In the case study area in Lahti the older adults reported the lack of public transport connections making access to the city center and local services difficult. The closest bus stop was on top of a steep street. On the other hand, many cultural services e.g. a library and theater were at the walking distance. Some of the residents reported to walk to the library weekly.

Concentration of service may attract seniors and older adults to the proximity. For many older residents who can't afford to move close to these services longer travel distances and travel time, and lack of public transport can become an obstacle. For them, the concentration of local services may decrease the access to services. Sheltered bus stops near housing may encourage the use of public transport (Fig. 3).



Figure 3. Sheltered transport stop with seating. (Image, Author)

5. Discussion

The share of older adults living in the cites is increasing. In the future, their service and housing needs are major factors of building social sustainability. [9, p.157]. The cities need to adapt their environment for older adults. It is estimated, that living areas with accessible apartment buildings, good transport connections and local services will continue see an increase of older population and densification [9, p. 65]. This leads to growing need for universally designed urban environment. It is a process to make urban environments age-friendly. The research question were: How have the qualitative factors for age-friendliness been implemented in the urban environment? and How does the Age-friendly Cities framework shape the urban environment in the case study cities? The built environment can support older adults' independence and participation. Age-friendly environment will enable older people to remain living in their familiar surroundings and maintain their local social networks.

Older adults report more often that other age groups green environment and outdoor environment as a factor of housing satisfaction [16, s. 27]. Walking friendly environment, and accessible urban green parks support wellbeing of older adults. Municipal programs for walking friendly environment enhance wellbeing for all. The transport planning can take into consideration areas with high share of older population and improve access to services.

The cities can promote UD housing construction suitable for older adults and accessibility renovations of existing housing. The housing choices of older adults are not related to their age, but rather to their life situation, functional capacities, and health. There are many new developments for age-friendly housing. Many new apartments are not affordable to those who would need them. Attention needs to be put on affordability of housing and integration of people of ages in the living environments to avoid spatial segregation. Sabater and Finney (2023) found in their study that the increasing housing costs are reducing the age-mixing and causing spatial age-polarization within a city, resulting in increasingly age-homogenous neighborhoods [17].

Our built environment can support community building and cross-generational encounters through UD. Living alone is increasing in all ages and may lead to the feeling of loneliness and insecurity among the most vulnerable resident groups. The local services can be seen as potential places for social interaction and inclusion. Access to local services, cultural services and outdoor spaces support community building and integration of all. The design of urban environment should leave one behind.

People of different ages need to have possibilities to meet to combat of ageism and increase cross-generational solidarity. Age-friendly environment, built according to UD principles is a good living environment for people of all ages. Promoting age-friendly environment requires collaboration with older adults, and relevant stakeholders in various disciplines. Short- and long-term planning enables to prioritize actions to improve the built environment for older adults.

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Development of New Public Buildings in Slovakia and Their Universal Accessibility: Architectural Design Competition as a Tool for Selecting the Best Design

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Abstract. The article discusses public buildings in Slovakia and two important topics that are inseparably linked to public buildings as such – the process of their creation as a public investment and universal design. We explore the possibilities of fulfilling this principle in the Slovak context – by selecting an architectural design through public procurement in the form of a business competition or through an architectural design competition, and we compare these approaches. The second essential principle is that any public building must be accessible to everyone without restrictions, which means that it should be designed and constructed according to universal design principles. We analyse the legislative and normative tools of universal design in Slovakia, based on key connections to international standards. The article examines the phenomenon of the mentioned architectural design competitions. The example of good practice – both in terms of selecting public investment through an architectural design competition and in terms of solutions adhering to universal design principles – represents a case study of the New Town Hall in Leopoldov. The conclusion summarises the findings from the research and makes key recommendations for stakeholders involved in the process, policymakers, public investors, and architects. The research methods used include content analysis, statistical analysis, comparison, and case study.

Keywords. Built Environment, Architecture, Public Space, Universal Design, Architectural Competitions, Legislation, Standards

1. Introduction

Each public building or public investment should be accessible to the public without restrictions, that is, it should be designed and implemented in the spirit of universal design. The creation of a public investment is a complicated process in which transparency and financial efficiency of the investment are at stake, but equally important is a high quality solution ensuring the full functionality of the object, including the already mentioned universal accessibility for all. In the case of a public investment, to

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which we all contribute from finances at the level of the state or the European Union, we simultaneously expect extraordinary aesthetic, artistic, architectural qualities, and timeless value of such an object. An architectural design competition can be a way to fulfil this goal or at least to get close to it.

The research questions are as follows:

What are the legislative instruments in Slovakia to achieve universal accessibility of objects in general that are also applicable for public investments?

What form of selection process is suitable for the implementation of public investment, public buildings?

Are there examples of good practice in implementing public investment in Slovakia?

Research employed the following research methods:

- Content analysis to examine information on universal design in Slovak national legislative and technical regulations, with some reference to the international context, as well as in design competition conditions. This method focusses on defining tools within the legislative and technical framework and public investment processes.
- Statistical analysis to investigate data on the development of architectural competitions in Slovakia during the observed period.
- Comparison of legislative and technical regulations, as well as the conditions of Slovak architectural competitions, focussing on the requirements to comply with universal design rules within their conditions.
- Case study of specific public building projects that were implemented based on a design selected through an architectural competition.

In the chapter titled Legislative and Technical Framework, the issue of universal design as defined in valid Slovak legislation and standards is discussed, following basic international reference documents. The chapter Architectural Design Competitions addresses the methods of implementing public investments, with a deeper focus on architectural design competitions. It includes the definition of universal design requirements within the competition conditions, as well as the analysis of the development of the number of architectural design competitions in Slovakia during the observed period. An important part of the article is the chapter Case Study of the New Town Hall in Leopoldov, which documents the example of good practice of public investment from the inception of the idea to its realisation in 2022 and significant architectural awards in 2023. The conclusion summarises the findings from the presented research and the recommendations for stakeholders.

The research was part of the national project Support for Universal Design, its partial section focused on the Slovak environment, legislation, technical standards, and the formation of public buildings. Therefore, it just briefly references international reference documents, without a broader comparison of the international context.

2. Legislative and Technical Framework

The physical built environment should be democratically accessible to all, and buildings and the spaces between them should be designed in the spirit of universal design. This basic thesis is based on elementary logic but also on the principles of justice and decency and should be valid even without the existence of relevant legislation and standards. [1] Legislation and standards should only help to make things easier to work. The internationally valid United Nations Convention on the Rights of Persons with Disabilities, which is followed by national legislation, talks about the right to full

participation in life even for people with certain forms of disabilities. This document follows from the philosophical approach of the democratic inclusion of all groups of people in life through preventing the exclusion of people with specific needs from society to the details of individual areas of life. Under Slovak conditions, the Convention on the Rights of Persons with Disabilities is superior to Slovak legislation and legal norms. At the same time, the Convention allows national legislation to be prioritised if it ensures a higher level of inclusion and rights of people with disabilities. Directly in the convention, the concept of universal design is defined as the design of products, environments, programmes, and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialised design. [2] As stated by Čerešňová et al.: Universal design has an ambition to ensure the fulfillment of basic human rights in various areas of life through active participation of all people including persons with physical, sensory, or intellectual disabilities. [3]

In Slovak legislation, in the case of accessibility of the physical built environment, Decree of the Ministry of the Environment of the Slovak Republic No. 532/2002 Coll., which establishes details of general technical requirements for construction and general technical requirements for buildings used by persons with mobility and orientation impairment. It refers to buildings in general, with a separate section dedicated to construction solutions for people with certain forms of disabilities. [4] The legal regulation has a technical nature with the definition of technical details. Despite its importance, application in practice, and respect of experts, it is a legal regulation that does not discuss the issue of accessibility comprehensively. Philosophically, it is tied to the time of its creation (2002) and shows signs of moral obsolescence and inadequacy, both in terms of content and scope. When looking in more detail at the specific articles of this Decree, we find the targeted exclusion of some types of building from accessibility for all or the inadequacy of some dimensional parameters or properties in relation to the currently valid requirements for different groups of users. The current level of knowledge requires a more complex concept of accessibility.

From 2021, the technical standard EN 17210:2021 Accessibility and Usability of the Built Environment, consisting of functional and technical requirements, is valid at the level of the European Union (EU) and therefore also in Slovakia, as an EU member country. [5] From June 2024, the national version is available: Slovak translation of part STN EN 17210:2024 Accessibility and Usability of the Built Environment: Functional Requirements. The standard comprehensively defines the accessibility requirements for the built environment, buildings, and exterior spaces of various types in relation to the various types of disabilities that users of the built environment may suffer from. It is based on the national technical and legislative regulations of individual member states of the European Union. [6]

In 2022, a major change in construction legislation was approved by the Slovak Parliament, Act No. 200/2022 Coll. on Spatial Planning. [7] and the Construction Act No. 201/2022 Coll. [8] with the planned effectiveness of the laws mentioned from April 1, 2024. The laws should replace Slovak construction legislation from the 1970s, still from the period of socialism. The new legislation partially entered into force on April 1, 2024, but at the same time, the essential parts of the legislation were postponed to the period from April 1, 2025. The new construction legislation caused the need for changes in the related legislation, for example, also in the case of Decree 532/2002 Coll. The part of this regulation devoted to the accessibility of buildings for people with mobility and orientation impairment is planned to be replaced by a separate Decree on Requirements for Barrier-Free Design and Use of Buildings of the new The Authority for Spatial

Planning and Construction of the Slovak Republic designed to implement the new building legislation. It can be described as a positive trend because information from the comprehensive European standard EN 17210 and the experience of the Centre of Design for All (CEDA) from the Faculty of Architecture and Design of STU in Bratislava, which participates in the creation of the decree, will be reflected in the said regulation. For better control of compliance with the universal design, specific checklists are proposed as part of the new decree. Checklists ensure standardised control of compliance with universal design requirements in all objects assessed in the building and construction approval process. At the same time, through them, designers will have a better overview of the requirements of universal design, which must be fully integrated into the design within the project.

3. Architectural Design Competitions

The set legislative and technical environment in Slovakia, defined by the above-mentioned regulations, speaks of the need for accessibility of the built environment. In the case of public investments and constructions intended for use by the public, there is no doubt about the general accessibility of the objects. A large part of public investments in Slovakia are financed by subsidies from the European Union, where the accessibility of the object is directly required by the conditions of the subsidy schemes. This is one of the basic parameters that gives meaning to a building accessible to the public, to make it democratically accessible to all people. The goal is to achieve an inclusive environment in which a wide range of people would have the opportunity to use the physical environment, products, services and information equally, and at the same time actively participate in social events. [9]

At the same time, one of the other key requirements is the quality that the public investment brings, combined with economic efficiency, and at the same time, the transparency of the selection of the proposal. The selection should clearly be subject to the possibility of public control in the selection process. In Slovakia, the selection of a public investment takes place through public procurement, which is a form of business competition with established selection criteria. The basic selection criterion is usually the lowest price. At first glance, this may seem like a rational way. Price is undoubtedly a very important parameter of public investment, and avoiding the waste of public resources is certainly very important. This is one of the legitimate criteria when choosing a construction contractor, even if in conjunction with others, for example, the professional ability to implement a specific order, the supplier's experience, the supplier's capacities, time aspects of the work, and so on. In the case of the selection of the proposal to be implemented, it is more complicated, and the criterion of the lowest price cannot be the main and certainly not the only criterion for the selection of the proposal. In this selection process, it frequently occurs – and continues to occur – that the contracting authority lacks clarity regarding the design and quality they will receive. This is because they base the competition for architectural services solely on the lowest price, without a clear vision of the outcome of the investment – the building or the appearance of the public space. Therefore, to choose the most suitable proposal, the architectural design competition is the way [10], in which complex aspects of an architectural work are evaluated, architectural aesthetic, structural, functional-operational, ecological, but also universal design and accessibility of the object and, but not exclusively, as in the business competition process, also economic efficiency. It can therefore be concluded that

although more energy and a higher volume of funds are spent at the beginning of the investment, these are very rationally spent resources in relation to the result. [11] This method integrates public procurement and anonymity with the other mentioned criteria, which guarantee the selection of the best proposal, not only the lowest price. Deciding on the result of the competition by the institute of a jury composed of experienced independent experts and representatives of the contracting authority guarantees a higher degree of objectification of decision making and is a tool for preventing corruption.

Therefore, it can be concluded that a good public investment, which creates a public building, must be economically efficient in implementation and subsequent operation, but must be based on a high quality and architecturally valuable design. An integral part of such a design is the fulfilment of the universal accessibility criteria of the object.

In the past in Slovakia, neither the selection of a high-quality design in the form of an architectural design competition nor the application of a universal design was a matter of course. The best design was not chosen, but the lowest price was compared without knowing what design would be created. In recent years, there has been a turnaround and positive change in the practice of selecting a proposal for public investment. There are a growing number of architectural design competitions and therefore high-quality designs evaluated and selected by an expert jury have the potential to be realised. The awareness and professional erudition of architects in the field of universal design, which appears in proposals, is gradually increasing. Anchoring the requirement for universal design and accessibility of objects and the environment is already included in the introductory documents, the tender assignment, which was not a matter of course in the past, and the solution of accessibility was rather a matter of the individual initiative approach of individual architects.

3.1. Examples of requirements for accessibility of buildings under competition conditions

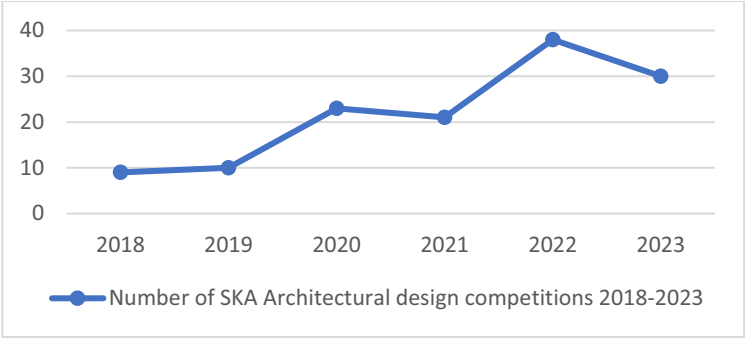
Transformation of the First Slovak Literary Gymnasium Revúca, Architectural design competition, 2020:
In the Competition Conditions, part of the Exhibition libretto, the exhibition intention is defined: The exhibition should have the character of a platform for experiential education (learning by playing / doing) and should also be accessible to the widest possible audience as a target group (including disabled people). Furthermore, the exhibition intention is even specified in accordance with the Convention on Human Rights: The presentation space should be freely accessible to people with mobility impairments, even to people dependent on mobility devices. A barrier-free toilet and changing area for mothers with small children should be a matter of course. It is recommended to create an alternative for blind and deaf people to visit the tour and a space for hyperactive children. Within the second part (multifunctional congress and educational space), it is necessary to create an alternative with the possibility of soundproofing and light reduction for the needs of children with autism or visitors with a social interaction disorder (the need to reduce external influences). Some selected elements of the exhibition are preferred to have the character of art therapy tools and aids for both small and large users. [12]

3.2. Development of the number of design competitions in the period 2018-23

In the monitored period 2018-23, with available statistical data [13], a clear trend of an increase in the number of architectural design competitions verified by the Slovak

Chamber of Architects (SKA) is demonstrable. The slight decrease in competition in the period 2020-2021 was caused by the negative impact of the COVID-19 pandemic in all areas of life. The slight decrease in 2023 compared to 2022 is caused by objective facts of the economic context and the slowdown of the economy. In 2023, the symptoms of the crisis began to manifest in the Slovak economy, with an impact on the public administration and the construction industry.

Table 1. Development of the number of SKA competitions. Source: SKA, Graphic: Author



The trend of design competitions is gradually becoming established in the Slovak practice of public investments; we can already see it in concrete implementations. Due to the length of the process, obtaining financial coverage for a specific investment, therefore, the examples concern the implementation of winning proposals before the statistically monitored period 2018-23. This is, for example, the implementation of the Barracks - Culture Park in Košice, built on Košice being the European Capital of Culture 2013, or the implementation of the New Town Hall in Leopoldov.

4. Case Study of the New Town Hall in Leopoldov

- Architectural office: zerozero - Irakli Eristavi, Pavol Šilla, Juraj Červený
- Investor: City of Leopoldov

The history of this realisation began in 2014 with a public anonymous architectural design competition. In the years 2015-18, the competition proposal was refined according to the investor's requirements, and the project was processed. The project was carried out over the period 2019-22. In 2022, the completion of the New Town Hall in Leopoldov was nominated for the prestigious Dušan Jurkovič Award under the auspices of the Association of Architects of Slovakia. In 2023, the completion of the New Town Hall in Leopoldov received the CE ZA AR award of the Slovak Chamber of Architects in the category of public and industrial buildings.

Although the 2014 competition assignment did not directly require the design of the building in the spirit of universal design, the experienced architectural team counted on the basic elements of accessibility of the building. In the design and implementation phase, these starting points were elaborated in detail.

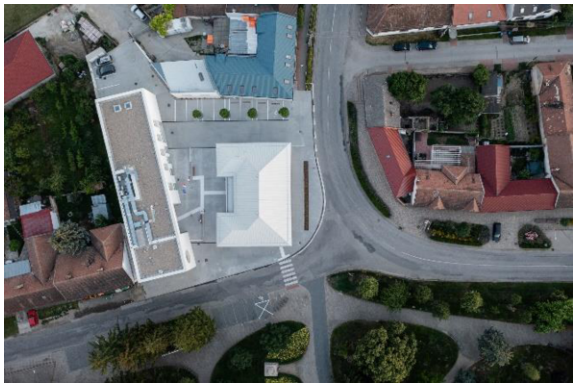


Figure 1. New Town Hall in Leopoldov: Universal design elements at the entrance to the building – tactile walking surface indicators for visually impaired people and accessible areas and parking places. Photo: M. Hakár

4.1. Principles of universal design in the object

The building is accessible by footpaths from the surrounding area, within the city centre. Barrier-free parking is provided for disabled people near the building. The entrance to the building is a wide entrance door at the same height level as the surroundings. Within the building, it is possible to move between individual floors in addition to a comfortable staircase using an elevator designed for the use of people in wheelchairs and with an assistant. The elevator is equipped for the movement of people with visual impairments, with descriptions embossed with symbols and Braille, and it is also equipped with sound signalling. Appropriately dimensioned corridors are implemented in the building. Doors with a minimum width of 800 mm are used that are suitable for the movement of a person in a wheelchair. Focal space with public access - the ceremonial hall is in contact with the main entrance with sufficient distraction areas. All areas for the public and employees are wheelchair accessible. On floors intended for the public, there are wheelchair accessible toilets with the appropriate space solution and equipment. In a three-track longitudinally shaped building with an asymmetrically located prominent entrance, the operation is configured clearly and logically, with a simple orientation in the interior. An information system has been designed in the building for easier orientation. We agree with Filová et al. statement that, in current practice, there is a strengthening trend and great desire to make public buildings more accessible and welcoming. [14]

5. Conclusions

The framework to ensure universal accessibility of buildings in Slovakia is defined by national and European legislation, together with technical standards. Nationally, Decree No. 532/2002 provides the legal basis, but it is considered incomplete. A more comprehensive and updated approach is needed. The forthcoming Decree on Requirements for Barrier-Free Design and Use of Buildings is expected to address the needs of various users with different disabilities more effectively.

Selecting a design for public investment through public procurement based on the lowest price is not ideal, as it oversimplifies decision making. An architectural design competition offers a more comprehensive view, allowing the contracting authority to

assess the project through a specific design tailored to the task. From 2018 to 2023, design competitions have shown a positive trend in Slovakia, according to SKA data.

The New Town Hall in Leopoldov showcases both high architectural quality and full accessibility, highlighting the value of selecting public investments through architectural design competitions. Multiple awards from architectural organisations further validate this approach.

Although the legal and technical frameworks for public investment selection and universal accessibility are in place, policymakers must pay genuine attention to these issues, particularly universal design. It is essential to adopt upcoming regulations, including the new Decree on Requirements for Barrier-Free Design and Use of Buildings, which will replace the inadequate Decree No. 532/2002. However, stakeholders can already exceed current standards. Achieving higher standards in design and accessibility depends on public investors and architects, who have a responsibility to promote democracy, transparency, and inclusion beyond the legal requirements.

The case study shows that, despite some requirements not strictly defined by legislation or technical standards, they were incorporated into the final design due to the expertise and social responsibility of the architect.

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Narratives in Generative Architectural Design: Exploring Sequential Functions and Usage

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Abstract. Architecture still excludes users despite decades of increased attention towards the designing of built environments to accommodate all. Partially, this grand problem is due to the uncertainty and plurality of future usage, which challenge architects in identifying potentially excluding mechanisms of their designs. Common approaches in responding to these challenges are either top-down assessment of architecture, or bottom-up collection of situated accounts from users. However, both approaches face dilemmas in developing representations of usage. This paper presents a framework that integrates qualities of both approaches using user-narratives and a rule-based generative algorithm to generate libraries of designs that each depict potential usage reflecting the narrative of users. The aim is to give architects and other decision makers tools to conceptualise the future usage of their design as plural and diverse. The presented framework is at an early stage of development. However, the principles proposed could hold potential to mitigate exclusion by explicating multiple potential use-events.

Keywords., People-centred Design, Architectural Design, Generative Design, Universal Design, Usage, Function, Narrative.

1. Introduction

Foreseeing future events is a general challenge. This is also true for architects who aim to design environments that accommodate the preferences and needs of future users [1, 2]. Discrepancies between anticipated and actual usage pose a risk of excluding certain users from the built environment [2, 3]. To reduce such discrepancies, architects use various types of information from past usage to adjust designs for more inclusive outcomes [4]. While guidelines and other top-down approaches provide generalised insights that can be operationalised with or without digital tools, qualitative and participatory methods offer rich, bottom-up information from the lived experiences of specific users [5, 6]. Despite the richness, the specificity and contextuality of bottom-up information complicate its integration into architectural design processes. This complication challenges the accurate representation of usage, particularly by those who are already marginalised within society [7].

In the effort of combining digital operationality with representation of actual usage, this paper presents a digital design framework that generates multiple architectural

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designs, each depicting a potential use-event based on a narrative from an actual user. A guiding question for developing this framework is: *How can digital design tools and methods be used to project singular past examples of architectural usage onto multiple future scenarios?* The framework does not intend to identify optimal designs but rather to enable identification of potential usage and, thereby, mitigation of the design's exclusionary mechanisms. In what follows, the paper first presents the theoretical background that provides context for the research's integration of digital design, people-centred design, and narratives. Subsequently, the methods employed for collecting, processing, and applying data in a generative design process are explained along with a comprehensive description of design experiments and results. The following discussion evaluates the proposed framework and its potentials before concluding remarks are given.

2. Background

2.1. Digital design tools in people-centred design?

Universal Design and other people-centred design concepts aim to support the accommodation of users' needs and preferences, and to mitigate exclusion by reducing the discrepancy between the intended and actual usage of designs [2]. These efforts often involve qualitative and participatory methods, critical thinking, and inductive reasoning to raise questions about designers' role in defining the potential of designs to accommodate for a diversity of users [7, 8]. Within the people-centred design field there is general consensus about the importance of including knowledge from bottom-up user perspectives in the design processes. However, there is equally widespread disagreement about if and how that perspective should be combined with professional top-down perspectives and methods [2, 7, 8]. These disagreements are also found in debates about the potential of digital architectural design tools to represent and give agency to users. On the one hand, digital design tools run on digits and are built to calculate – and this challenges the representation of users [3, 7]. On the other hand, digital design tools are increasingly accessible and aim to provide both users and professionals with the means to conceptualise objects and spaces [3, 8].

2.2. Usage and functions

Central to the discussion of digital design tools' ability to productively engage with the agency and representation of users is the distinction between usage and function, which are often used synonymously. This paper seeks to define, compare, and link those concepts to the dispute of digital design tools in people-centred design.

Functions are here understood as general categories of activities designated to objects, areas, etc. [3, 9] and due to this generality, functions cannot be unique. Conversely, usage is understood as what users actually do, including what might be considered misuse and conflict with intended functions [10]. These activities are mutual, yet asymmetric, interactions between users and environments [5]. The asymmetry arises from the biological and psychological properties of users that are not shared by built environments [11]. As particular events involving real users, objects, spaces, etc., the aspects of usage are infinite [5, 11] and it would be reductive to sum up the interactions in one word. Due to this infinity, usage can never be completely understood nor predicted - and this is different to functions, which are tied to individual words, such as 'cooking',

'reading', 'sleeping', and so on. Despite their ontological differences, usage and function largely depend on the same vocabulary when communicated through natural language. When users explain certain usage, they might well use words such as 'cooking'. However, the distinction between descriptions of usage and function is not only characterised by the unique words used but also how and why they are used. Use-descriptions can convey personal and situated accounts of experiences and their temporal progression [5]. Contrarily, by employing predefined categories of users, objects, and areas, functional descriptions can be used to both assess designs and guide designing through the ability to convey aspects of past, present, and future activities [3, 9, 12].

Digital architectural design frameworks are generally challenged by the qualitative and temporal nature of use-descriptions [13]. This leads to digital representation of usage that is biased towards functional descriptions and this is considered a problem for the accommodation of future users with particular preferences and needs.

2.3. Narratives, scripting, and digital design.

Narratives, as written or spoken accounts of connected events, have long been employed in architectural research and practice to challenge determinist conceptions of architecture [3, 9, 12, 14]. By shifting the focus from mere architecture to events, narratives offer a framework with which to describe sequential interactions between users and environments. Narratives can branch into multiple stories depending on the narrator, content, context, and audience [15], and this allows for parallel and equally valid stories of usage to be communicated. Furthermore, narratives can describe both "virtual" and "actual" events [16]. For instance, as evaluations of actual events (the door was too heavy!) or evaluations reflecting both virtual and actual events (the door was much heavier than I expected!). The ability to adjust narratives to such subtle differences means they have the potential to convey important details of usage as well as users' motivations and reflections.

By scripting narratives, stories are divided into individual sequences, each explaining a few functions [16], to engage with those parts of the narratives. Scripting is used in various fields to predict and engage with future usage. An example of this is 'narrative crime scripting', which is used in criminology as a method to prevent criminal activities [17]. This method breaks activities into logical sequences that explicate each event and explain the general motivations and prerequisites of their functions. Specifying the functions allows law enforcement to focus their efforts on the most vulnerable aspects of the criminals' activities [17].

A less dramatic example of scripts used to engage with future usage is 'User Scripts' for web browsers. These are programs written in the programming language Java, designed for (and often by) users to modify web pages to better suit their preferences and needs [18]. User scripts enable individual customization of web pages, for instance, by linking information or references, enlarging text, reading text aloud, and many other configurations.

By scripting a narrative told by an actual user and feeding these scripts into a generative design framework, the research presented in this paper seeks to explicate a multitude of potential future use-events. The aim of these efforts is twofold: first, to mitigate exclusion of users by integrating user experience of past events into the architectural design process to accommodate future inclusive use-events, and second, to develop a digital framework for architects to handle, explore, and communicate multiple architectural designs and their potentials for usage.

3. Methods

3.1. Data and data model

The generative framework proposed in this paper is based on a series of methods and tools that, due to limited space, will only be briefly explained.

The data used was collected through interviews with a user, 'Jane,' who is in her eighties and lives alone in a detached house north of Copenhagen [5].

A conceptual data model was developed to structure an ontology-based integration of the interview data with data conveying top-down registration of Jane's entrance, and thereafter to store the integrated data in a graph database, forming a knowledge graph that links descriptions of entities with descriptions of users' experience of them [13].

In this paper, the knowledge graph is used to identify a particular situation explained by Jane and to rewrite that into a script. Each sequence of the script communicates one or more functional relationships between Jane and objects with which she interacts during the event. The script is stored as a linear graph of nodes representing sequences connected in their sequential order. The linear graph is exported to CAD framework, where the data can be applied to the generative design process presented in this paper.

3.2. Generative Design

In digital architectural design and research, generative design is a broad term that encompasses many and diverse processes [19]. However, generative design processes generally produce multiple designs based on input data through a generative algorithm that operates using variables, constraints, parameters, and objectives, as well as methods to select the most desirable designs [20] (Fig. 1).

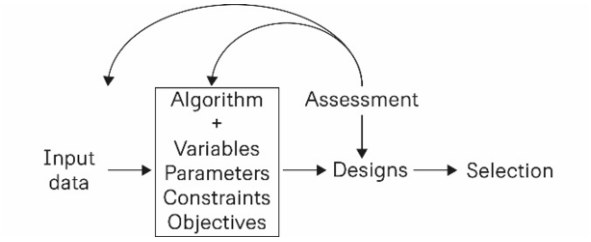


Figure 1: Diagram depicting a generative design process.

The generative design framework presented in this paper is a rule-based system that performs stochastic distribution of designs according to predefined rules within certain boundaries. This approach is relatively simple and, in that sense, distinct from other and more complex generative design frameworks that aim to optimise designs and/or adapt design through exposure to data [21]. Rule-based generative design frameworks allow designers to explore relations between design variations, input data, and generative rules. These rules often aim to reflect real-world constraints related to functions such as building regulations and quantifiable user preferences and needs [22, 23]. When designed well, rule-based generative design frameworks enable unforeseen designs to emerge within a structured system, allowing for assessments of both the designs, rule definitions, and potential links between them [24]. The explication of designs and design

logics, provide material for critical reflections among users and professionals, aligning well with the motivations found in people-centred design [2, 3, 8].

The rule-based generative design framework presented in this paper is developed in Grasshopper [2], a visual programming environment within the CAD application Rhinoceros. Using a scripted narrative and an architectural floor plan drawing as input, the framework generates a collection of designs, each depicting a potential use-event based on the same narrative.

4. Results

4.1. Input data.

During an interview, Jane explained that she had used a window above her front door as a safe medium to communicate with suspicious strangers who rang her doorbell [6]. From her accounts, a script of such an episode was written (Fig. 2, a). This script is stored as a graph (b) and overlaid on a ground floor plan of Jane's house. (c).

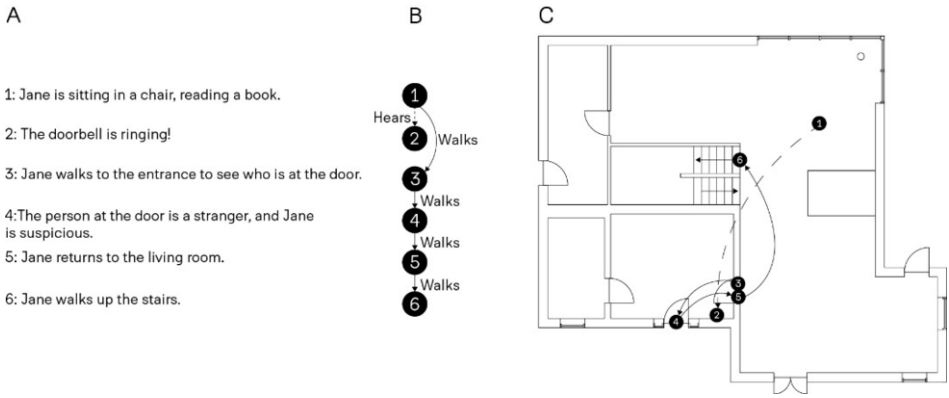


Figure 2: A) a script of Jane's experience, B) The script stored as a graph, C) The graph placed on a floor plan of Jane's house.

4.2. Design generation.

The generative algorithm developed to generate designs consists of native Grasshopper components, or code blocks, that together with the variables, parameters, constraints, and objectives define the rules for design variations. The *variables* include several objects extracted from the script and labelled accordingly ('chair', 'doorbell', 'entrance room door', 'front door', and 'stairs'). A grid of points evenly laid out on the floor plan serves as *parameters* to which the objects are relocated based on a series of *constraints*. Specifically, these constraints ensure that the 'chair' is positioned at a point in the living room, avoiding placement in front of doors or stairs. The 'doorbell' is placed at any point within both the living room and entrance room. The 'front door' is located at either the

[2] https://www.grasshopper3d.com/

actual front door of Jane's house or at a garden door she also uses as an entrance. This constraint ensures a larger degree of variance, as the use-events not including the actual front door are only taking place within the living room on ground floor level. Finally, the 'entrance room door' and 'stairs' are consistently placed identically in all designs they are included in. The *objective* is to stochastically distribute the objects to points according to the constraints and reconnect them in the sequential order of the script.

By applying the described framework, a small library of 100 designs that describe similar, yet different, potential use-events is generated (Fig. 3).

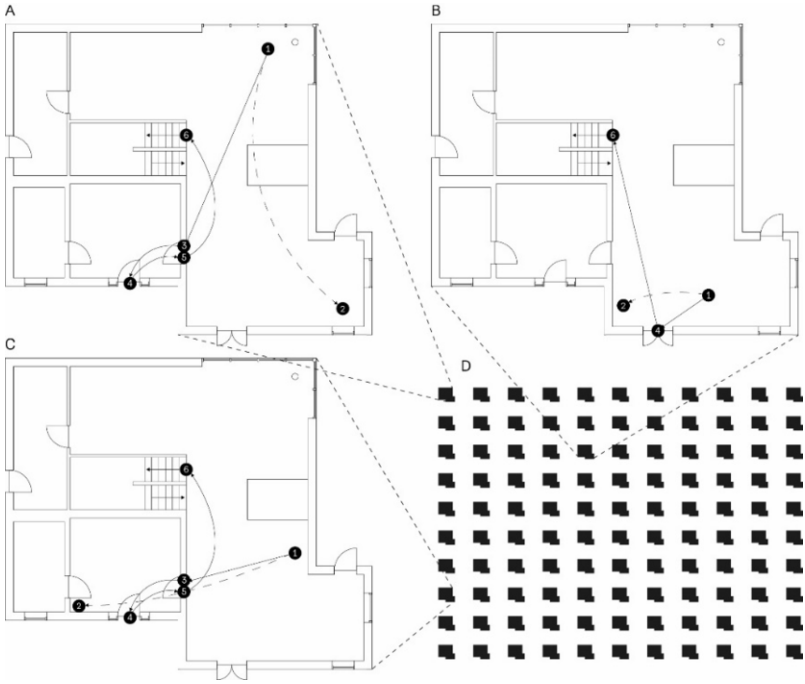


Figure 3: A, B, C) Designs reflecting the narrative of Jane while indicating different usage, D) A library of 100 different designs.

4.3. Design evaluation.

The means of selecting desirable designs proposed in this paper combines quantitative assessments of the generated designs with qualitative interpretation of the relationships between the designs and the scripted narrative. Numeric measurements extracted from each of the 100 designs describe the distance between the ‘chair’ where Jane is sitting and the ‘doorbell’ ringing, as well as the distance traversed by Jane during the use-event. These measurements are used to identify groups of designs and recurring patterns for detailed study. While these particular measurements are considered somewhat related to Jane's hearing impairment and varying mobility, they do not address any social aspects, such as the general fear of burglaries that prompted Jane to explain the episode examined. Therefore, by visualising the different designs and potential usage, the framework aims to provide interpretive readings of the design’s potential for architects to support both the functions of each sequence and the combined use-event described in the script. The

designs explicate potential events, from which questions related to social aspects can be extracted and considered prior to related decision-making.

The three designs shown in Figure 3 are selected based on the distances mentioned. In the first design A, both the distance traversed and the distance between the chair and the doorbell are long (9,9 and 21 m.). The position of the chair next to the big windows is interpreted as a potentially nice place to read a book. Here, Jane would not be exposed to people looking through any of the windows at the frontside of the house, which could otherwise increase the feeling of insecurity as suspicious strangers could locate Jane without her knowing it. Conversely, the position of the doorbell raises questions about proper placement and distances, conflicting with the authors' functional logic. In the second design B, the distances are short (2,7 m. and 9 m.). In the third design C, the distances are found to be fairly average (8,1 m. and 14,2 m.) among the 100 designs. In both designs B and C, the chair is placed close to the front door, and in design C, Jane can be seen reading her book by the stranger. This could significantly alter the situation described by Jane. The position of the doorbell in the living room in design B is interpreted as potentially good due to its proximity to the front door (which intuitively makes sense to the authors) while Jane is expected to be able to hear the doorbell from both the living room and the kitchen.

5. Discussion

By applying the rule-based generative design framework presented, 100 different designs were generated, each depicting a potential use-event reflecting a narrative told by Jane. Visualising these use-events, and making them searchable, allows the framework to present opportunities for designers and other decision-makers to identify multiple potential use-events. This should offer tangible means to adjust designs accordingly, challenge biases, or to qualify questions for users to specify their preferences and needs, aligning with motivations found among several people-centred design scholars [2, 3, 25]. While the generated designs are successful in contextualising functions in virtual space and sequential order, their ability to convey usage by combining the functions could be questioned. Besides discussions of representation, this relates to questions of agency in the processes of selecting data and designs, which are currently carried out top-down. In future iterations of the generative framework, these questions could be productively investigated by including several users in various parts of the design process as well as multiple narratives from various users and contexts. Besides increasing the number of potential use-events, the inclusion of more users, contexts, and narratives would enable investigations into whether, and how, commonalities could be identified.

6. Conclusion

Initially, this paper presented theoretical accounts of fundamental differences between actual ‘usage’ and the ‘function’ of architecture. By generating architectural designs and explicating the sequential order of functions in a certain use-event, the generative design framework aims to combine the qualities of representations of usage and functions to critically assess the design’s potential for various users. While the framework is still in the early stages of development and requires further work, this principle could hold

potential to mitigate the exclusion of users from built environments by presenting a diverse plurality of future usage.

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Universal Design for Balance Disorders: A Multifaceted Challenge

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Abstract. Individuals with balance disorders are often an overlooked population in discussions surrounding universal design. Balance disorders encompass a wide range of conditions, affecting individuals across demographics and significantly impacting their mobility and independence. Despite their prevalence and potential severity, limited guidance exists for designing spaces that effectively cater to these varied needs. This paper aims to address this critical knowledge gap by investigating the challenges faced by this diverse group in navigating their built outdoor environment, and thereby contribute valuable insights to the development of evidence-based universal design standards that better support individuals with balance disorders.

Employing a combined methodological approach, this paper describes a study in which a literature review has been utilized to establish an understanding of balance disorders and their impact on navigating environments. Furthermore, it expands upon this knowledge by gathering firsthand experiences and perspectives through individual surveys, focus groups, and observations. This multifaceted approach captures diverse data on travel habits, route selection strategies, and the limitations imposed by balance disorders. The research goes beyond simply identifying challenges; it delves into the complex sensory experiences of individuals with balance disorders, including light sensitivity, dizziness, vertigo, and disorientation caused by uneven surfaces, fluctuating light conditions, and excessive noise.

A crucial element of this research is recognizing the heterogeneity within the population with balance disorders.. Different individuals experience varying combinations of symptoms, leading to diverse needs and preferences in their surroundings. By analyzing this data, critical design shortcomings that contribute to navigation difficulties, as well as areas of design conflicts, are identified. Actionable recommendations for improvement and solutions to achieve a balance between the often-contrasting needs within this population are explored and proposed. Ultimately, this research aims to create a universally designed environment that fosters greater independence and participation in society for all individuals with balance disorders.

Keywords. Inclusive design, universal design, balance disorders, accessibility, mobility

1. Introduction

Many individuals with balance disorders face challenges when navigating in daily life. This research delves deeper than simply identifying these barriers. It employs a

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multifaceted approach, combining a literature review with firsthand experiences gathered through surveys, focus groups, and observations. The research delves into the complex sensory experiences of individuals with balance disorders, including light sensitivity, disorientation caused by uneven surfaces, fluctuating light conditions, and excessive noise.

A crucial element of this research is recognizing the heterogeneity within the population with balance disorders. Different individuals experience varying combinations of symptoms, leading to diverse needs and preferences in their surroundings.

2. Methodology

A multifaceted approach was employed to understand the challenges faced by individuals with balance disorders navigating the built outdoor environment. This research began with a literature review to establish a foundation in balance disorders and their impact on mobility. The review was complemented by analysis of existing site visit data specific to pedestrian bridges. This initial phase informed the development of an online survey targeting individuals with balance disorders, capturing their experiences and the limitations imposed by their condition. Finally, focus group interviews with survey participants provided deeper qualitative insights. recommendations.

2.1 Literature review

To gain a comprehensive understanding of the existing research on inclusive design for individuals with balance disorders, a multifaceted literature review was conducted. This approach combined established academic databases (Scopus and Oria) with strategic Google searches. In order to achieve a comprehensive understanding of balance disorders, the investigation was broadened beyond scholarly databases. General web searches were conducted to supplement the research with information on the definition, prevalence, and impact of these disorders.

2.2 Site visit data analysis

This research phase delves into the analysis of existing site visit data generously provided by Trondheim Municipality (TM). Site visits offer valuable insights into real-world user experiences, and TM's data focused on pedestrian bridges in Trondheim's central area with participation from individuals experiencing balance difficulties. Ethical considerations were paramount throughout the analysis, ensuring participant privacy and acknowledging the limitations inherent in working with data not directly collected by the researcher. The analysis process focused on identifying patterns within the data related to user experiences, aiming to capture both positive and negative design elements impacting user comfort and accessibility.

2.3 Individual online survey

An online survey (N = 78) was chosen to gather comprehensive data on balance disorders and their impact on inclusive design principles. This method offered a wide reach and efficient data collection process. The survey instrument covered demographics, medical

history encompassing diagnoses and symptoms, travel habits, factors influencing route choices, and participants' perceptions of design elements impacting comfort and accessibility. A three-pronged approach was implemented for participant recruitment: leveraging the member database of the national association for vestibular diseases (LFVS), utilizing active social media groups dedicated to balance disorders, and reaching out to the general public through personal networks. Prior to survey distribution, ethical considerations were addressed by securing approval from the Norwegian Agency for Shared Services in Education and Research (Sikt) and ensuring participant anonymity throughout the research process. Pilot testing was conducted to guarantee the effectiveness and clarity of the survey design and questions for subsequent analysis.

2.4 Focus group interviews

To achieve a comprehensive understanding of participants' experiences with balance disorders in the context of inclusive design, two focus groups were conducted. Each group comprised three participants, resulting in a total of six individuals. This approach facilitated a deeper and more nuanced exploration compared to individual surveys. Focus groups foster reflection and dialogue among participants, enriching the data collection process. A semi-structured interview guide and moderator ensured a focused discussion while maintaining inclusivity and managing group dynamics. This methodology capitalizes on the strengths of focus groups, generating richer data compared to individual surveys. The recruitment strategy leveraged the existing participant pool from the prior survey, inviting interested individuals to participate in the in-person discussions.

3. Literature review: Understanding balance disorders and inclusive design

This chapter summarizes the key findings from the literature review on balance disorders and inclusive design principles with a special focus on the challenges met when crossing pedestrian bridges.

Balance disorders represent a significant concern for public health, impacting a substantial portion of the general population. In Norway, estimates suggest that between 10-16% of individuals experience dizziness and difficulties with balance within a three-month timeframe (Goplen, 2021; Helse Bergen, 2024). This translates to a significant number, exceeding 100,000 Norwegians consulting general practitioners annually solely due to dizziness (Helse Bergen, 2024). The underlying causes can vary considerably, ranging from short-lived issues like dizziness following a concussion to chronic conditions affecting the inner ear. Notably, Benign Paroxysmal Positional Vertigo (BPPV) emerges as a prevalent diagnosis, estimated to impact around 85,000 Norwegians each year (Goplen, 2020, 2021).

Furthermore, the spectrum of balance disorders encompasses a diverse range of conditions with varying degrees of severity and duration. While some individuals experience brief episodes of dizziness linked to illness or injury, others face ongoing challenges that significantly impact their daily activities and mental well-being (Berge et al., 2014; Goplen, 2021; Hegstad, 2019; Jacobsen, 2013). This spectrum includes episodic conditions like BPPV and Meniere's disease, which can cause dizziness episodes lasting from minutes to hours. Conversely, chronic issues manifest as persistent,

less intense symptoms (Goplen, 2021). These chronic conditions can significantly hinder daily life, making tasks like work, household chores, or even short walks challenging.

Existing regulations and manuals, like the Building Technical Regulations and the Universal design guidelines from The Norwegian Public Roads Administration, prioritize general accessibility but lack specific guidance for individuals with balance disorders (Byggteknisk forskrift, 2017; Statens Vegvesen, 2011).

The challenge lies in balancing general design principles with the specific needs of diverse user groups with balance disorders (Luck, 2018; Newell et al., 2011). User empathy and understanding should be emphasized in design decisions (Grandić et al., 2024). Additionally, existing regulations need to be reviewed and updated to reflect best practices for inclusive design.

The design of pedestrian infrastructure and pedestrian bridges, can significantly impact the experience of individuals with balance disorders. Several elements can be problematic, disrupting their sense of balance and making navigation challenging.

- Visual patterns: Complex visual elements like high-contrast patterns, reflective surfaces, and intricate linear designs can disrupt balance (Kane & Beyts, 2018). Simpler visual environments with clear visual cues are preferred.
- Lighting: Flickering or rapidly changing light patterns can trigger symptoms (Ménière's Society, n.d.). Consistent and even lighting is crucial.
- Moving visuals: Gaps in bridge floors revealing moving water or a mismatch between static and moving visuals can be problematic (Barton, 2019).
- Walkway flooring: Sloping floors, uneven surfaces, and geometric patterns can cause difficulties (Duguid, 2021). Firm, smooth flooring is ideal.
- Non-orthogonal geometry: Inclined floors and conflicting visual information can exacerbate balance issues (Duguid, 2021). Open bridges with level floors and vertical parapets are generally easier to navigate.

4. Results

4.1 Site visit data analysis

The site visit identified key design elements for pedestrian bridges to better serve individuals with balance disorders. Slip-resistant surfaces like asphalt or Plexidekk® were found to be preferable over wood or polished concrete. Bridges with excessive swaying or bouncing movements were flagged as challenges. Clear separation and signage for pedestrians and cyclists were deemed crucial for safety, while open railings with see-through gaps were found to be unsettling. Perforated steel plates offered a better compromise. Round-profile handrails made of wood were preferred for ease of gripping. The importance of user-centric design was highlighted, with a desire for seating that provides back and arm support. The need for adequate lighting that illuminates elevation changes, transitions, and bridge extremities was emphasized. Shadows and overly intricate railing designs were identified as potential hazards. In conclusion, the site visit underscores the importance of user-centered design principles that prioritize slip resistance, bridge stability, clear user guidance, unobtrusive railings, functional handrails, well-positioned seating, and effective lighting to create inclusive and safe pedestrian bridges for a wider range of users.

4.2 Individual survey

There were a total of 78 participants in the survey. The survey revealed a surprising demographic trend, with over 90% of participants identifying as female. The majority fell within the 46-55 age range, and vestibular diagnoses were most common. Dizziness was the most prevalent symptom, but many participants reported experiencing multiple issues simultaneously.

Regarding daily activities, a significant portion of participants traveled daily, favoring cars over other options. Walking was chosen for shorter distances, good weather conditions, and exercise purposes. However, some participants avoided walking due to safety concerns or a lack of suitable walking routes in their area.

When choosing walking routes, several factors were important. Route length, lighting conditions, minimizing traffic and noise, wide sidewalks, and even surfaces were all highlighted. Interestingly, some participants with specific symptoms even preferred challenging terrain.

The overall perception of pedestrian infrastructure, including elements like sidewalks and designated walking paths, was "pretty good," but with room for improvement. Areas identified included uneven surfaces, inadequate winter maintenance, and a lack of clear separation between pedestrians, cyclists, and vehicles.

Challenges within the broader built environment also presented difficulties. Lighting design (avoiding flicker and excessive brightness), uneven surfaces, limited space, visually overwhelming patterns, noise pollution, and a lack of handrails and rest areas all contributed to discomfort and difficulty.

4.3 Focus Group Discussion

The focus groups delved deeper into the survey findings and explored the reasons behind the gender imbalance. Discussions centered around observations of similar imbalances in support groups, leading to questions about whether women are more affected by balance disorders or simply more likely to seek help. Stress and hormonal factors were also considered as potential contributors. Overall, the focus groups emphasized the need for further research on this topic.

The initial survey finding of a high preference for private cars (82.1%) was further investigated. Focus groups revealed a more nuanced picture. While driving offered a sense of control, predictability, and a way to manage symptoms by focusing attention, it was not always feasible or advisable due to the potential impact of symptoms themselves. Participants highlighted the importance of maintaining mobility and independence, and some even saw driving as a way to achieve this. Ultimately, the choice of transport depended on symptom severity, individual preferences, and the availability of alternative options.

A recurring theme throughout the focus groups was the difficulty navigating uneven and slippery surfaces, such as wet pavement, smooth tiles, and cobblestones. Visually cluttered environments like busy streets, brightly lit stores, and areas with excessive patterns and colors were also identified as sources of discomfort. Participants emphasized the critical need for more seating options, both indoors and outdoors, to allow for rest periods. Handrails were seen as crucial for providing support on stairs and uneven terrain. Sensory overload emerged as another significant challenge, with participants reporting feeling overwhelmed by excessive noise, bright lights, and strong smells.

Lighting was a double-edged sword. Participants found both inadequate and excessive lighting problematic. Flickering or moving lights, as well as harsh LED lights, were particularly bothersome. Lighting also played a role in visual stimuli. Busy patterns, stripes, and other repetitive visual elements were found to be disorienting. Interestingly, some participants even found guidelines for the blind to be a source of difficulty.

Traffic presented another challenge. Participants reported feeling anxious and stressed when navigating busy streets with heavy traffic. The noise and movement of cars, along with the constant need to be aware of surroundings, were all cited as contributing factors.

A key takeaway from the discussions was the importance of predictability and control. Participants emphasized their desire to anticipate and manage their environment as much as possible, avoiding unexpected changes in surface texture, lighting, or noise levels. Overall, the focus groups underscored the need for more accessible and inclusive public spaces that take into account the needs of individuals with balance disorders.

5. Discussion and recommendations

The research identified design recommendations for pedestrian bridges to improve accessibility for balance disorders. However, some solutions may conflict with the needs of other users. The following table outlines recommendations for bridge features, highlighting potential conflicts. Inclusive design solutions are proposed to bridge these gaps and ensure accessibility for all.

Table 1. Recommendations for design elements in pedestrian bridges, including a description of recommended design, benefits, potential drawbacks and inclusive solutions.

Design element	Description	Benefit for balance	Drawbacks	Inclusive solution
Handrails	Continuous, on both sides. Consistent height, non-slip material.	Provides support and stability.	Obstructs views for short people.	Two height options. Contrasting ends for better visibility.
Railing	Solid panels or closely spaced slats.	Reduces visual distractions and movement below.	Obstructs views for short people.	Integrate viewing windows at appropriate heights.
Walkway Flooring	Slip-resistant, even surface with consistent texture.	Minimizes slipping and falling. Reduces distractions.	Highly textured surfaces can be hard to clean.	Choose easy-to-maintain texture with good grip.
Signage (visual cues)	Clear markings indicating pedestrian/bike lanes and separation.	Improves spatial awareness.	May not be visible for visually impaired. Overwhelming for some.	Limit markings to essential info, maintain clarity.
Lighting	Well-lit bridge with consistent illumination. Flicker-free light sources.	Improves visibility, reduces tripping hazards.	Glaring/uneven lighting can be problematic.	Implement diffused lighting, avoid sudden brightness changes.

Resting Areas	Designated seating with back support and armrests.	Provides opportunities to rest and regain balance.	May create congestion or block flow. Armrests limit other use, constituting hostile architecture.	Strategically placed seating to minimize obstruction. Armrests on both sides for wider usability.
Width of Pathway	Sufficient width for maneuvering with assistive devices.	Accommodates those who need extra support.	Narrow paths can be challenging during high traffic.	Minimum width for comfortable passage with assistive devices.
Slope	Gentle inclines and declines with consistent gradients.	Reduces exertion for those with balance difficulties.	Steep slopes can be dangerous for wheelchairs.	Maintain a gradual slope throughout the bridge.

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Driving Forces and Enablers for Universal Design in Urban Planning

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Abstract. The built environment is still, to a large extent, not accessible and usable for all. The awareness of people's different conditions and abilities sometimes seems to be far from the agenda for planning and architecture.
Universal Desing (UD) is pointed out as a strategy to achieve a built environment for all people regardless of age and abilities. UD has a radical potential to bring about change and raise attention to spatial practises that produce or reproduce exclusion and inequalities. But it is also challenging the contemporary planning discourse and several of the actual strong planning trends. Densification, mixed-use and mobility management are some of these trends that needs to be met by an elaborated practice with human diversity as a starting point.
Curiosity about what universal design can mean in practice is growing among many professionals. Lack of accessibility is easy to trace, while the good examples blend naturally into the environment and are often taken for granted. It is the good examples that are decisive to achieve social goals such as equality, participation and a sustainable society. There is a need to highlight and discuss the driving forces and enablers for a UD-approach, in the different stages of processes, in the design of buildings and places and applied to different spatial scales.
This paper will highlight some of these driving forces and enablers related to UD, for an in-depth discussion on the conditions to realise urban development characterised by human diversity.

Keywords. Built Environment, Universal Design, Urban Planning, Human Rights

1. Introduction

The Swedish Disability Policy and commitments on international level states that accessibility for all shall be reached through Universal Design (UD) [1], [2]. Among professionals, however, the use and understanding of the concept is still limited and among professionals related to accessibility [3]. Societal planning means to handle many shifting ideals and goals, and it is not always societal goals such as equality or accessibility that are on top of that agenda. There are different ways for the planner to handle the plurality in planning practise, where one's own values can matter [4]. In addition, there is also a resistance to accessibility among involved actors to deal with [5]. Moreover, there is often a clear intention-action gap within the public body, where the result of a construction project at the end do not correspond to current laws and policies [6]. There are also several perceived conflicts of interest to handle. The neoliberal planning practice supports, for example, conflicts between a neoliberal approach and social sustainability. Private actors play a major role in urban development and are given an ever-increasing space through the notion of cities space competition for economic growth as the primary goal. Society's responsibility to ensure social interests is weakened [7].

The understanding of human diversity in the built environment seems to have declined with new ideals in community planning in recent decades. Inequality and segregation are growing in our cities. It is a megatrend that can be traced both locally and globally. Florida [8] calls this the 'new urban crisis' and gives a recipe for how an 'urbanism for all' can emerge. In the pursuit of urban attractiveness, people who do not fit the image of the successful citizen are weeded out. This applies to people with disabilities, but also to older persons, people with different ethnic backgrounds and other socially vulnerable groups [9].

So, how do you get UD and human diversity to become an important and attractive parameter that takes place in today's societal planning ideals? The studies presented in my thesis, touched the presence and absence of UD and human diversity in planning, construction, and urban development processes from different aspects [6].

Among the findings, driving forces and enablers for a built environment that welcomes all users were identified. The studies covered the entire urban development process, from the early, visionary stage to completed buildings and places. 'Driving forces' is represented as factors and phenomena in the process that have been clearly important for establishing a UD-approach in the start and keep the visions all the way through the project. 'Enablers' are here related mainly to objects and artefacts in the built environment that meet UD principles and goals.

In contrary to the belief that inaccessibility is something that will be automatically removed over time, the findings showed how the footprint of UD was greater in remodeling projects than in new construction. Despite difficulties in the form of technical challenges and protective regulations on culturally valuable buildings, the case studies showed how it is possible to find innovative UD solutions in projects where economic profit was not the main driving force. The issue of driving forces linked to profit interests and power is also important in relation to sustainability. Even from that perspective, society's commitment is required for important societal goals to be achieved.

The aim of this paper is to highlight UD driving forces and enablers in urban planning, to discuss how these can contribute to promote equality and good social living conditions; and to support the development of strategies and approaches to realise human diversity in urban planning. By applying UD at different levels and scales - in the process, in the urban form, in the actual design of buildings and places and in people's experiences and by using a variety of tools the current gap between vision and practice can be bridged.

2. Methods

The paper is based on the studies included in my thesis [6]. The qualitative research included document studies, a multiple case study, four workshops, six interviews with professionals and go-along interviews with citizens.

The document study included 15 documents from different stages of the planning process in one Swedish city. Texts, illustrations, and photos were analysed [10], [11], [9]. The multiple case study [13] was based on a strategic selection of cases, eight construction projects in Gothenburg. Among them were five projects new constructions and three remodeling projects of older culturally protected buildings and areas. The workshops handled the entire planning and building process, with 28 participants from city administration, developers, and architects. Six semi structured interviews were afterwards held with six selected participants from the workshops, each with different

professional roles in urban development [14]. The go-along interviews were held in three Swedish cities with 16 participants [15].

By choosing these different methods, I was able to collect a rich material that covered the entire process from vision to the finished built environment. Selected methods and the amount of data have facilitated the analysis of what happens during the course of the urban planning process. The analysis of policy programs, workshops and interviews with actors has made it possible to identify driving forces that support or oppose a UD approach during the process. The 'enablers' has emerged in the analyzes of go-along interviews with citizens, and through the case studies.

I completed the studies as an industrial PhD in connection to my professional role as an accessibility advisor with extensive experience from accessibility work both in municipalities and the private sector.

3. Driving forces and enablers for UD in urban processes and the built environment

This section describes the use of the concepts of driving forces and enablers in this context and the methods used to identify them. Based on collected data and findings from the studies, a description is then made of tools to support and facilitate the implementation of UD and human diversity in practice in planning and construction.

I use the term ‘driving forces’ when describing conditions that have had a direct impact on the final result of the project. In this context it is related to the urban development processes and the conditions for a practice that can implement human diversity and UD from start to end in the planning and construction process. By ‘enablers’ I turn to examples of design solutions related to principal challenges connected to UD in the built environment. The driving forces and enablers are identified in my studies as aspects that distinguish examples characterised by the presence of UD and a high level of accessibility from its opposites.

3.1. Driving forces for UD in the urban development process

In the multiple case study, workshops, interviews and walkalongs made in the studies, aspects both supporting and impeding UD in planning and construction, were identified. The the most influencing factors were related to power, organisation, economy, and the mindset.

3.1.1. Power-related driving forces

The gap between vision and practice often arises in the planning and design phase of a project. Even if it was expressed in early visions that what is built and constructed should be for all citizens, something happens with the issue of accessibility and usability in the next step. The degree of power and influence in the project is decisive for which values will survive the process from vision to the constructed built environment.

In the comparison between newly built projects and reconstruction of culturally protected older buildings, the presence of a UD approach emerged more strongly in the reconstruction projects. All these projects, unlike the others, were owned and operated by the city [13]. The main purpose of the reconstructions was not economic benefit, but

to protect cultural values and modernize the buildings, where the extension of the number of possible users was included in the planning.

The conflict between neoliberal planning practice and social sustainability [7] becomes apparent here. The profit interests of private actors need to be balanced by the public actors' protection of public interest and social values, and this protection needs to be strong early in the process. In workshops and interviews, it was expressed that it was too late to review accessibility and usability as late as the in the building permission process. In addition to the practical difficulties of making major changes so late, it also entails costs for the developer, which can cause resistance.

Driving forces for holding on to UD-related issues during the construction process are very much about the management and ownership of the public sector, and the ability to use its power to set the right demands at the right time in the process and make well-thought-out decisions. To complete the task, all parts of the organisation must also have a common knowledge base, about regulations, possible and suitable solutions and not least about humans and human diversity and the demands it places on the environment.

3.1.2. Organisational driving forces

The lack of cooperation across administrative boundaries was highlighted in the workshops as a real risk of losing the overall picture in various projects. A lack of common goal images, poor coordination and insufficient handovers between administrations during the process contributed to losing control, especially in the earlier phases. For the public sector to be able to maintain its role for important societal goals to be achieved, the organisation needs to stick together. In many Swedish municipalities, reorganisations are now being carried out where civil engineering administrations are merged with, for example, technology and environmental administrations. Regardless of the organizational structure, the management layers in the municipalities must ensure that a common target image for how a society can be built for everyone is created and developed. To help, there are many concrete tools and methods to use. Some of these that have come to the surface in the partial studies are the needs to

- Visualise human diversity in images and texts in policies and programs
- Concretise UD values and goals in agreements, contracts and public procurements
- Make human diversity and UD visible in reporting and follow-up activities

3.1.3. Economic driving forces

The social and national economic potential of UD in planning and construction has so far been underestimated and unexplored. Accessibility is among many developers seen as something that increases the costs, mainly because it is highlighted late in the process, knowledge about suitable solutions is limited and the budget horizon is limited to the own company and profit interest. The benefits for society should be calculated on, in an overall cost-benefit analysis of each project. Any possible additional costs in a project based on a UD approach, need to be compared with the costs for compensatory measures and extra community services that otherwise will arise afterwards. Design that is not intended in advance for a limited group of users, but for human diversity, would by all means be more beneficial to the community.

From interviews and workshops in one of the studies, participants from the city administration expressed on several occasions the point of view that special requirements are cost-driving and that therefore one does not have the opportunity to go further than the minimum requirements the law specifies for accessibility and usability. In this

context, 'special requirements' refers precisely to requirements for better or more far-reaching accessibility than what is stated in law and regulations. One informant indicated the possibility to ask the developers to propose solutions that the municipality then could evaluate. An actor can voluntarily undertake to do better, but the municipality cannot make demands, was the conclusion.

The projects in the case studies that could be said to bear traces of a UD approach were all remodelling projects that were owned by the city and that had an identified budget line for accessibility. These were all linked to preliminary studies and analyses where different possible solutions were discussed. In this way, it became possible to budget correctly in advance and to prevent costs for adaptation later.

3.1.4. Mindset-related driving forces

Categorizing people into different population groups often risks leading the thoughts in wrong direction and becomes particularly critical when it comes to issues of accessibility and disabilities. In the Swedish building legislation, 'people with reduced mobility or orientation capacity' are mentioned as the group for which the regulations on accessibility and usability are for [18]. Interviews and workshops showed a large knowledge gap regarding the concept of this target group in building legislation. Most often, the requirements were interpreted from the point of view of wheelchair users, while the needs of users of other mobility aids or people with sight, hearing or cognitive impairments were captured only to a small extent or not at all in the projects. To get to a point where the entire human diversity is covered in planning and construction, the categorization 'persons with reduced mobility or orientation' is not enough. It still leads to the idea that there is a kind of normal user and others to whom certain parts of the environment need to be adapted, sometimes.

Hedvall et al. [19] have introduced *nonclusion* as a way to get away from norm-deviation thinking. Nonclusive design means that you do not define or set limits in advance for whom the design is for.

In all studies there are several individual examples that confirm these thoughts. Three principal strategies have distinguished the good examples from others, namely the design of environments where

- low demands are placed on the user's functional abilities
- users are not divided or separated
- focus is on the function instead of person
- avoids special solutions and focuses on expanding the number of possible users

The multiple case study from 2021, showed how human diversity needed to be a part of the mindset in all the phases of the planning and building process [13]. The need to keep human diversity in mind from vision to practice is a real challenge for all actors involved in the process. Critical aspects, supporting and impeding the implementation of a UD approach was identified. Guidelines for UD in the planning and building process was elaborated, based on these findings.

Identified driving forces in the process were linked to start to raise demands in public procurement and contracts, to allocate resources at an early stage and to make visible the consequences of alternative decisions.

A changed mindset is also about reversing the perceived conflicts. Knowledge of how innovative ways have succeeded in making older culturally protected buildings more accessible to more people can be a driving force in modernisation and conversion to UD in existing environments. In the case study there were several examples where arguments

for environmental sustainability landed in poor or completely inaccessible design of places. The sustainability concept needs to be held together and innovative solutions need to emerge, not least when it comes to urban mobility. In this way, social sustainability can become a driving force both for a UD approach and sustainability strategies that hold for the entire population.

Data from the case study, workshops, and interviews, was used to develop guidelines for UD in planning and building processes. These guidelines aim to connect vision and practice by holding together the idea of human diversity and UD in all phases of process, by identifying core tasks in each phase.

3.2. Enablers for UD in the built environment

The described identified enablers in the built environment are design solutions and equipment to handle challenges linked to topography, distances, space and time.

3.2.1. Topography and level differences

'It's a nightmare to build houses in this hilly environment!' The words came from one of the interviewees, responsible for traffic planning in an urban development area. The person could very well describe the consequences of choosing a topographical challenging area to build on, as well as the results of the lack of cooperation between administrations in the city. The plan was to build a walkway and bike path outside the buildings which resulted in the need to adjust the heights of the buildings and to change the design of entries. To build in hilly areas needs a lot of communication, cooperation and consequence analyses, not at least when it comes to how people with reduced mobility can move around in the area. How the buildings are designed and how they are placed in the terrain are other important aspects to enable an accessible environment.

Examples of enablers in hilly areas discussed in the study was in example outdoor lifts, special smaller vehicles for mobility in the neighbourhoods' and well thought out plan for where to place bus stops and parking spaces. On the detailed level, handrails on both sides of outdoor stairs, clear contrast markings and well-designed walkways was mentioned, as well as to put stairs and ramps or elevators close to each other to avoid long detours.

3.2.2. Distances

Distances in a City is a challenge for many people in general. All mobility strategies need to be based upon human diversity, with flexible mobility modes. Both public transports and individual transportation are needed. The walkalongs revealed the necessity for several of the participants to use the car to be able to visit the city. Either the bus stop was too far away, or the buses was inaccessible. Some decided their points of destination in the city merely based on where to find a suitable parking spot. In one of the Cities a flexible bus route, call controlled traffic, was enabling participants to visit the city centre.

From this and previous research [20] we know that benches, well spread over short distances, are a prerequisite for being able to move longer distances than would otherwise be possible.

3.2.3. Space

Free space is an important prerequisite to realize UD in the built environment. These are areas for flexible mobility, space for ramps or lifts next to stairs and slopes, parking spaces in general and larger parking spaces for people with reduced mobility, etc.

The lack of space in front of buildings was discussed in the workshops, causing problems to plan for accessible walkways and entrances, especially in hilly areas.

Another problem with lack of space in front of buildings and entrances was the problem for emergency services to reach the building in time.

Keeping free space in the built environment enables also more green areas and flexibility for future needs. It is also an important enabler for orientation. In times of densification, a good dimensioning between the heights of buildings and the width of the spaces inbetween is important both for orientation, daylight in housing and not at least for climate reasons.

3.2.4. Time

The access to public toilets was pointed out by participants in the walkalongs, as one of the main the conditions for being able to spend a day in the city center. For many, it was decisive for how long one could be in town and thus also determined possible activities.

Flexible transport modes are another aspect related to time. The ability to quickly get to and from the visit point were crucial for some participants. Not being forced to put a lot of energy into the trip itself could enable to have strength left for the activity that was planned.

4. The way ahead – implementing UD in urban planning

To achieve success in implementing UD in the entire urban planning process and to the built environment, takes more than relying on the good will only. New methods and ways of thinking are needed to make actors to consider people's differences and take them into account in planning and construction. UD's goals and principles need to become embedded among the current trends and ideas that now dominate urban development; if it shall be possible to reach societal goals as equality, human rights, and everyone's right to an accessible and usable environment.

The implementation of UD in urban planning concerns both the process itself, design choices and people's experiences of the built environment; and therefore, needs to be applied on the holistic as well as the detailed level. It concerns all the different stages of the urban development, the final design of buildings and places as well as the spaces between and the context in a whole-city perspective. The findings from the studies give us important guidance and knowledge for future research how to put universal design into practice. Avoiding it to stop at words and visions, several parts of current urban development practice need to be challenged. It is about bridging the gaps in the process, between actors and internally in the municipalities; to consider societal costs and not short-term private profit interests only, and to realize that disabilities are natural parts of human diversity. To reach good solutions in the final stage, universal design must be included from the beginning of the process and integrated from the start in the overall planning issues that determine how land, topography, distance and surfaces are to be handled in the urban development process.

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Understanding the Challenges in the Urban Street Navigation of Persons with Visual Impairment: A Field-Based Study in the Indian Context

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Abstract. Urban street environments have been designed for ages by the sighted, for the sighted. This presents various challenges for persons with visual impairment while navigating the streets, as the physical elements can act as barriers to them. The intensity of this problem is manifold in the case of Indian streets, which are multifunctional, vibrant public places where all aspects of human life can co-exist with its primary function of mobility. To truly address this issue, the complex process of PVI pedestrian navigation needs to be understood and mapped contextually, through a user-perspective study method. This paper presents the results of a contextual study conducted with 5 participants who are visually impaired from birth, in Thiruvananthapuram, a Tier 2 southern city of India in the state of Kerala.

Keywords. PVI navigation, Indian streets, cognitive mapping, sensory landmarks

1. Introduction

As Golledge rightly pointed out, 'the disabled live in a transformed space'. This means that even though all sections of society use the same streets for day-to-day activities, it presents bigger challenges to persons with disabilities than to an abled-bodied. The issues in the design and maintenance of streets, disturb the effective use of the same by all users, but this is multiplied manifold in the case of persons with disabilities (1). A misplaced drain slab, an unattended pothole, an unscientifically placed traffic board, an illegal advertisement banner, or a two-wheeler illegally parked on the sidewalk; all become deathtraps to a person with disability. Streets as a concept had been historically developed with the intention of using it with the help of sight as the primary sense. All activities happening on streets, whether related to movement, socializing, relaxing, or protesting, need visual data, to be carried out. Vision being the dominant sense, provides more information than the other senses combined (2). It must be for this specific reason that the streets across the world had been designed for ages with vision as the primary sense of comprehension. But the visual cues that are used by people who are sighted, for navigating the streets, such as signages, street elements, paths, and landmarks, are ineffective for PVI (3). In the current scenario, for the same reasons discussed above,

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street elements act more as barriers for PVI navigation than as facilitators. But incidentally, during PVI street navigation, their interaction with these same street elements is inevitable. This leads to our impending question of 'how these streets can be navigated by those with impaired visual abilities?'

The context of this research revolves around the urban street navigation of persons with visual impairment in Tier 2 Indian cities[2]. Visual impairment is a high-incidence disability. India is home to about 17% of the world's population. But an estimated 25% of visually impaired people globally, live in India (4). Currently, more than one-fourth of persons aged 50 years and above are visually impaired in India (5). The city of Thiruvananthapuram, where this study is conducted, is the capital city of the southern state of Kerala. Kerala has a faster rate of aging population than the rest of the country owing to its strong focus on healthcare and social welfare, reduction in fertility and mortality and higher age at marriage (6). The elderly population in the state is projected to be more than 25% by 2051.

Understanding the lived experiences of PVI while navigating a tier 2 Indian street can shed light on the strategies that they use to deal with challenges resulting from a lack of investment and poorer maintenance of infrastructure. This can also lead to the development of contextual design strategies for the street elements that can aid PVI in their day-to-day street navigation.

2. PVI Street Navigation

Studies as early as the 1990s have suggested that PVI navigation happens based on a mental map they create with the help of non-visual cues (auditory, haptic, and olfactory) that they get from the environment (7). These mental maps consist of sensory landmarks that help PVI to orient themselves in a physical environment. While navigating urban environments, PVI prefer familiar streets in which they have either received training or have prior experience and understanding. Over the years, researchers have reported various street elements that act as landmarks for PVI navigation (8)(9)(3)(10)(11). This navigation process becomes more complex and difficult when street elements fall short due to underdevelopment and improper maintenance, like in the case of LMICs like India (3).

PVI use physical elements on the street to navigate and orient themselves (12)(10)(13). But while using streets, other than motorized traffic, the major threat to PVI's movement is the presence of these same street elements. While the permanent and semi-permanent street elements, which are safety-critical, are easily detectable by sighted people, they present a huge challenge to the PVI (14). This means the street elements act both as barriers and facilitators in PVI urban navigation. So understanding how PVI orient themselves and how they use physical elements as clues for orientation within the urban space is paramount when designing urban street elements (15).

3. Method

This study was conducted with 5 participants with severe visual impairments from the National Association for the Blind Kerala, Thiruvananthapuram in two phases. The first

[2] Indian cities classification by Reserve Bank of India based on 2011 census

phase was an exploratory survey conducted to understand the issues they faced during pedestrian street navigation and to identify the street for participant observation. This was done through semi-structured interviews. The second phase had three steps. The first step was a field observation to document the street and identify the existing street elements. The data collected at this stage are the photographs and the field diary and the outcomes are a street map and a list of street elements. The second step consisted of participant observation of the PVI street navigation. The entire process was video recorded and PVI-street interaction points were noted. The outcomes of this stage were the journey map and the identified barriers map. The final step consisted of a semi-structured post-observation interview with the participants to understand the sensory cues and landmarks that they have used for the navigation. The outcome of this stage was a sensory landmark map. These four layers were then combined to create a PVI street navigation mind map.

Table 1. Research methodology chart

Method	Data	Tool	Outcome
Exploratory Survey	Interview transcript	Semi-structured Interview	List of issues Street identification
Field Observation	Photographs Street element positions	Field Diary Photography	Street map Street elements list
Participant Observation	Video recording Markings on map	Videography	Journey map Barrier map
Post-Observational Survey	Sensory cues Markings on map	Semi-structured Interview	Sensory landmark map

3.1. Exploratory Survey

The interviews and discussion were conducted in the language of Malayalam, for the contextual understanding of the scenario. The interview transcript was then converted into English for the purpose of analysis. The semi-structured interview was conducted separately with 5 persons with severe visual impairments. Data collected from interviews is analyzed and grouped under the headings of Challenges faced during street navigation, General street behaviors, Assistive technology used, and Navigation techniques used.

Table 2. Overview of the exploratory survey

Challenges faced during street navigation	General Street Behaviour	Assistive Technologies used	Navigation Techniques used
Footpaths not designed and maintained properly Electric post and its stay cable Trees and their roots Signboards (permanent & flexible) Illegal two-wheeler parking Unannounced maintenance Stones & potholes Lack of standardized tactile pavement designs	No formal training for urban street navigation First time walking on a newstreet always with a companion Navigate on a street by touching the side elements (hand or white cane) Mostly avoid footpaths and walk on the carriageway	Google TalkBack Where is my Train Lazarillo Be my eyes (rarely)	Mind map Non-visual cues Sensory landmarks

3.1.1. Street Identification

From the exploratory survey with the PVI regarding street navigation in Trivandrum city, a mostly used street was identified. The participant PVIs highly use this street as part of their daily commute to the organization (National Association for the Blind Kerala), where they learn computer courses and other supporting activities. The 70m stretch of Charachira road, from Plamood Jn. to National Association for the Blind Kerala, is being used by almost all PVI associated with this association on all working days.

3.2. Field Observation

The first step of the second phase was field observation, where the selected street was studied using the tools of field diary and photography, to collect the data of street elements. The outcome of this stage is a base map and the list of street elements present. A base map was created, which showed the selected street where the study is taking place, the street elements present, and the immediate buildings that line the street. The street elements identified from field observation are electric transformers, metal grill drain covers, parked vehicles, signboards, metal posts, concrete posts, and footpaths. These are marked on the map and a legend is inserted to identify the positions.



Figure 1. Existing Street Elements in the Field: footpaths, compound walls, parked cars and two-wheelers, lamp posts (metal & concrete), sign boards, electric transformer, trees, and drain grill. Source: Author

3.3. Participant Observation

All the 5 participants were males, age varying from 28 years to 65 years. Each participant was asked to walk from the nearby junction to the NAB building after confirming verbally that this is the route they take every day while coming to the association. They were told that their action would be video graphed and photographed for the purpose of study. Participant observation revealed the path taken by each participant to reach the

destination, and the issues and barriers they faced. These were noted and were used to generate questions for the post-observational interview. The outcome of this stage was a list of barriers, PVI journey map, and a barrier map.

Table 3. List of participants

Sl. No.	Name	Age	Gender	Degree of Blindness	Age of Blindness
1	P1	40	Male	Totally Blind	From Birth
2	P2	65	Male	Totally Blind	From Birth
3	P3	48	Male	Totally Blind	From Birth
4	P4	39	Male	Totally Blind	From Birth
5	P5	28	Male	Totally Blind	From age 21

3.4. Post-Observation Interview

Post-observation interview was aimed at understanding the reasons for the decisions taken and issues faced by the PVI during street journey. The tool used was a semi-structured interview, with questions generated from the observed pattern of individual journeys. The interview was conducted separately with each participant based on their specific street journey. The responses were noted and later added to the already generated journey map as an additional layer. The result was a sensory landmark map.

4. Results

This part of the paper presents the results of the two-phase study conducted among 5 totally blind males in a Tier 2 Indian city of Thiruvananthapuram. The major outcomes are (a) a cognitive map of PVI street navigation and (b) a list of challenges faced by PVI in an Indian street.

4.1. Cognitive Map

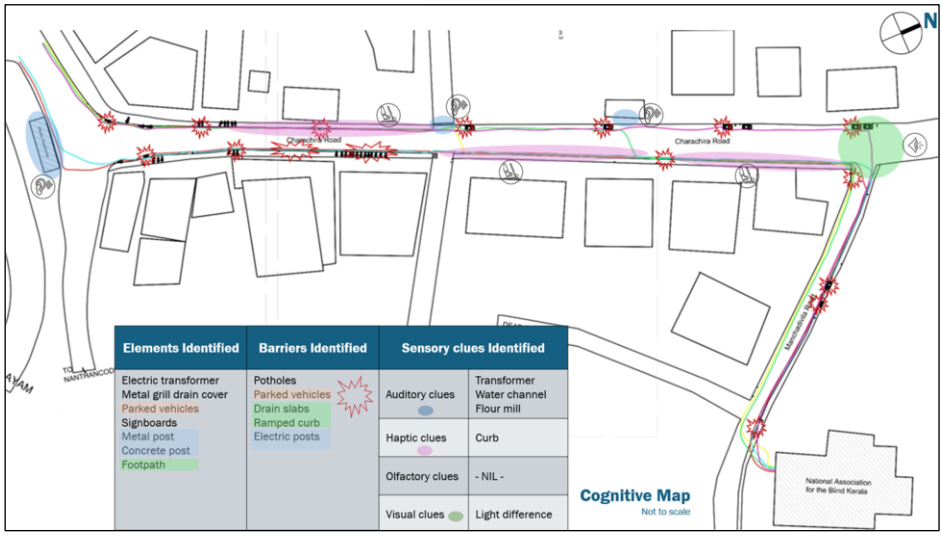


Figure 2. Cognitive Map Showing Journey Route, Street elements, Barriers, and Sensory Landmarks. Source: Author

Once all three stages of the study were done, a final cognitive map was generated overlapping all the four maps (base map, journey map, barrier map, and sensory landmark map) generated at various stages. This cognitive map contains all the collected data and shows the analysis of PVI street journey. This is an attempt to visually represent the combined cognitive maps of all 5 PVIs while navigating on the street. All the information represented in this map is either directly observed by the researcher or analyzed from the interaction with the PVI after the observation survey. This way of representing the cognitive map of PVI navigating a street can bring in new understanding in terms of the interaction between PVI and street elements.

4.2. Challenges Faced by PVI in an Indian Street

It was noticed that the challenges and issues mentioned by the participants in the initial exploratory phase were validated during the second phase. There was a lack of continuous footpaths in the street and insufficient width, where it was present. As the participant PVIs were already aware of the dangers of footpaths, it was seen that they avoided walking on the footpath and were walking on the carriageway. This itself presented a greater danger of motor accidents as the road was narrow with an average width of 6.3m and two-way traffic. Furthermore, there were additional issues arising from potholes, curb ramps that do not conform to standards, and unauthorized parking. The list of challenges presented is strictly from this study with 5 participants.

Table 4. List of challenges

Category	Challenges
Footpaths not designed and maintained properly	Unavailability Insufficient width Misplaced/broken drain slabs Electric posts and its stay cables Trees and their roots Signboards Stones & potholes Unannounced maintenance
Carriageway not designed and maintained properly	Stones & potholes Unannounced maintenance Unscientific curb design Insufficient width
Unauthorized activities	Unauthorized parking Unauthorized permanent and flexible signboards and banners Shops encroachment into footpaths
Lack of standards	No standardization for tactile tile usage
Street elements failing to give multi-sensory cues	Street elements designed for visual cues

Most of the challenges faced by PVI during urban street navigation is based on the fact that the footpaths are not designed and maintained properly. The issues range from the limited width of the footpaths to the placement of different elements. Unscientific placement of electric posts and their stay cable create a major challenge to the free movement of PVI through the footpaths. The presence of large trees and their roots in the footpaths makes PVI movement difficult due to reduced width and undulated walking surface. The presence of signboards (both permanent and flexible) on the footpath creates a hindrance to PVI movement. Illegal two-wheeler parking happens on the footpaths in front of shops which creates problems for the PVI movement as they are

unpredictable and dangerous. Another major problem faced by PVI on footpaths is the unannounced maintenance happening and uncovered drains and holes on the footpath after maintenance. Stones and potholes on footpaths and roads also create problems for the free navigation of PVI.

PVI also faces challenges during street navigation due to the non-cooperation of sighted people. Even though most of the time they receive help from sighted people, there are times when they have bad experiences from society. This includes non-cooperation during road crossing, reading bus boards, giving seats in bus, etc. Sometimes the drivers are not concerned with white cane users and overrun and destroy the white cane.

5. Discussion

The outcomes present a better understanding of how PVI navigates a Tier 2 Indian city street. The visual cognitive map generated is a novel attempt to plot the various aspects and parameters influencing and affecting PVI street navigation. The three layers in the map; the street elements, barriers, and sensory cues, when purged together, create a unique understanding of the complex interrelationship between each other. The complex character of this interrelationship arises primarily from the challenges resulting from a lack of investment and poorer maintenance of infrastructure in a tier 2 city of a low and middle-income country. This has been reported in the limited research on the topic done in the Indian context (3). The lack of contextual field-based studies pertaining to PVI street navigation is reflected in the existing street design standards in the country. In most of the manuals, provision for PVI navigation is limited to a suggestion to use tactile tiles in the footpaths (16)(17)(18)(19)(20)(21). But there are no suggestions as to what type of tile to be used in which situation and what are the design criteria to use these. There is a possibility of using the cognitive mapping technique suggested in this study for designing better inclusive streets.

Even though the externalization and visual representation of a PVI cognitive map is questionable in terms of its accuracy, it can help the researchers and designers to communicate and illustrate the performance of street elements during PVI navigation to policymakers and government organizations. The reliability of the suggested method lies in the fact that all the information represented in the map is collected and confirmed in a two-step verification method. The observed interaction between the PVI and the street elements, whether it being a barrier or a facilitator, is discussed with the PVI in detail in the post-observation interview. This gives a better understanding of how these elements are influencing PVI street navigation.

6. Future Research

This study presents a methodology that can be used to study the complex interrelationship between PVI and the street environment, in an Indian city. The cognitive mapping tool suggested can be used to understand and analyze the complex nature of this interaction between the street elements, barriers, and sensory cues, in any Indian street. After the analysis, a contextually better-designed street can be represented through a suggested cognitive map, the aim of which will be to reduce and avoid barriers and use street elements to create a multi-sensory urban environment usable by PVI. The

resulting street environment can enhance the experience of all users in terms of ease of navigation, infrastructure, and aesthetics.

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Universal Design and Transport

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Cost-Benefit Appraisal of Universal Design in Public Transport and Walking/Cycling Infrastructure

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Abstract. Public budgets are limited and priorities must be made between competing projects. Cost-benefit analysis (CBA) is the standard tool to assess projects and prioritise between them, as is done, e.g., in national transport plans.

Universal design (UD) is typically a legal requirement in new investments and their benefits and contribution in CBA have usually not received much attention. Therefore, there is a risk that benefits are underestimated in projects that include UD elements and that these projects are subsequently ranked lower than what they ought to according to CBA performance.

In this paper, we develop a user-friendly methodology for CBA of UD projects in public transport and walk/cycle infrastructure which aligns with national handbooks and guidelines for project appraisal. It contains five core elements:
1. User benefit. User benefit stems from valuation studies and are summarized and discounted over an assessment period, which in Norway is 40 years. This includes annual real price adjustments and the use of a discount rate according to guidelines.
2. Non-user effects. The degree to which UD projects affect other travellers, this (dis)benefit is accounted for.
3. Costs. Budget costs include investment and possible reinvestment at the end of economic life and annual operation and maintenance costs. These are summarized and discounted over the analysis period. Residual value after 40 years is subtracted.
4. Demand. Increases in walking and cycling have health benefits. Moreover, demand diverted from motorized transport and car to public transport, walking and cycling will affect external costs of road congestion, emissions, and accidents.
5. Shadow prices. According to Norwegian practice, the use of public funds has an inefficiency cost. Therefore, we add a shadow price on money from the public purse.

With worked examples, we demonstrate that UD projects in transport are indeed available for CBA appraisal. What is more, they compete surprisingly well with alternative uses of public budgets. In fact, UD projects outperform most other transport projects in Norway when considering their cost-benefit performance. Money spent on UD gives more welfare back to society than most other uses within the transport sector. This means that UD need not only be a legal requirement in new installations. UD can also compete with, and be prioritized over, other transport investments and projects.

Keywords. Transport, appraisal, cost-benefit analysis, universal design, accessibility

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1. Introduction

Public budgets are limited and therefore, projects must be prioritized. In transportation, the standard approach to prioritize between projects is a welfare analysis which considers benefits in light of the project's costs; a cost-benefit analysis (CBA) appraisal.

Assessments of universal design (UD) projects do not usually follow this logic but are instead considered a statutory requirement to allow for accessibility for all in new or upgraded services, developments and installations. Although being legal requirements, the implementation of UD projects is curtailed by budget availabilities. Accessibility benefits, in particular for those with impairments, are therefore usually not accounted for in CBA [1]. This way, economic benefits from UD projects (or projects which include UD elements) are systematically underestimated or ignored in project appraisal. Attempts to include accessibility benefits of UD projects can result in the treatment of UD effects as merely time gains, as done in the UK [2].

However, there are reasons to believe that UD projects in public transport (PT) and in transport in general provide benefits over and above time gains [3]. Examples include visible and audible travel information, bus stop amenities, smooth driving style, and cycle/walk facilities to reach stops/stations. What is more, Fearnley et al. [3] made an interesting and important observation: UD was not merely regarded as helpful for people with special needs; a majority of PT passengers do in fact regard UD as quality-enhancing for all. This finding was echoed in an updated 2018 study [4].

When the benefits of UD projects are not limited to specific groups but accrue to all passengers as well as all cyclists/pedestrians benefitting from UD upgraded facilities, it follows that these effects should be included in CBA and prioritization. Two main prerequisites are necessary in this respect: a quantification of user benefit of UD projects, and a methodology for incorporating UD projects and their effects in regular CBA. The former, user benefit or *willingness to pay*, of UD projects, was recently documented as part of the Norwegian national valuation study and is reported in Veisten et al. [4]; [5]. The latter, to develop a CBA framework for economic appraisal of UD projects, is the purpose of this paper.

Following in-depth interviews with practitioners and policy makers, it is evident that two main considerations are important when developing a framework for CBA appraisal of UD projects [6]: 1) it must be user-friendly because UD projects are usually decided at a lower organizational level where competence may be weaker, and with lower budgets for assessments; and 2) it must adhere to government CBA handbooks and guidelines such that results can fed into ongoing appraisals and be compared with competing (non UD) projects.

The remainder of this paper is organised such that Section 2 describes CBA methodology for summarising and discounting benefits and costs into decision and prioritisation criteria. Section 3 shows how this is implemented in an online tool and how it can be applied. Section 4 concludes the paper.

2. A simplified and user-friendly tool for CBA in a Norwegian context

Cost-benefit analysis is a theoretical test for whether 'winners' can compensate 'losers' and still be better off or the reverse, whether 'losers' can bribe 'winners' to restrain from the project. In practice, CBA is a test for whether social benefits exceed social and budgetary costs. A project's net present value (NPV) exceeds zero when that is the case.

The benefit-cost ratio (B/C ratio) tells how much welfare society gains per currency unit of project costs. CBA has a long tradition in transport. Transport appraisal is not necessarily confined to CBA, but CBA is an important part of the impact assessment and central to prioritisation between projects that compete for the same budgets. Hence, for example, projects in the Norwegian National Transport Plan (NTP) are routinely subjected to CBA.

The following sub-sections detail key aspects of CBA *code of conduct* as described by the Norwegian Public Roads Administration and how this is implemented in a simplified CBA tool for UD measures.

2.1. Benefits

In general, benefits from UD projects stem from two main sources. The first is the benefit of the UD item itself, e.g. of improved comfort, information, ease of access, or good lighting. The second is often a biproduct of UD, but one which has high social value: time savings. Time savings may occur, e.g., when bus boarding and alighting goes quicker, or infrastructure improvements enable faster waling and cycling. In PT, such time savings accrue to all passengers on board and not only to those who board or alight the vehicle and, importantly, they accrue to the operator, whose time value can be substantial. UD projects can also produce disbenefits, e.g. time loss for car users if a bus bay is replaced by a curb stop or bus bulb.

The social value of benefits is by standards measured as *willingness to pay* (WTP), which expresses user benefit (or utility) in monetary terms. WTP for use in our CBA tools has various sources. Where sources are from different years, they have been adjusted to common values according to a combination of the consumer price index (CPI) and a real price adjustment. Table 1 presents some values of relevance for UD projects.

Annual benefit, B_{annual}, equals the sum of $\sum Q_j * WTP_i$ where Q is the number of passengers or operator-minutes or person-km, WTP_i is the sum of benefit for all relevant UD measures including travel time, and j is either user, non-user or operator. Next, we must summarise and discount benefits over an analysis period of 40 years, which is the norm in Norwegian appraisal. This is done by combining the discount rate, r, which is currently 4% in Norway and an annual growth rate, g, due to expected increase in gross national product (a proxy for wealth increase), which is set to 0.9%, as done this way:

$$d = \frac{r-g}{1+g} = 3.07\%. \quad (1)$$

We use the following formulae to factor up B_{annual} into the net present value of benefits over a given analysis period, B_{NPV}:

$$B_{NPV} = B_{annual} * \text{Annuity}_{growth} = B_{annual} \frac{1}{d}\left(1 - \frac{1}{(1+d)^t}\right) = B_{annual} * 22.8468 \quad (2)$$

Where t is the analysis period, which is 40 years in Norway.

Table 1. Values for calculation of user and operator benefit, in EUR assuming NOK10 = EUR 1. 2019 prices. Sources: Flügel et al. [7] for travel time; Veisten et al. [4] for UD benefits; and Fearnley and Killi [8] for operator costs.

UD measure	Unit	Value, € in 2019 prices
Travel time PT	€ per minute per passenger	0.129
Travel time walk	€ per minute per person	0.288
Travel time cycle	€ per minute per person	0.193
Travel time car	€ per minute per passenger	0.246
PT operator cost	€ per minute	0.781
Seating at stop/station	€ per passenger	0.399
Shelter at stop/station without seating	€ per passenger	0.787
Shelter at stop/station with seating	€ per passenger	1.008
Removal of ice and snow at stop/station	€ per passenger	1.267
Electronic signs on board showing next stop	€ per passenger	0.505
Audible next stop information on board	€ per passenger	0.352
Lighting at stop/station	€ per passenger	0.693
Low floor entry adjusted to kerb	€ per passenger	0.217
Walk/bike path during winter: from 'often slippery' to 'almost always good traction'.	€ per person-km	0.316
Walk/bike path standard: from 'larger potholes and puddles' to 'no potholes'	€ per person-km	0.159
Walk/bike path: from no lighting to good modern lighting	€ per person-km	0.271

2.2. Costs

A project's costs can be split between investment cost and annual maintenance and repair costs. The investment happens in year zero. Depending on the investment's economic life, reinvestments may be necessary during the 40-year analysis period. So, if a bus shelter has an economic life of 15 years, it must be invested in year 0 and then reinvested in years 15 and 30. In year 40 its residual value is 5/15 of its investment cost. This shall be subtracted from the cost estimates (residual value can also be treated as 'residual benefit' of a project at the end of the analysis period). The net present value of investment costs *minus* residual value, C_{iNPV}, is calculated as

$$C_{iNPV} = -C\frac{1-(1+r)^{-nm}}{1-(1+r)^{-n}} - C\ \frac{40-nm}{n} * \frac{1}{(1+r)^{40}} \tag{3}$$

Where n is the installation's economic life, and m is the largest integer which satisfies $(m-1)n \leq 40$. Details of how the equation is developed can be found in Odeck et al. [9]

We assume that an annual cost, C_a, accrues every year during the analysis period. If, for example, the UD project is a bus shelter, the annual costs would include maintenance, cleaning, and so on. Note that some UD projects, like snow and ice removal, may only incur annual costs and no investment cost. The net present value of annual costs, C_{aNPV}, is given by:

$$C_{aNPV} = -C_a * \frac{1}{r}\left[1 - \frac{1}{(1+r)^t}\right] = -C_a * 19.7928, \tag{4}$$

when t=40 and d=4%.

2.3. External effects and shadow prices

Improvements in walking and cycling facilities give rise to societal benefits that the average pedestrian or cyclist don't take into account. For one, accident risk reductions mean that health costs and sick leave are reduced. Additionally, when these UD projects increase walking and cycling, there are two main sources of benefits to society. One is improvements in public health to those new pedestrians and cyclists who switch from car and PT. The other is related to reduced car use with its associated social costs of congestion, noise, emissions, etc.

Regarding UD improvements in PT, we disregard demand effects and change in modal share. The main reason for this is that the evidence does not justify their inclusion. Fearnley et al. [10] showed that demand effects of quality improvements, beyond travel time and travel cost reductions, in PT are difficult to measure and observe and that scientific evidence suggests that we treat demand effects as zero.

The use of public funds poses an efficiency loss to society since taxation distorts prices. This *shadow cost* is standardized to be 20 percent of public budget costs of a projects. A project's budgetary costs is therefore multiplied by a factor of 1.2. If, however, the public funds stem from a source which does not distort the economy, this shadow price does not apply. This is the case if public funds come from road tolls, which internalize the external costs of congestion. The inclusion of UD benefits might also correct distorted markets and distorted price information, such that the efficiency loss for society is not obvious, cf. [11].

2.4. Criteria for efficiency improvement and ranking

A UD project's net present value summarises the project's benefit elements from equation (2) and costs from equations (3) and (4), multiplied by the shadow price factor:

$$\mathrm{NPV} = B_{\mathrm{NPV}} + 1.2^{*}(C_{\mathrm{iNPV}} + C_{\mathrm{aNPV}}) \tag{5}$$

If net benefits exceed a project's budget costs multiplied by the shadow price factor, NPV>0, and the project improves social welfare, or economic efficiency.

In theory, every project whose NPV is positive should be implemented. In practice, however, budgets are limited, and projects must be prioritized.

To rank projects, net present value per unit of budget is the best indicator of the amount of welfare gain a project gives per dollar spent on that project – much like dividend on an investment. All else equal, projects which produce the most welfare gain per unit of budget expenditure (i.e. the highest benefit-cost ratio) should be given highest priority. The benefit/cost ratio, B/C, is defined as NPV over budget costs:

$$\mathrm{B/C} = \frac{\mathrm{NPV}}{(C_{\mathrm{iNPV}} + C_{\mathrm{aNPV}})}. \tag{6}$$

This way, a B/C ratio of, say, 0.8 means that society enjoys 0.8 dollars' worth of welfare gain per dollar spent on the UD project *in addition* to the one dollar spent. Defined this way, a B/C ratio above zero means that a project improves social welfare.

The criterion for a welfare improving project is therefore: NPV/C > 0.[2] However, for ranking purposes, the project with the highest NPV/C should be given highest priority – provided NPV/C > 0 – since higher B/C ratios mean that society enjoys more social welfare relative to budgetary costs.

3. Application: online CBA tools for UD measures in public transport and walk/cycle infrastructure

All the above has been implemented in two online CBA tools, the "Public transport calculator" on https://www.toi.no/kollektivkalkulator and the "Cycling and walking infrastructure calculator" on https://www.toi.no/GS-driftskalkulator. Since many of the assumptions are standardized (e.g. projects' economic life and demand effects) and since benefits are proportional to the number of affected travellers, a cost-benefit analysis can be performed with a minimum of local input data. In many instances, budget costs and annual number of passengers are sufficient input to perform the analysis for the PT calculator. For the C/W calculator, necessary input includes the annual number of cyclists and pedestrians, the road length, and type of area (urban/rural).

Figure 1 shows a screenshot of CBA of bus shelter with seating from the PT calculator. The required local input data (shaded boxes filled in with dummy numbers) are installation cost, annual cost and annual number of passengers that benefit from this bus shelter. The analysis shows passenger benefit (NOK 2265583), benefits to others (NOK 0), benefits to the operator (NOK 0) over a 40-year analysis period. Next, costs over the analysis period (NOK 1639522) and shadow price on public funds (NOK 327904) are added. The project's net present value, NPV, is NOK 298156) and the benefit/cost ratio is 0.18. The conclusion is that this project is welfare-improving, i.e. benefits exceed costs. For every NOK spent on this project, society gains NOK 0.18.

Figure 2 is a translated screenshot of the cycling and walking calculator with the example of lighting. Here, we assume an improvement from no lighting to LED lighting on a 2 km path in a medium urban area and with 15,000 annual pedestrians and the sme number of cyclists. The welfare analysis shows various sources of benefits. Accident benefits are negative, which reflect higher accident risk for walking and cycling relative to car, PT and not travel. The net present value is positive and so is the B/C ratio.

Even if the CBA tools don't require much input data, lack of data or inaccurate data may still be a problem for the user. Therefore, the CBA tools include visual illustrations to help the analyst in judging a project's CBA performance. Figure 3 is based on the same example as in figure 1 and shows two graphs. The one to the left holds cost data constant and lets the project's NPV differ with passenger numbers. NPV is positive when annual passenger number exceeds 8684. The other, to the right, holds passenger numbers constant and lets the project's NPV differ with investment costs. The project's NPV is positive as long as investment costs are below approximately NOK 550000.

[2] This is identical to other countries' benefit cost ratio decision criterion of >1; the difference is only related to whether costs are included in the numerator.

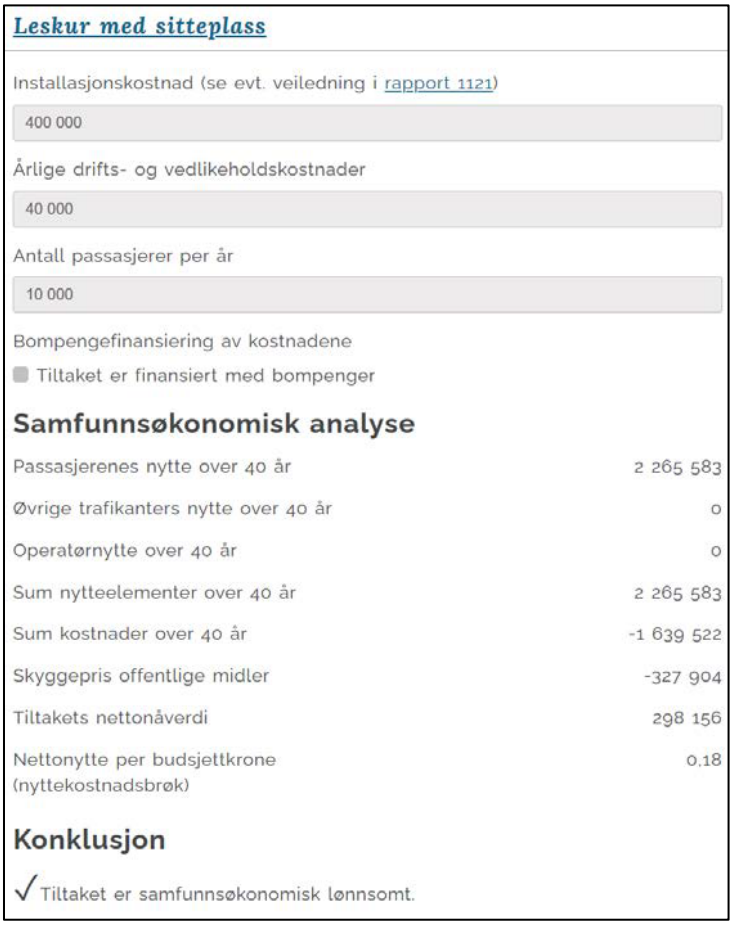


Figure 1. Screenshot of online PT calculator CBA tool. Source https://www.toi.no/kollektivkalkulator/#holdeplasser

Figure 4 shows how NPV of different UD measures on public transport stops/stations depend on the annual passenger number, i.e. the number of passengers who use that stop/station. *Ice and snow removal* is clearly the most welfare-increasing UD policy measure. Its NPV is positive even with well under 5,000 passengers per year (note that in this case, the relevant passenger number is those who benefit from the UD measure, i.e. those using the stop/station during winter conditions) and increases sharply with passenger numbers. NPV for *seating at bus stop* is positive at around 5,000 annual users – or 14 per day. Compared with seating at bus stop, the benefit of *shelter with seating* is higher per passenger but requires more passengers for NPV to be positive because the installation cost is higher: 8,684 per year as already shown in figure 2.

Lighting
Level
⦿ From no lighting to LED lighting
○ From Fra high-pressure sodium lighting to LED lighting
○ From no lighting to high-pressure sodium lighting

Location
○ Larger urban area (> 100 000 inhabitants)
⦿ Medium urban area (15 000 - 100 000 inhabitants)
○ Sparsely populated area

2.0	Road length in kilometer
15 000	No. of cyclists per year who benefit from the improvement
15 000	No. of pedestrians per year who benefit from the improvement

Welfare analysis over 40 year

Benefit to cyclists	2 207 817
Benefit to pedestrians	3 062 709
Benefit to other travelers	9 652
Public health benefit	1 901 920
Accident benefit	-9 427
Other external effects	24 100
Sum benefits	7 196 771
Sum costs	-3 931 201
Shadow price on public funds	-786 240
Net present value	2 479 330
B/C ratio	0.63

Conclusion ✓ The project is welfare improving

Figure 2. Translated screenshot from online Cycling and walking CBA calculator. Source https://www.toi.no/GS-driftskalkulator.

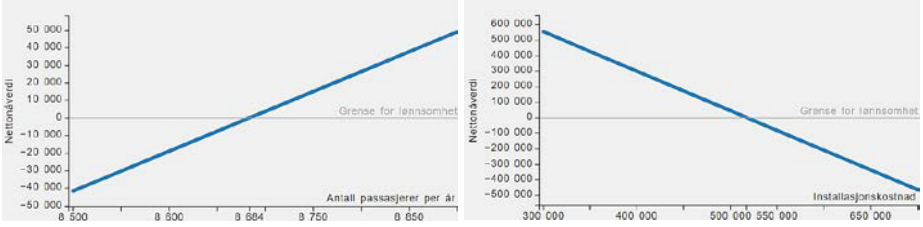


Figure 3. Screenshot of online CBA tool's graphs. Source https://www.toi.no/kollektivkalkulator/#holdeplasser

Similar exercises can be done with the online CBA tools for a host of UD measures, including: high kerbstone at a bus stop for step-free boarding and alighting, visual and audible next stop information on board, audible information about service disruptions at stops and stations, clear route number and destination signs on bus exterior, lighting at stop/station/walk path/cycle path, emergency phone on stop/station, safety personnel, on board cleaning (e.g. for people with allergies), and ice, snow and autumn leaves removal.

A striking result for all these UD measures is that their NPVs are often positive even with fairly small number of passengers and users. Compared with other –large – projects in the transport sector, e.g. Norway's National transport plan [12], it is evident that UD measures are quite unique in that respect: in fact, a large share of all NTP project produces *negative* NPVs. Although all inputs to a CBA include uncertainty, in addition to the possibility of omitted benefits or disbenefits, economic efficiency gains and social welfare gains would easily be made if UD projects were to replace some of the current NTP projects.

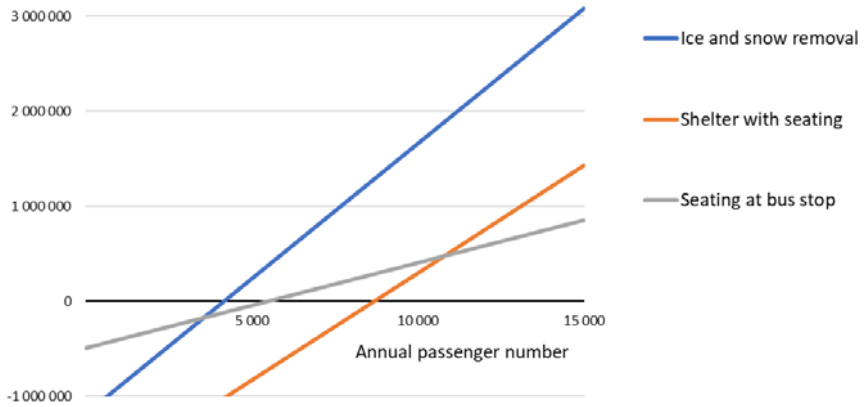


Figure 4. Net present values of UD projects at public transport stops/stations, by annual passenger number.

4. Conclusions

Universal design (UD) in public transport (PT) provides benefits – to all passengers – over and above any time gains of improved accessibility. Hence, UD improves PT's attractiveness vis-à-vis the car.

We have developed a framework for inclusion of UD projects in cost-benefit analysis (CBA), which aligns with national CBA handbooks. This framework is implemented in two online tools, the *Public transport calculator* and the *Cycling and walking infrastructure calculator*, which facilitate CBA analysis with a minimum of data and skill requirement.

With worked examples we have shown that UD projects perform very well in project appraisal compared with most other alternative uses of public budgets in the transport sector. There is an additional issue of sequencing of UD projects, that the valuation of a specific UD element is affected by how many UD projects are already implemented [4]; [5]. However, UD projects can compete for the same budgets as other PT projects like service frequency improvements, or even other transport projects like road investment.

With this evidence, UD can be given a more prominent role in transport policy and investments, world-wide. UD measures need not be restricted to statutory requirements for new or improved projects. UD can also compete for scarce public budgets since they might very well outperform other transport investments. Once the benefits of UD measures are quantified as *willingness to pay* (WTP), a full CBA may require only two main inputs: passenger numbers and a cost estimate. For other countries to follow suit, WTPs and CBA framework should be elaborated locally and according to national principles.

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Quantifying Benefits of Universal Design in Public Transport

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Abstract. Universal design (UD) relates to many aspects of public transport (PT), comprising the vehicles/wagons, stops/stations, and access/egress to/from stops. While some UD elements are decisive for relatively few, others enhance the overall PT quality and subsequently improve the well-being of many users. If the service quality is improved, some users will be willing to pay more, either in terms of ticket price or travel time. Improved UD elements in PT therefore increase social benefits for public transport users, in economic terms, even if ticket costs are maintained unchanged.

PT users in Norway have been asked to choose between journey alternatives with varying levels of UD elements between the alternatives. These UD elements comprised: a) on-board facilities and driver quality; b) stop/station qualities: shelter, seating, safety, lighting, information; and c) the qualities of the area surrounding stops/stations: road surface quality / icing, lighting, facilities/amenities, information. In total, 25 UD qualities were assessed, in addition to travel time. Fare was one of the varying elements in the journey alternatives, enabling estimation of willingness to pay (WTP) for UD quality improvements. The WTP yields benefit estimates of improvements that can be assessed against the costs of upgrading, maintaining, and running these UD-related elements in PT.

More than 2000 respondents participated in our web-based survey. Almost one in five reported special needs when travelling by PT. Comparing those reporting special needs against those not reporting needs/difficulties, we find that their WTP is similar for most UD qualities, but WTP differs on some particular UD elements. Those reporting needs/difficulties show higher WTP for improved cleaning and air quality on board, and for benches and highly visible real-time departure info at stops/stations. All PT users have high WTP for improved access, without detours, to stops/stations, that have shelter and de-iced road surface. Overall, our findings provide a case for increased focus on UD in economic assessments of PT.

Keywords. Stated choices, willingness to pay, web-based survey, special needs

1. Introduction

What is the economic value of a universal design (UD) improvement in public transport (PT)? The question is important because most public investments in the transport sector in countries like Norway need to demonstrate their economic benefits. Travel time savings typically make up the brunt of expected benefits in PT investments. However,

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UD-related improvements also provide economic benefits that can be quantified and may be substantial [1][2].

In this paper, we report from a survey of PT passengers, asking them to choose between PT trips that differed in the levels of UD-related factors, as well as in travel time and ticket cost. The analysis of these hypothetical stated choices, a discrete choice experiment (DCE), yields money estimates of the UD factor improvements. The work leading to this paper was part of a large national valuation study in Norway [3][4]. We compare the valuation of UD factors in a sub-group reporting special needs or difficulties in PT against the valuation in the sub-group not reporting difficulties.

2. Appreciation of UD in PT

We follow an extensive approach to UD, e.g., as defined by the UN [5]:

> "*Universal design" means the design of products, environments, programmes and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design. "Universal design" shall not exclude assistive devices for particular groups of persons with disabilities where this is needed.*" (CPRD, Article 2, last paragraph)

Various factors in PT might contribute to the usability for the greatest extent possible. Some well-known UD-related factors, like low-floor vehicles and step-free platforms/stops have been assessed economically and are now implemented as recommended standard in Norwegian cities [2][6]. But UD encompasses the design and facilities that affect the entire PT trip, including access/egress as well as various features of the stations/stops [7][8][9]. A broad approach to UD will encompass PT accessibility for individuals in challenging life phases or psychosocial challenges [10][11].

The literature on the economic valuation of UD-related factors in PT, using the UD term, is still relatively scarce [12]. In addition to a former Norwegian study applying stated choices [2], a study from Chile applied similar methodology [13]; they asked their respondents to choose between bus trips that were described by (varying levels of) audio-visual information at stops, elevation of stops, and bus access ramps, in addition to travel time; finding that those reporting reduced mobility indicated twice as high valuation of improved levels of the UD-related attributes compared to those not reporting reduced mobility [13]. There exist other studies, not necessarily under the UD umbrella, applying DCE to value PT service quality, e.g., on-board services like air quality, temperature and driver quality [14][15], or real-time information at stops [16]; and other factors [17] [18].

While DCE is about choices between alternatives specified by their attribute levels, other studies have applied contingent valuation, a stated preference method based on asking about payment or acceptance to pay a given amount [19]. E.g., in a study from South Korea, it was found that PT users were willing to pay increased tax for an installation of vertical/horizontal moving-assistant systems [20]. Similar access facilities were valued in the UK [21]. Others have assessed economic benefits of improved PT access or other UD-related factors, not applying stated preference methods. One study calculated user benefits from boarding/alighting time reduction, together with estimated cost reductions for service suppliers [22]. Demand-increasing impacts from improving the levels of UD-related factors have also been estimated, deriving monetised benefits based on demand shifts and the generalised cost of transportation [23][24].

3. Economic valuation of UD-related factors in Norwegian PT

3.1. UD attributes in discrete choice experiments

Our selection of UD attributes for economic valuation was guided by representatives of the Norwegian Public Roads Administration and the National Railway Directorate [4]. We specified a common three-level attribute description: a lowest level, a medium level, and a highest level. For many of the UD attributes these three levels could be denoted as "none", "limited (partial)", and "extensive (almost complete)", but for others a more specific denotation was necessary.

Table 1 lists the 25 UD attributes that were included in our study. These were presented and valued for three separate sub-samples (x, y, z), with eight attributes per sub-sample (with one additional attribute in the x sub-sample). Before the economic valuation, the respondents were asked to indicate what level of the eight UD-related qualities best described their last PT trip. The survey questions were adapted to the respondents' indicated mode, e.g., such that those reporting PT trip by train/metro faced descriptions/questions including the terms "station"/"platform", while those reporting PT trips by bus/tram faced descriptions/questions including the term "stop".

There is supposedly variation across these 25 PT attributes in terms of their importance for UD; and their importance will depend on individual needs and possibly other features of the localities [7]-[11]. The first subset (DCE1), for all three sub-samples, relates to the stations/platforms or stops. The second either relates to the access/egress surrounding area (x-DCE2), on-board travel (y-DCE2), or to various elements of the door-to-door PT trip (z-DCE2). Increasing the level of the UD-related attributes might contribute to improved physical accessibility, safety and security, or more comfortable waiting/transit or travelling on board [7]-[11]. After the respondents reported the attribute level that best resembled their last personal PT experience, they were routed to the DCE, where they would face the same eight UD attributes.

Before the DCE, the respondents were also asked which PT mode was primary mode in their last PT trip. They were also asked to provide estimates of the travel time elements in their last PT trip; the time from origin to platform/stop (access time), the waiting time at the platform/stop, the in-vehicle time, etc. (and they were also asked whether there was any extraordinary delay on that PT trip). Those using season tickets (e.g., 30-day travel card) were asked about their average number of PT trips per month and if they could estimate their implied cost per trip; in an attempt of increasing the perception of trip cost change for those using season tickets.

3.2. Survey data

The sample was partly based on on-board intercepts in Oslo and Trondheim (~60%) and use of a national (postal) e-mail registry (~40%); respondents from both recruitment sources responded to the same web-survey [4]. They were asked to apply their last PT trip as a reference. There was about 25% each reporting metro and train as primary mode, while about 10% reported tram and 40% bus.

Table 1. 25 UD attributes valued in six discrete choice experiments (DCE), in three sub-samples (x, y, z).

Sub-sample	Quality attribute	Lowest attribute level	Medium attribute level	Highest attribute level
x - DCE1: rail/metro station platform / bus/tram stop	*Shelter*	no shelter	small shelter (w/ back panel and roof) / small, roofed area at station platform	larger shelter (w/ back panel, side panels and roof) / mostly roofed station platform
	Bench(es)	no bench	small simple bench(es)	larger bench(es) w/ armrests
	Cleaning (stop/station)	poor (very often dirty/littered)	limited (sometimes dirty/littered)	extensive (almost always clean)
	Maintenance / repair	poor (station/stop decays, things are rarely repaired/replaced)	limited (damaged / worn out things get repaired/replaced after some weeks)	extensive (damaged / worn out things get repaired/replaced within a few days)
x - DCE2: road surface in access/egress area	*Road surface (smoothness)*	poor (larger cracks/holes)	limited (smaller cracks/holes)	extensive (no cracks/holes)
	Removal of gravel/sand	poor (remains for several weeks after snow melting)	limited (remains for about a week after snow melting)	extensive (road surface is mostly clean)
	Removal of leaves	poor (remains for several weeks)	limited (remains for about a week)	extensive (road surface is mostly clean)
	Lighting (access/egress)	none	dim light	bright light
	De-icing	poor (often slippery)	limited (sometimes slippery)	extensive (almost always good foothold)
y - DCE1: rail/metro station platform / bus/tram stop	*Access (& egress)*	larger detours (to reach platform/stop)	small detour (to reach platform/stop)	almost straight-line distance (to reach platform/stop)
	Bicycle parking	none	simple rack	lockable rack under roof
	Real time departure info	none	visible when on stop/platform	visible in distance from stop/platform
	Services / shops	none	kiosk adjacent to stop/platform	kiosk and café/shops adjacent to stop/platform
y - DCE2: on board	*Driving quality / smoothness*	poor (only a minority drives smoothly)	limited (approx. 50% drives smoothly)	extensive (almost everybody drives smoothly)
	Temperature regulation	poor	limited temperature regulation	extensive temperature regulation
	Air quality	poor	limited air quality regulation	extensive air quality regulation
	Cleaning (on board)	poor	limited	extensive
z - DCE1: rail/metro station platform / bus/tram stop	*View / observability*	hidden	partly hidden	open w/ view
	Camera surveillance / closed-circuit television (CCTV)	none	CCTV at platform / stop	CCTV at platform / stop and surrounding / entrance area
	Security guard access	none	phone no. on stop/platform	phone no. on stop/platform and emergency alarm button
	Lighting (stop/platform)	none	dim light	bright light
z - DCE2: rail/metro station platform / bus/tram stop	*Timetables / network info*	timetable for the stop / platform	timetable for the stop / platform and info about the specific route(s) / line(s)	timetable for the stop / platform and info about all route(s) / line(s)
	Local area info	none (no map)	map	map w/ info about paths / roads to various local destinations
	Phone charging facility	none	charging on board	charging on board and at platform / stop
	Phone app for defining special needs	none	limited (covers major PT interchanges and their surroundings)	extensive (covers all stations/stops in the PT network)

Note: In x-DCE1, in the course of the survey, the "removal of leaves" attribute was replaced by the "lighting (access/egress)" attribute, as it appeared that the level of removing leaves did not have any significant impact on choices.

We asked the respondents (after the DCEs) to indicate whether specific impairments or life phases or situational issues made it difficult to use PT. We listed the following: impaired vision, asthma/allergies, impaired hearing, mental health difficulties, mobility impairment, luggage/pram, problems in understanding route info / timetable. Those ticking at least one of these were entered in a sub-group of PT users stating special needs or difficulties.

In total, 2261 respondents provided answers that were applied for the DCE and UD-benefit estimations. For our comparison of the sub- group indicating difficulties in PT against those not indicating difficulties, we removed 44 respondents that ticked either "do not know / cannot answer" to the question about impairments or other issues that made it difficult to use PT. The remaining 2217 were fairly equally distributed between the three sub-samples (x, y, z), thus about 750 respondents in each. As every respondent faced six pairwise choices per DCE, and two DCEs, there are about 4500 choice observations per DCE and about 27,000 choice observations from all six DCEs.

3.3. Stated choice method

As indicated, DCE is a stated preference method that is based on showing survey respondents alternatives with (varying) attribute levels and asking them to choose the alternative they consider the best [19]. In our study, respondents were shown pairwise alternatives with four UD quality attributes plus travel time and ticket cost. An example of how a pairwise choice between PT alternatives was presented, in the first DCE for sub-sample x (x-DCE1), is displayed in Figure 1 (with metro/train as PT reference).

Please choose …

	Alternative A	Alternative B
Shelter	no shelter	mostly roofed station platform
Benches	small simple benches	small simple benches
Cleaning of station	almost always clean	very often dirty/littered
Maintenance / repair	damaged / worn out things get repaired/replaced after some weeks	damaged / worn out things get repaired/replaced within a few days
Waiting time (at platform)	7 minutes	4 minutes
Ticket cost (per trip)	27 kroner	30 kroner
	Alternative A	Alternative B

Figure 1. Example of a pairwise choice task, within x-DCE1; 1 krone (NOK) ≈ 0.1 EUR

In the intro to the DCE, the respondent was told to consider a similar PT trip as the one reported (e.g., a commuting trip), but that they would be able to choose between alternatives that differed in some quality properties (four UD-related factors per DCE), as well as the travel time. In addition, we varied the context, e.g., whether the platform/stop situation was when waiting for the PT et the start of the PT trip, or, if relevant, in the interchange between two or more PT legs. The DCE intro specified the

reported purpose of the reference PT trip. After the first DCE, with six pairwise choices, they passed directly on to similar intro to the second DCE, with six more choices.

As shown in Table 1, all UD attributes had three specified quality levels. Travel time and travel cost were given a reference level based on the respondents' stated reference level, with two lower ("better") levels and two higher ("worse") levels [3]. The six pairwise choices were randomly drawn from a pre-specified set of attribute-level combination blocks (adapted from a so-called Bradley-Terry design [25]).

The preference for each attribute is derived by logit model analyses of the choices. We applied a mixed logit model (MXL) that allows for a distribution of the attribute preference parameters [26], but the travel cost parameter was fixed. Dividing the coefficient of a UD attribute by the travel cost coefficient yields a WTP estimate for a unit of improvement. We estimated a common MXL for all choices, comprising 6×2 choices per respondent, for three respondent groups (x, y, z). The UD attributes were specified as three-level attributes, thus coefficients and WTP are estimated for the change from the lowest level to the mid-level, as well as for the change from the mid-level to the highest (or, from highest to mid-level, setting the latter fixed). In total the MXL estimate 68 parameters; it was estimated for the sub-samples indicating difficulties in PT travel, for the sub-sample not indicating such difficulties, and for the joint sample.

4. Results

About 20% of the respondents reported difficulties in travelling by PT, in our sample of PT users. About 1-2% ticked each of the specified categories, except for luggage/pram that was ticked by nearly 5%; and ~4% ticked "other"; 371 respondents, in total. We will present comparisons of this sub-group's valuation of UD attribute improvements against the sub-group not stating difficulties, the remaining 1846 (of the 2217) respondents.

The estimated WTP per UD attribute, summing the two steps between lowest and mid-level and between mid-level and highest, varies from €0 (removal of leaves) to nearly €1.80 per trip (cleaning on board). These endpoints in the WTP estimates for UD qualities stem from the sub-group indicating difficulties in PT travel.

Figure 2 shows WTP estimates as points in a diagram, points that show the WTP for the two sub-groups. The WTP estimates in the sub-group indicating difficulties are measured on the horizontal axis, while the WTP estimates in the sub-group not indicating difficulties are measured on the vertical axis. Points to the right of the diagonal line in the diagram indicate that the attribute level improvement was more highly valued by those with difficulties in PT travel. For many attributes the points are close to the diagonal line, i.e., WTP for the attribute improvement is equal across sub-groups. Preventing icing on/around stop/platforms in winter, access/egress without detours, shelter at stops/platforms and proper temperature regulation on board are relatively highly valued across sub-groups. A phone app that enables travel planning defining special needs obtained relatively low WTP and the point in the diagram is to the left of the diagonal access; the sub-group indicating difficulties in PT does not have higher WTP for this attribute (Figure 2).

Regarding travel time valuation, it was also found that the average value for 5 minutes travel time reduction was in the interval of about €0.45 to €0.70, depending on sub-group and travel time component. The valuation of access/egress and waiting time savings was somewhat lower in the sub-group indicating difficulties in travelling by PT, but the estimated valuation of (reduced) in-vehicle time was equal across sub-groups.

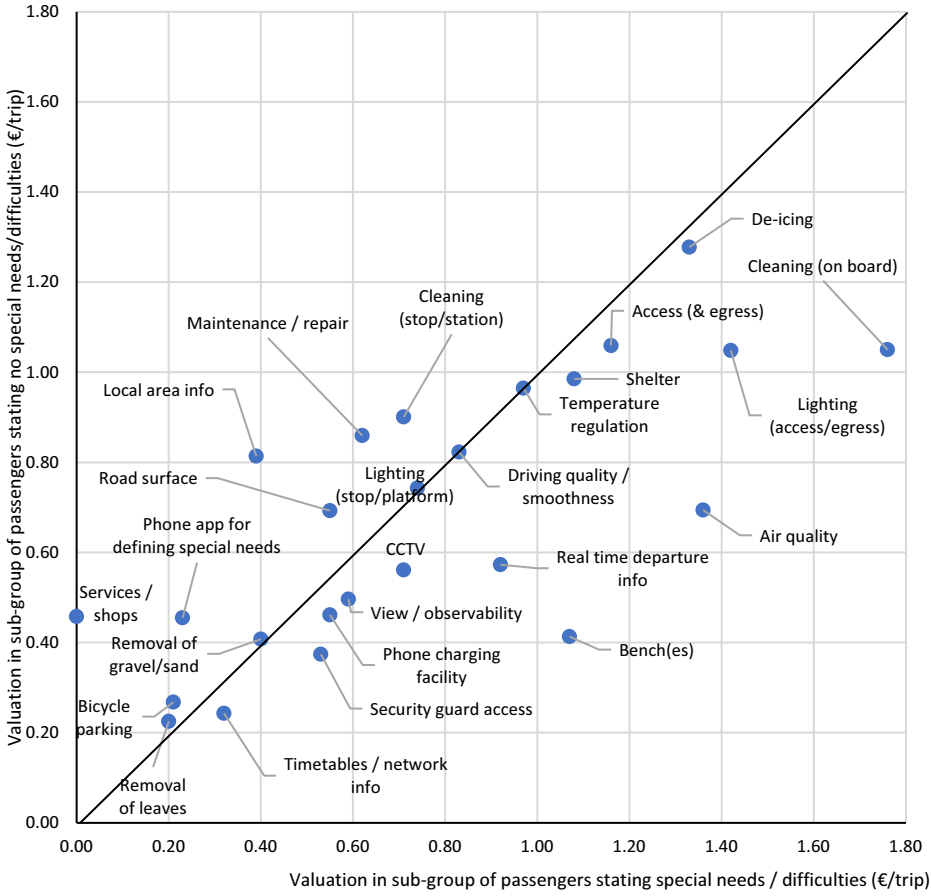


Figure 2. Derived valuations of factor improvements (€/trip) in sub-group w/ difficulties in PT (horizontal axis, n=4452, choices from 371 respondents) vs. sub-group not stating difficulties (vertical axis, n=22152, choices from 1846 respondents); WTP with respect to factor change from the lowest level (no facility or minimum quality) to the highest level.

We tested whether there is a statistically significant difference in choice pattern between the sub-group indicating difficulties versus those not indicating any difficulties in PT travel. We applied a likelihood ratio test to the MXL modelling that included all six DCEs. The test applies the log-likelihood values from the models of the two split sub-groups (lnL_{DIFFIC} and lnL_{NO_DIFFIC}) and the log-likelihood of the joint model including both sub-groups (lnL_{JOINT}): $Q=-2*(lnL_{JOINT}-(lnL_{DIFFIC}+lnL_{NO_DIFFIC}))$. Q is a chi-squared distributed test statistic with degrees of freedom (df) equal to the number of parameters in the model (including the constant). For the (upper tail) critical value of the chi square distribution, we apply $\alpha=.05$, such that $1-\alpha=.95$. For 68 df the critical value is 88.25. The test value, the estimated Q, is 96; thus, we can reject a null hypothesis of overall equality in choice behaviour (and subsequent valuation of UD attributes and time savings) between the sub-group stating difficulties and the sub-group not stating difficulties.

5. Discussion/Conclusions

We have presented economic valuations of a large set of UD-related factors in PT, covering much of the door-to-door PT trip. We have estimated WTP of UD improvements that are comparable in size to a valuation of about 5 minutes travel time savings. Our estimates are at the higher side compared to the international literature [18], but relatively close to estimates from a former Norwegian study [2]; and Norway has been among the countries with highest cost-of-living and income levels. The valuations of travel time savings are close to those reported in parallel Norwegian studies [3].

Comparing WTP estimates from the sub-group indicating special needs or difficulties when travelling by PT, against those not indicating difficulties, the first-mentioned show relatively stronger preference for higher cleaning and air quality levels on board, as well as for benches and highly visible real-time departure info at stops/stations. Relatively strong preference for such qualities were found in former DCE-based studies [14]-[16]; the additional WTP by those indicating difficulties in PT travel, in our study, was relatively limited compared to a similar comparative study [13]. However, our sub-group of PT users indicating difficulties was a very heterogeneous group, such that the sub-group average might mask underlying variation. Beyond that, our results confirm findings from former Norwegian studies, that most PT qualities that enhance UD are valued by all PT [1][2]. PT users in general valued improved access to stops/stations, avoiding slippery surfaces in winter, and have a shelter when waiting.

There is always a challenge that studies based on stated preference can yield overestimates due to the hypothetical survey framework [19]. We included questions and reminders to bring forward the travel cost impact, also for those travelling with season tickets. We could not link the UD attribute level change to the respondents' stated reference level, differently from the travel time and travel cost attributes. Moreover, the link between quality levels and ticket cost might be perceived as somewhat dim: ticket costs regularly increase in the beginning of the year irrespective of quality level changes. Still, the valuation pattern indicates that respondents in general considered the survey information and responded to the presented type of change and size of change.

In the sampling, we targeted only PT users in a few major city areas where various types of PT were available. Although our sample is relatively large, we cannot rule out that PT users in other areas value UD qualities differently. Moreover, some individuals that currently do not use PT may have preferences and WTP for PT improvements, possibly including prospective PT users with special needs stops [8]-[9]. A considerable part of the financing of PT and its UD quality is not based on PT users' fares, such that the general public could also have provided their WTP for UD quality levels, using other payment mechanisms. We leave these and further issues for future investigations.

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Essential Accessibility Information About Travel Chains for Everyone

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Abstract. Accessible travel for all passengers is considered a fundamental right in Europe, addressing both physical and digital accessibility needs. Public transportation must cater to a diverse range of passengers with varying physical conditions, cognitive abilities, and cultural backgrounds. The European Sustainable and Smart Mobility Strategy (2020) underscores the necessity of making mobility accessible and affordable for all, including better connectivity for rural and remote regions. This study examines the importance of considering universal design (UD) in public transport, emphasizing the need for inclusive solutions that benefit as many passengers as possible without requiring specialized adaptations. Research material on the effect of UD measures in accessible travel chains was collected during the planning and implementation phases of the travel chain. The usability and content of travel information sources related to accessibility were examined in these phases. The key findings highlight significant travel chain accessibility challenges in both digital and physical aspects. The planning phase findings show that the digital information about infrastructure accessibility was fragmented, creating difficulties for passengers with low digital literacy to identify, book, purchase, and obtain tickets for accessible transport. The implementation phase revealed inadequately designed physical environments, a lack of multi-sensory guidance, and gaps in the provided digital information. Various accessibility challenges in the physical environment and insufficient digital accessibility information prevent a seamless travel experience for persons with disabilities. While the built environment was initially designed using UD principles, maintenance and functionality have deteriorated over time. Providing accurate digital information about the functionality of infrastructure in advance could enable passengers to make more suitable route choices.

Keywords: Accessibility, universal design of public transport, travel chain experience.

1. Introduction

Public transport plays a crucial role in ensuring the rights of all citizens, with accessible travel being a fundamental right in Europe. Accessible and barrier-free public transportation requires equal access to services, physical environments, and information via accessible websites and mobile apps. Approximately 87 million Europeans have

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some form of permanent disability or temporary obstacles to mobility [1]. In Finland, nearly 19% of people have disabilities [2]. Barriers—such as obstructed infrastructure, poorly guided routes, and insufficient digital travel information—make traveling difficult for persons with disabilities (PwDs). *Disabilities* can include physical or motor impairments, visual and auditory impairments, cognitive difficulties, aging-related issues, and temporary impairments due to accidents or illnesses [3]. Therefore, designing physically and digitally accessible transport systems must consider these diverse needs.

Initiatives like the intelligent transport system (ITS) initiative [4] and the National Access Point (NAP) initiative [5] aim to create a more inclusive and accessible transportation network across Europe. Universal design (UD) in transportation is promoted by establishing common European specifications to ensure the compatibility, interoperability, and continuity of ITS solutions, such as providing real-time traffic and travel information. The development of multimodal travel information services is encouraged, integrating various modes of transport into a single, user-friendly system. NAPs serve as gateways for mobility data, ensuring that essential information (including accessibility details) is available to service providers and developers in order to create more accessible and user-friendly transport solutions. They facilitate the access, exchange, and reuse of transport-related data, helping provide EU-wide interoperable travel and traffic services. NAPs also promote the use of open and common standards and interfaces, enhancing the accessibility and usability of transport systems for all users. In Finland, the Act on Transport Services (643/2017) [6] obliges all transport operators to share essential information about their services, including information about the services and assistance available to PwDs, the accessibility of the equipment, and the equipment that facilitates the passenger's access to the vehicle and interaction with the driver. Mobility as a service (MaaS) [7], also known as *mobility combination services*, combines different transport modes to offer a tailored mobility package, and includes other complementary services, such as trip planning, reservation, and payments, through a single interface. MaaS is a user-centered service adopting the advances of technology and ICT to offer a transport solution that is best from customer's perspective to be made via multimodal trip planning feature and inclusion of demand-responsive services, such as taxi. Transportation providers collaborate to offer a seamless travel experience.

The sequence of different modes of transportation and services that a traveler uses are called a travel chain. It consists of different stages: planning, the initial journey, the main journey, and the final journey. Each stage has its own measures, opportunities, and challenges. An accessible travel chain enables barrier-free movement and access to information at all stages [8]. This includes accessible services, physically accessible and multi-sensory guided routes, stops, transport means, and station spaces, allowing all passengers to travel independently and smoothly. When designing public transport and travel chains, it is critical to consider accessibility for all potential passengers. Including the customer in the design process is key to developing universally designed travel chains and hubs [9]. PwDs prefer travel chains that are accessible, have minimal challenging exchanges, and are comfortable throughout. The fragmentation of travel information is a major bottleneck in trip planning for everyone, including PwDs [10]. During journeys, mobility challenges include physical barriers like long walking distances and irregular surfaces. Visually impaired persons face obstacles such as the lack of tactile braille signs and inadequate announcements. Concerns about platform locations, transfer times, and onward connections also affect confidence in using public transport. On the other hand, potential facilitators include the easy browsing of timetables and accessibility information, and the ability to buy tickets for the entire journey from one source. During

the journey, facilitators include real-time information about the stages, departure platforms, delays, and disruptions, as well as intuitive navigation during exchanges. Universal technical solutions, particularly within MaaS, have the potential to simplify trip planning and enhance safety, benefiting all passengers, including PwDs [11].

Literature has extensively examined physical barriers in the built environment and public transport [12]. However, there is limited research on the availability and use of accessibility information for PwDs, which is related to the planning and execution phases of travel chains. This article addresses the gap by studying the essential accessibility information offered and its alignment with the needs of PwDs. The article is structured as follows: Section 2 describes the methodology, research area, participants, and the data collection process. Section 3 describes the results of the travel chain experiences of PwDs in relation to UD. Section 4 considers the development of accessibility information, and Section 5 concludes with recommendations for improving public transport travel chains from a UD perspective.

2. Methodology

The empirical material for the article is from the project Accessible Mobility Travel Chains (ELMA, based on the name of the project in Finnish), conducted by the authors during 2023–2024. The results of the project related to essential accessibility information about travel chains was reported in another article [11]. From the same research material, this article will examine the usability and content of travel information sources in relation to the available accessibility information about the travel chain in the planning and implementation phases. The goal is to demonstrate the importance of considering UD in building and in providing accessibility information about public transport.

2.1. A Description of the Study Area and Participants

The case study was conducted in Riihimäki, southern Finland, showcasing how accessibility information for travel chains is provided in smaller Finnish cities. Public transportation in Riihimäki includes standard local bus lines, demand-responsive transport R-kyyti (ride-hailing type small bus), two on-demand service small bus lines with door-to-door services, and taxi services for PwDs. All buses have low floors and space for wheelchairs and other aids. Key hubs include the railway station, bus station, and expressway connections to regional buses, ensuring interconnectivity. The city uses the Reitit ja Liput mobile application and its online version for reserving and buying all the tickets required by the chosen travel chain. This MaaS solution combines route planning and mobility services, allowing users to profile their transport needs. The mobile application also offers the option to book and buy tickets by phone. Another MaaS-based route guide, VR Matkalla, is available online and as a mobile app, providing similar services for train journeys. The third nationally available MaaS-based application paired with third-party navigation apps, BlindSquare, delivers detailed points of interest and intersections for safe, reliable travel both outside and inside, for the blind, deafblind and partially sighted passengers.

Thirteen volunteer representatives, aged 40 to 82, were recruited with the help of local and regional disability councils and organizations using the snowball method. The participants were current public transport users; eleven used public transport independently, while two required assistants. The group included individuals with

temporary or permanent mobility and/or sensory challenges due to illness, aging, or disability. Table 1 summarizes the diseases and conditions affecting the participants, the aids and services used by the PwDs, and the information and communication technologies they used. All the participants had computer and Internet access at home and owned a smartphone, but their skills in searching for information on the Internet and using a smartphone varied.

Table 1. The target group of the volunteers.

Disease/condition	Number of PwDs	Assistive devices/services	Information and communication technology
Physical or motor disability	6	Wheelchair (x1), occasional electric wheelchair (x1), electric wheelchair (x4)	Computer, smartphone
Visual impairment, blindness	3	White cane (x3), guide dog (x1)	Computer, smartphone
Visual impairment, low vision	1	None	Computer, smartphone
Aging with temporary physical difficulties	3	Assistant	Computer, smartphone

Thirteen volunteer representatives, aged 40 to 82, were recruited with the help of local and regional disability councils and organizations using the snowball method. The participants were current public transport users; eleven used public transport independently, while two required assistants. The group included individuals with temporary or permanent mobility and/or sensory challenges due to illness, aging, or disability. Table 1 summarizes the diseases and conditions affecting the participants, the aids and services used by the PwDs, and the information and communication technologies they used. All the participants had computer and Internet access at home and owned a smartphone, but their skills in searching for information on the Internet and using a smartphone varied.

2.2. Data Collection

Data collection began by identifying the available and useful accessibility information for PwDs before and during the trip. *Regarding the planning phase*, the goal was to understand how the participants typically planned their trips, the tools, and sources they used, the accessibility information they sought, and what they missed. The travel chain included traveling from the point of origin to the destination with necessary vehicle exchanges at hubs. Thematic interviews and travel chain planning were conducted in eight workshops wherein the participants explained their planning processes and choices. All the conversations were recorded and analyzed using content analysis methods. Each volunteer participated in 2–6 workshops and interviews.

During the implementation phase, data was collected through the direct observation of the journey and by participants and researchers retrospectively recalling the journey with thematic interviews afterward. The effects of UD were analyzed using both the observation data from the journeys and the retrospectively recalled data covering the entire travel chain. To ensure a comprehensive collection of data, reflecting the diverse impairments and informational needs of the PwDs, information was gathered from various travel chains, encompassing multiple journeys made by the PwDs using different

modes of transportation and locations. These joint journeys helped understand how UD is present in the physical environment and how different stages of travel are affected by varying information needs.

3. Results

The study results were compiled into different phases, highlighting the access and information needs within the travel chain. The planning phase findings illustrate the strategies employed and how the PwDs found the necessary information to meet their accessibility needs. The implementation phase findings detail the information and methods used by the PwDs during the actual travel, emphasizing the access and utilization of available information and addressing the missing information during their journeys. Additionally, it provides insights into how well the built mobility environment and universally designed public transport solutions worked for the PwDs. Data from the PwDs and observations were compiled into a themed table (Table 2), summarizing joint journeys, categorized by different disabilities and travel independence.

Table 2. The results of the PwDs experiences and observations from joint journeys.

Disability and travel independence	The digital applications/ websites used	Travel booking strategies	Access to transfer stations and accessibility information
Physical or motor disability	- Ticket options were researched using a computer - The web version of VR Matkalla was used for booking and purchasing tickets using - The Reitit ja Liput app was used for DRT[a] booking - In-person assistance at an R kiosk was relied upon	- Using online platforms to research and book tickets - Initially planning to buy tickets at an R kiosk - Using DRT and a PwDs' taxi for transportation to the station - Preferring to buy tickets at an R kiosk in order to get personal service	- Checking for maps multiple times in order to understand the stop locations - Receiving helpful notifications from DRT[a] - Facing issues with non-automatic doors at the station - Having no clear feedback channel for door issues - Requiring assistance from other passengers to enter the station - Using an accessible entrance when available - Not needing a ramp service due to using a rollator
Visual impairment, blindness, independent	- The VR Matkalla application was used for booking a ticket - The Junat.net app was used to check a station node - The Lahitaxi application was used to order taxi - E-mails were used for communication and assistance	- Using a mobile phone to buy a ticket for a taxi service - Buying train tickets with the VR Matkalla application - Buying tickets from an R kiosk	- Using the BlindSquare application to simulate the pathway to the transfer station - Relying on previous trips and navigation at stations
Visual impairment, blindness, assistant	- Digital applications were not used for booking - In-person service was relied upon - The assistant helps with tickets and uses applications	- Walking to the station - Buying tickets at an R kiosk	- Navigating the station on foot - No specific accessibility issues mentioned; the information consists of information on old trips

[a]DRT: demand-responsive transport.

This analysis examines how these disabilities affect access to transfer stations, strategies for acquiring travel information, and booking and retrieving tickets, and it outlines the digital tools used to obtain information about the travel chain.

The planning phase revealed significant shortcomings in the digital information provided by authorities. Although there was a wealth of information available, web-based details about infrastructure accessibility were fragmented and sometimes inconsistent across different routes. This information included specifics about the accessibility of vehicles, platforms, stops, advance details on platform locations, and accessible routes at intersections. Passengers with limited digital skills faced challenges in finding the necessary accessibility information online, as well as in booking, purchasing, and obtaining tickets. Consequently, they often relied on telephone advice and in-person services instead of digital information.

The implementation phase highlighted inadequately designed physical environments and infrastructure, a lack of multi-sensory guidance, and gaps in digital knowledge. Significant issues included elevator malfunctions, particularly at junctions where passengers needed to switch between modes of transport or platforms via tunnels or station bridges. These problems often interrupted the entire journey or required rerouting, lengthening, and complicating the journey. There was no advance digital information about these elevator malfunctions at the stations, nor were alternative routes or service options provided. The PwDs who were proficient with digital tools and able to access data on their smartphones were more likely to travel independently. However, their independence was contingent on the travel information provided by the application being up to date.

4. Discussion

A range of accessibility challenges related to the physical environment and lack of digital information prevented the realization of a safe, smooth, and seamless travel chain experience for PwDs. These challenges arise due to inadequate design or maintenance. The planning phase revealed that fragmented digital information about infrastructure accessibility created difficulties for passengers with low digital literacy skills in relation to finding the necessary accessibility information and booking, purchasing, and obtaining tickets for accessible transport.

The implementation phase of travel chains showed that the design of the built environment in regard to mobility is insufficient to meet today's accessibility requirements. Although the built environment was designed according to the accessibility standards in force at the time, the functionality and maintenance of these solutions have deteriorated over time. Inconsistently guided accessible routes at junctions, such as stations, proved to be challenging. Similarly, advance information about the malfunctioning of primary accessibility solutions, such as the out-of-order elevators, and guidance for alternative routes were almost entirely lacking. Providing digital information about the functionality and non-functionality of the physical environment in advance would enable passengers to consider more suitable route choices.

Regarding MaaS, both the Reitit ja Liput and VR Matkalla solutions were found to be useful and reasonably easy to use. The participants appreciated the combination of services, allowing them to search for routes and schedules, and purchase tickets through the single application. They also benefited from the ability to browse the services via a

computer and valued the digital accessibility of these services. Additionally, everyone emphasized the importance of having travel information services that are available in alternative formats.

MaaS solutions benefit from more comprehensive data access, advanced combination services, and enhanced user profiling in order to help reroute travel chains during unexpected challenges. However, in the apps under consideration the current user profiling options were still quite limited. VR Matkalla offers choices for pets, a bike, a wheelchair, and an escort, while Reitit ja Liput provides options for a wheelchair, strollers, and a rollator. The wheelchair option ensures barrier-free routes during planning but does not update if there are unexpected changes during trips. In Reitit ja Liput, user profiling primarily benefits operators for predicting space requirements rather than directly aiding passengers. Overall, there is significant room for improvement in real-time adaptability and passenger-focused features in MaaS applications.

5. Conclusions and Future Work

The study indicates that the UD of public transport has not been fully realized, often leading to disrupted travel chains or rerouting. However, the analysis also highlights improvements achieved through universal planning, providing insights into developing seamless travel chains and enhancing the travel experience for all.

Legal frameworks and ethical guidelines promoting UD and equal treatment emphasize accommodating diverse needs during the development and execution of public transportation systems. The travel chain consists of successive stages, wherein UD use and its implementation determine the travel experience. Various actors specialize in planning and implementing these stages, but ensuring seamless compatibility and functionality from a universal accessibility perspective remains a challenge. Verifying user experience is crucial in the UD process to ensure goals are met regarding installation, construction, and performance. Post-construction evaluations would determine whether UD guidelines were successfully implemented. Several large players, such as the VR Group in Finland, have started focusing on accessible travel chain experiences by hiring dedicated service designers, involving diverse passengers, and organizing customer councils and forums.

Information about mobility services and their purchase is increasingly dependent on online services, with in-person service only being provided at stations and service points. The challenge is to ensure that mobility services are accessible to everyone, including individuals with limited digital skills, those needing assistive technologies, and people facing challenges in obtaining digital travel information. The study confirmed that multiple options are needed for passengers with different digital skills, particularly during the planning phase. While improving digital information flows is essential, customer service development must not be overlooked.

Declaration of Conflicting Interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Navigating Inclusivity: Exploring Accessibility in Oslo's Public Transport Mobile App

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Abstract. This study investigates the accessibility of the Ruter mobile app, a major digital platform provided by the public transport authority for Oslo and Akershus counties in Norway. By employing a combination of case study analysis, accessibility audits, and user experience testing, the research evaluates the app's compliance with WCAG and its overall usability for individuals with disabilities. Despite the inclusion of several accessibility features, the findings reveal significant areas for improvement, particularly in contrast handling, form field support, and logical sequencing. Feedback from a group of six participants highlights the necessity for continuous enhancement of the app design to ensure it is user-friendly and accessible. This research emphasizes the importance of universal design principles and suggests that with targeted enhancements, Ruter AS can significantly improve the inclusivity and accessibility of its digital platforms.

Keywords. navigation, public transportation, accessibility, inclusivity, mobile app

1. Introduction

Ensuring equitable access to transportation services for all individuals, irrespective of their functional profile or backgrounds, hinges on the accessibility of both digital and physical support systems within public transport authorities [1]. Accessibility in public transportation is not only a matter of convenience but also important to social justice and inclusion [2,3].

In the context of public transportation, digital platforms such as mobile applications play a crucial role [4,5]. These platforms provide essential services, from route planning and real-time schedule updates to ticket purchasing and customer support. For individuals with disabilities, these digital tools can either facilitate seamless travel or present significant barriers. Therefore, it is imperative that these platforms adhere to stringent accessibility standards to ensure that they are usable by all individuals, including travelers with reduced functioning [6,7].

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This paper presents a study of the inclusivity and accessibility of the digital platforms offered by Ruter AS[2], the public transport authority for Oslo and Akershus counties in Norway. Ruter offers essential services through mobile apps, the web, and physical retailers. The Ruter mobile app is an indispensable tool for commuters, providing real-time information on bus schedules, metro, trams, ferry services, and fare regulations.

This study evaluates Ruter's mobile app accessibility, focusing on ease of navigation, assistive technology compatibility, and alternative communication methods, guided by universal design principles. An analysis of the app's current accessibility and recommended improvements is presented, contributing to the broader discourse on digital accessibility in public transportation and highlighting the importance of continuous improvement and best practices.

2. Literature Review

There are several accessibility laws and guidelines that should be followed when designing a public sector transportation app to ensure it is usable by all individuals, including travelers with disabilities. The Web Content Accessibility Guidelines (WCAG)[3] provides recommendations for making web pages and web applications, including content used on mobile devices, more accessible. WCAG is divided into three levels of conformance: A, AA, and AAA. Level AA is generally considered the minimum target for accessibility. In the United States (US), Title II of the Americans with Disabilities Act (ADA) requires state and local governments to make their services accessible to individuals with disabilities[4]. The European Accessibility Act aims to improve the accessibility of products and services in the EU, including public sector websites and mobile applications. It requires compliance with the EN 301 549 standard[5], which is closely aligned with WCAG 2.1.

The general best practices for accessible Android apps include: (1) to provide content descriptions for images, buttons, and other elements; (2) to ensure that the app can be navigated using a keyboard and other assistive devices; (3) to use scalable text and ensure high contrast between text and background; (4) to ensure touch targets (e.g., buttons) are of adequate size (at least 48dp by 48dp); (5) to support Android's Voice Access allowing users to control their devices with spoken commands; and (6) to conduct usability testing with people with disabilities to identify and address potential accessibility issues [8,9].

These guidelines and standards provide a relevant starting point for designing accessible digital platforms. However, compliance with these standards requires continuous effort and adaptation, especially as technology and user needs evolve. In reviewing the literature, it is evident that while significant progress has been made in digital accessibility, gaps still exist, particularly in the practical implementation and enforcement of accessibility standards. Studies have shown that many public sector apps fall short of full compliance, often due to a lack of resources, awareness, or technical expertise [10,11]. These insights provide a foundation for evaluating the accessibility of the Ruter mobile app and identifying areas for improvement to better serve all users, including those with disabilities.

[2] https://ruter.no/en/

[3] https://www.w3.org/TR/WCAG21/

[4] https://www.ada.gov/resources/small-entity-compliance-guide/

[5] https://www.etsi.org/human-factors-accessibility/en-301-549-v3-the-harmonized-european-standard-for-ict-accessibility

3. Methods

Several research methods are utilized, including case study analysis, accessibility audits, and user experience testing. Case study analysis involves analyzing relevant documentation, policies, and initiatives undertaken by Ruter to improve inclusivity. Accessibility audits are performed on Ruter's mobile app to assess compliance with accessibility standards and guidelines. Usability testing sessions with users representing diverse demographics are used to evaluate the effectiveness of Ruter's accessibility features during common interactions, such as planning a journey and purchasing tickets.

3.1. Case Study

A detailed document-based examination of the Ruter mobile app, focusing on its design, functionality, and user experience, was conducted using publicly available documents. Specific case studies on the Ruter mobile app were limited in availability. In Norway, the Authority for Universal Design of ICT (Tilsynet for universell utforming av ikt)[6] is responsible for enforcing regulations on the universal design of ICT solutions, linked to the Equality and Discrimination Act. The inspectorate mandates that all public websites and apps must have an accessibility statement, created in the Norwegian Digitalization Agency's (Digdir) central solution, uustatus[7]. This accessibility statement helps businesses get an overview of their compliance status and provides users with the opportunity to report accessibility issues and give feedback. Ruter's app includes a similar accessibility statement accessible through the app's menu (Profile → Support menu → Accessibility statement)[8].

3.2. Accessibility Auditing

Accessibility audits involve the evaluation of a digital product to identify barriers and assess its conformance with accessibility guidelines and standards. As part of this study, an accessibility audit of the Ruter mobile app was conducted using the Android Accessibility Scanner [9] to identify potential barriers for users with disabilities. These results were compared with publicly available accessibility audit reports of the Ruter mobile app.

3.3. User Experience Testing

To evaluate the ease of navigating and operating the Ruter mobile app, we conducted user experience testing in a real-world environment. A diverse group of six participants, each with varying levels of technological proficiency and different disabilities, provided comprehensive feedback. 1 provides an overview of these participants. The participants were tasked with common activities such as planning a journey, purchasing tickets, and navigating the app's features. Some were already familiar with the app, while others required assistance with installation, ticket purchase, and actual travel. The aim was to identify usability issues and understand the challenges users face when interacting with the app.

[6] https://www.uutilsynet.no/english/about-us/903
[7] uustatus.no
[8] https://uustatus.no/nb/erklaringer/publisert/b8590bd9-b039-4bf6-84d0-ca57e24a8625
[9] https://play.google.com/store/apps/details?id=com.google.android.apps.accessibility.auditor

Table 1. List of participants for user experience testing

Participant ID	Age	Gender	Characteristics	Prior Experience with Ruter App	Technological Proficiency
P1	19	Male	Bachelor student in Humanities	YES	Medium
P2	26	Female	Master's student in IT	YES	High
P3	35	Female	Individual with visual impairment /legally blind	YES	High
P4	40	Male	Individual with motor disabilities	NO	Medium
P5	53	Female	Immigrant housewife	NO	Low
P6	72	Male	Pensioner	NO	Low

4. Results

4.1. Case Study

According to the Ruter AS accessibility statement published on uustatus.no, the Ruter app partially complies with the requirements for the universal design of ICT. There are breaches of 13 out of 42 requirements. Ruter presents the content on the app that is not universally designed. In the statement, they explained which content applies, the reasons for non-compliance, and what it means for the user. It is presented in the same order as the WCAG 2.1 recommendations. Ruter AS categorizes the content that is not universally designed in the Ruter (Android) app as follows:

Principle 1: Perceivable

- Information and Relationships: Visual headings are not always coded as headings, making it difficult for users to jump between sections.
- Meaningful Sequence: The onboarding flow has an illogical sequence, requiring users to choose between using the image carousel or the next button to complete the flow.
- Identify Purpose of Input Data: Some form fields lack the ability to autofill data, particularly for entering payment cards and phone numbers during login and user creation.

Principle 2: Operable

- No Keyboard Traps: It is not possible to exit QR scanning for keyboard scooters.
- Pause, Stop, and Hide: The reservation amount for ordering a scooter is displayed for only 7 seconds, after which it is no longer visible.
- Visible Focus: The app uses the standard focus indicator from Android, which can be almost invisible in certain cases.

Principle 3: Understandable

- Language on the Page: Deviation messages may be missing or in the wrong language, and receipts are generated only in Norwegian.
- Identification of Errors: Some text fields during ticket purchase and profile registration do not show error messages for incomplete data.
- Prompts or Instructions: Command text-in-text fields for feedback during mobility use, travel search, and phone number registration are inadequate, making it difficult to understand how to fill in the fields.

Principle 4: Robust

- Parsing: The webview for adding cards has validation errors and is unreadable without the stylesheet, complicating the presentation of information.
- Name, Role, and Value: Some UI components lack button roles, making it difficult for screen reader users to understand their function.
- Status Notifications: Changes in departures for active trips and scooters are not automatically announced to screen readers.

4.2. Accessibility Auditing

Google's Android Accessibility Scanner provides issues related to content labels, touch target size, clickable items, and text and image contrast. Figure 1 shows three issues detected by the scanner on its home screen.

1. Image Contrast: The contrast ratio between the image's foreground and background is 1.52. It should be increased to 3.00 or greater.
2. Text Contrast: The text contrast ratio is 3.84. Consider using colors that result in a contrast ratio greater than 4.50 for small text or 3.00 for large text.
3. Touch Target: The clickable item's size is 21dp x 21dp. It should be increased to at least 48dp by 48dp.

Figure 2 shows three issues detected by the scanner on its ticket purchasing screen.

1. Item Descriptions: Multiple items have the same description, which can confuse screen readers.
2. Text Contrast: The text contrast ratio is 3.15. It should be increased for improved readability.

4.3. User Experience Testing

Participants provided valuable qualitative feedback, highlighting both strengths and areas for improvement. Here are some key quotes from the participants:
P1: *The overall design and look of the app are quite appealing. I was a bit confused when they redesigned the app initially, but I am getting used to it, and it's becoming easier to understand.*
P2: *Purchasing tickets was mostly straightforward, but the lack of clear error messages during the process was frustrating. It would be helpful if the app provided more guidance when something goes wrong.*
P3: *I feel like the text contrast is too low, making it hard to read, and some buttons don't have proper labels for screen readers. Additionally, a voice-to-text feature for inputting start and destination points would be very beneficial.*
P4: *It would be helpful to incorporate features like larger touch targets and voice commands to make the app more accessible. I am not aware of the accessibility information feature of the app.*
P5: *I found it hard to understand certain parts of the app because the instructions weren't clear. I prefer using physical travel cards over the app for convenience.*
P6: *I am not a fan of mobile apps, and they confuse me sometimes. The small touch targets and low-contrast text made it difficult to use the app. I prefer using physical travel cards since they are easier to handle and more straightforward for someone of my age.*

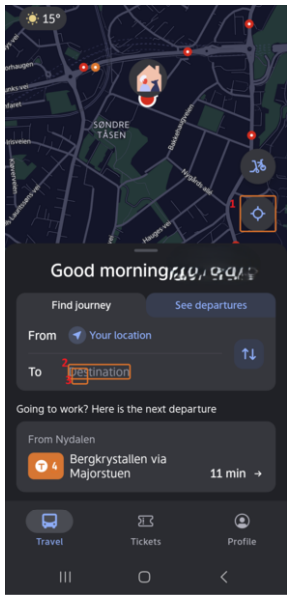


Figure 1. Home screen of Ruter with accessibility issues (shown in colored boxes with numbers).

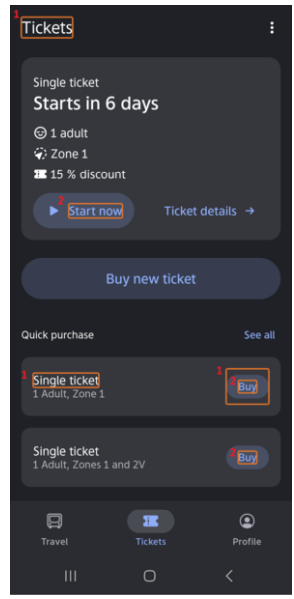


Figure 2. Ticket booking and ticket expiration screen of Ruter with accessibility issues (shown in colored boxes with numbers).

The Ruter app also provides accessibility-related information regarding public roads and stops during transit. Figure 3 illustrates this feature in the app, and Figure 4 shows how this information is presented.

5. Discussion

The findings from this study highlight both the ongoing challenges and progress in enhancing digital accessibility within the public transport sector, using the Ruter mobile app as a case. Despite significant efforts, critical areas still require improvement to achieve full compliance with universal design principles and to provide an inclusive experience for all users [12].

The Ruter app demonstrates a commitment to accessibility through various features designed to aid users with disabilities, such as the provision of real-time information, support for assistive technologies, and efforts to ensure ease of navigation. However, the case study revealed several shortcomings in these areas. Accessibility barriers, such as inadequate form field support for autofill, and issues with the visibility of focus indicators, suggest that more rigorous testing and user feedback incorporation are needed.

The accessibility audits revealed that the Ruter app does not fully comply with WCAG 2.1 standards. While the app incorporates basic accessibility features, significant room for improvement remains to ensure these features are implemented correctly and comprehensively. A particular area of concern is the app's handling of contrast, crucial for users with visual impairments. Current WCAG contrast checks are primarily effective for dark text on bright backgrounds but often yield inaccurate results for light text on dark backgrounds. This limitation suggests the app may not be optimally accessible in

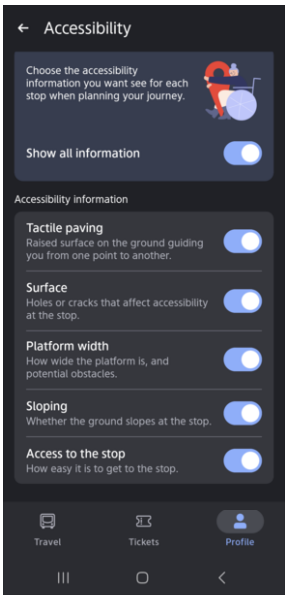


Figure 3. Accessibility information in the Ruter app.

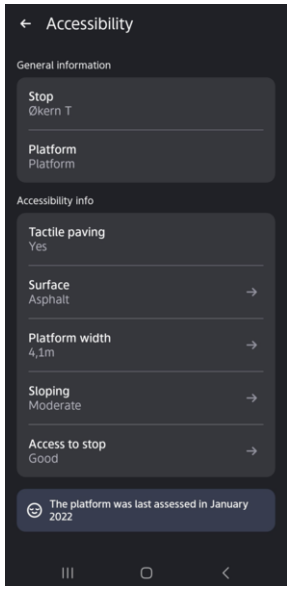


Figure 4. An example of accessibility information presentation.

dark mode, which is increasingly popular among users. To address this issue, there is an initiative to adopt the APCA (Advanced Perceptual Contrast Algorithm) contrast model, which is better suited for evaluating contrast in inverted (dark mode) color schemes, providing a more accurate assessment of accessibility for all users [13].

Although the user experience testing was conducted with only six participants, the insights gained are invaluable in understanding how real users interact with the Ruter app and the challenges they face. The feedback underscores the necessity for continuous improvements to enhance the app's accessibility and usability for all users. It is noticeable that although the Ruter app provides accessible information related to each stop (refer to Figure 4), users are not aware of this feature and therefore do not use it. Increasing public awareness of various features that make the app more inclusive and accessible should be prioritized. With a more structured testing process involving a larger and more diverse group of users, we could obtain varied perceptions and feedback, leading to even more comprehensive improvements.

Based on the findings, several recommendations can be made to enhance the accessibility of the Ruter mobile app:

- Enhanced testing and feedback mechanisms: Implementing more rigorous testing procedures such as regular accessibility audits and user testing with individuals with diverse disabilities, can help identify and rectify accessibility barriers more effectively.
- Incremental design improvements: Addressing specific issues such as text and image contrast and touch target sizes can significantly improve the user experience for individuals with disabilities.

- Compliance monitoring: Regularly updating the app to comply with the latest WCAG standards and other relevant guidelines will ensure that the app remains accessible as standards evolve.

6. Conclusion

The study of the Ruter mobile app highlights the importance of ongoing accessibility improvements in digital public transport services. While the app demonstrates progress in adhering to universal design principles, further enhancements are necessary to improve accessibility. By addressing these areas, Ruter AS can create a truly accessible and user-friendly app that benefits all passengers. Additionally, we plan to share our findings with Ruter to facilitate more in-depth discussions about their internal accessibility practices, standards, and barriers, contributing to a collaborative approach to improving accessibility. The future scope of this study also includes conducting detailed manual testing on the app as well as testing on different platforms such as iOS. We also plan to expand user testing to include more diverse participants in the experience testing process to gather comprehensive feedback on the app's accessibility features.

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Inclusive Tourism and Cultural Heritage

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Attitudes of Employees in Tourism Towards Guests with Disabilities in Norway: A Survey Study

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Abstract. Associations for people with disabilities in Norway receive much feedback about negative experiences with travel. Little research has been done on this topic, and thus there is little knowledge about what can be done to improve these experiences. In this study, we have mapped travel experiences of people with disabilities and attitudes from employees in the tourism industry with two digital surveys. The questions were created in a workshop by collaboration with researchers, user representatives from a national association for people with disabilities, and employees from the tourism industry. The results show that some of the employees' attitudes that are perceived as discriminatory by guests with disabilities are paradoxically caused by fear of doing something wrong. There seemed also to be a need for more knowledge about invisible disabilities, and a company-level and practice-based strategy for implementation of universal design in the customer service.

Keywords. Universal design, accessibility, tourism, customer service, hospitality.

1. Introduction

It is estimated that 20% of the population in Norway has some kind of disability [1]. The term "disability" includes both permanent and temporary, visible and invisible disabilities. The population in the Global North is also getting older [2], which is associated with several disabilities that are usually developed in those ages.

The rights of people with disabilities are described in the UN Convention for Persons with Disabilities (CRPD [3]), which Norway ratified in 2013 [4]. Article 9 of the convention describes the right to "have an independent life and be able to participate fully in all areas of life". The right to enjoy leisure and travel is considered an important area in which society must then provide for adapted services so that everyone can participate. This includes, for example: planning, booking, transport, accommodation, service and activities at the travel destination. Facilitating all these aspects of tourism is therefore not only a right, but also an opportunity to stimulate local economies, increase employment and create new opportunities for profitability for the tourism industry.

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However, literature on this topic is very scarce. Most of the articles on accessible tourism focus on the attitudes of people with disabilities (i.e., potential customers for the tourism industry), but do not examine how employees experience receiving guests with disabilities. A study in Poland [5] investigated what students in tourism think about "accessible tourism". They found that although they were positive about making travel more accessible, they find it difficult to achieve. The survey showed that the reason for this behavior was largely a lack of experience, and this was taken as an argument for developing training materials in their environment.

Bizjak et al. [6] mapped educational offers for the tourism industry in Europe to find out how they address meeting guests with disabilities. In the 12 countries they surveyed, they found no training on this topic. Beyond Europe, we can note the qualitative study by Hui et al. [7], who interviewed both managers and employees with direct contact with the public in the hotel sector around Asia. However, the discussion was mostly about the employment of people with disabilities, not about the guests.

In the study "Personal and societal attitudes to disabilities" from 2005 [8], the authors proposed two mapping tools for attitudes about disabilities, i.e. "Scale for interaction with disabled persons" and "Scale of attitudes towards disabled persons". Moreover, they discussed the difference between private and societal attitudes. The results showed that it is easier to change societal attitudes than private ones. In other words, people are more likely to say what society expects them to say about disability, instead of what they mean. It is therefore important to survey attitudes - by carrying out a survey in which one asked both what employees think and how they behave when meeting guests with disabilities.

The present study takes context in a central region of Norway, called Vestfold and Telemark County (*Vestfold og Telemark fylkeskommune*). This county is implementing a regional strategy for tourism from 2022 to 2030 that prioritized accessibility “as a premise for value creation” [9]. In this context, a local cluster of tourism companies coordinated by Visit Bø AS started a collaboration with Norway’s biggest interest organization for people with disabilities (Funksjonshemmedes fellesorganisasjon, FFO). FFO receives a remarkable amount of feedback from members saying that they experience being rejected, discriminated against, or met with little or no understanding from employees within various service and service-providing sectors. In this project, we wanted to contribute to full inclusion and equality for everyone in the meeting with the service and service-providing sector (i.e., transport, public offices, cafes/restaurants, shops, cultural events, education, tourism, healthcare, etc.). An additional goal is to empower employees in this sector when dealing with people with disabilities.

To achieve this, there is a need to acquire a knowledge base to design universally designed services and to develop a skills development program for all employees in the service sector. In the long term, it will increase knowledge, awareness and understanding of the CRPD and improve the quality of the offer for everyone.

The study described in this article is a mapping of the situations and attitudes both among people with disabilities and employees in the tourism industry when it comes to the provision and universal design of the destination, activities and transportation means.

We propose the following research questions:

- What competences do employees in the tourism sector need to have to be able to meet people with disabilities in an equal and respectful way?
- How do people with disabilities experience being met by employees in the tourism sector?

2. Methods

The project initially considers a lack of knowledge as the main reason why employees in the tourism industry do not meet customers with disabilities in a good and inclusive way. Therefore, the choice of method was aimed at forming the basis for a potential skills development program.





Figure 1. Participants from disability organizations (left) and from the tourism industry (right) working on the questionnaires.

We chose an online questionnaires and collaborative workshops as the survey method. We developed two online questionnaires: one for people with disabilities and their companions, and one for employees in the tourism industry. In the collaborative workshop, we processed the questionnaire drafts together with representatives from both target groups, to ensure that a) the questions captured as much information as possible about the situation, b) were universally designed, understandable, precise, and c) used the correct language. In addition to the workshop, we went through the questions for both forms in several rounds of digital meetings with the project partners.

Before the workshop, we made a first draft of both forms and then went through it in several digital meetings. The draft was created in Google Docs while we considered which digital tool to use to create the final versions after the workshop. After joint review, both Visit Bø AS and FFO in Vestfold and Telemark sent the draft for internal review in their organizations. All these rounds led to feedback that were implemented in the version that we brought to the workshop.

2.1. Collaborative workshop

The workshop was held at Bø Hotell in September 2023. There were 16 participants from which 10 came from 8 companies in the tourism industry, and 6 from different local and national associations for people with disabilities. The workshop started with an introduction from Visit Bø, where the purpose and plan for the day was presented. We printed out the questionnaires and gave a copy to each participant. We then explained the main parts of both forms and what we wanted to capture in each part. The participants' first task was to go through the forms individually and write down feedback on, among other things, question wording, answer options, language, structure, length, and time spent. We accommodated special needs – for example, reading aloud for a partially sighted participant, but reminded participants that the completed questionnaires should be digital and universally designed, not on paper.

After individual review and a break, we started discussions in separate groups (see Figure 1). After the group discussion, we put together new groups that included mixed participants from each type,so that the user representatives could give input on the questionnaire to employees and vice versa. Finally, we had a plenary discussion.

2.2. Online questionnaires

After the workshop, we collected all input and discussed which platform should be used to create the online forms. The questionnaires had to be universally designed and anonymized. We decided to use Microsoft Forms. This solution has several features that allow for universally designed surveys, like support for screen readers, keyboard navigation, browser-dependent visual configuration, alternative text for visual resources, and question dependencies for possible adjustment.

We decided to send them out immediately after the 2023/2024 Christmas period, so that the respondents came up with recent experiences from travel during the Christmas holidays that could contribute to better answers to the survey. The questionnaires were open for responses for one month. This was extended by two weeks to try to get a few more answers from employees in the tourism industry. A closer description of the questionnaire can be found in the report published after the project finish [10].

3. Results

We received 465 answers to the questionnaire for people with disabilities and their companions, and 132 to the questionnaire for employees in the tourism industry. We performed descriptive statistical analysis to the closed-ended questions and thematic analysis to the respective open-ended questions. In this section we will summarize the most relevant data and findings from the survey; a complete overview of all the data can be found in the recently published report (in Norwegian) [10].

3.1. Respondents with disabilities and their companions

Most of the respondents to Q1 were middle- or older age adults, having 9.3% of participants less than 30 years old. There was a majority of women (69.2%), of Norwegian nationality (96.6%) and with Norwegian parents (94.6%). 48.4% of the respondents had higher education, followed by 25% upper secondary education. 55.1% viewed their economic status as “average”, whereas 25% considered it to be “low”. Concerning disabilities, there were 39% of the respondents with muscular or bone conditions, in addition to 22.8% that alleged some kind of movement impairment. There was also a relatively high occurrence of respondents with concentration or memory-related conditions (23.2%), hypersensitivity/chronic fatigue (15.9%) and hearing impairments (13.33%). There were some respondents with other kinds of cognitive disabilities apart from memory or attention disorders (11.6% with psychosocial challenges, 11.1% with general cognitive impairment, and 8.6% with reading or writing difficulties). Therefore, there was a stronger representation of motor disabilities, as opposed to some sensory ones (only 12 and 11 blind and deaf respondents, respectively). Some participants used the field “Other” to formulate their disabilities in their own way,

from which we concluded that it is necessary to include fields for “allergy” or reformulations of some disabilities related to cognition.

The two most usual reasons for travelling were leisure (51.4%) and visits to friends and family (25.6%). 32.3% of the participants who travel for leisure repeat sometimes the same destinations, whereas 19.36% of them do it on a regular basis, and the rest of them (15.7%) tend to travel to new destinations each time. The relative majority of the participants have Oslo as the most frequent travel destination nationally (15.1%) and Europe as the most frequent one internationally (52.3%). 73.6% of the respondents do not travel alone, and the most usual travel companions are family members (57.2%). The most used information source to plan travels is the Internet (79.4%)

When it comes to discriminatory experiences, although the majority claims not to have experienced discrimination when they travel (71.8%), the rest of them have experience it to varied extents, mostly due to their disabilities (67.1%).

We categorized their descriptions of discriminatory experiences as follows:

3.1.1. Unhelpful or disrespectful employees

Several respondents referred to situations where employees in tourism industries did not give them the assistance or help they needed. This led to them feeling neglected (“[…] I often have to run to catch it [transportation] as I have wasted a lot of time looking for employees to get more information.”) or exposed (“[My needs] were pitted against each other and asked to refrain from assistance in front of everybody. Therefore, I travel less and can't rely on getting help."). It also makes them compare themselves with what others experience ("I have to play detective where everyone else manages and find other fellow travelers by walking around."). Several respondents claimed that they have more trust in fellow passengers than in employees when it comes to assistance ("The only reason why I haven't been left behind is help from fellow passengers, as the lift or the ramp that could have solved the problem was only for wheelchair users."). Some episodes refer to directly hostile reactions from the employees ("[I encounter] rolling eyes when I spend longer time on things", "I stated that I was ill, and got a reply back that sick people should stay at home.").

3.1.2. Inaccessible processes

Travel involves many processes: airport security, coordination with travel group to participate in activities, ticket use, check-in, etc. Several participants described situations where the processes led to a lot of frustration ("I often have to wait a long time for help when I travel alone. I feel like I'm being put away like a wet umbrella.”). Lack of universal design of these processes means that planning becomes overwhelming and demanding for people with disabilities ("It takes a lot of detective work to plan a trip, and it's more exhausting to deal with when traveling than having a disability."). Some of the respondents also described how they have been turned away from travel destinations/travel opportunities under the pretext that the regulations prevent them from being able to participate ("Now there are new rules that make it forbidden for me as a blind person to take the ferry alone, […] The argument is that an emergency situation may arise and that the crew then does not have the capacity to help me as a blind person.").

3.1.3. Invisible disabilities

Many of the respondents claimed that much discrimination is based on having invisible disabilities: "The fact that you do not have a visible handicap and a card does not mean that you do not need accommodation. And it is precisely that small, simple arrangement that can give us a good experience.". Some employees seem to even react in very negative ways ("I don't use aids 100%, so I feel distrusted when I ask for help"), even when the customers use other ways to signal their disabilities ("[…] I began using sunflower bands, but that is clearly not something that security guards and other employees in tourism are informed about").

3.1.4. Inaccessible digital information

In travel planning, there is usually a need to use several digital tools at the same time. This requires enormous digital competence and becomes too complicated for many users ("It quickly becomes very confusing when there is not just one travel app, and often there are several apps within the same company."). This problem applies not only to travel planning, but also to the execution of the trip. Some of the customers with disabilities need accessible digital information in order to successfully complete their journey: "Several times I've gone to the bathroom or bought food and drink, then come back to the platform or the street and discovered a blank screen - my only source of information. [...] Written information is always given lower priority than spoken language information - you have to get better at it."

3.1.5. Lack of knowledge or competence

In the quotes presented earlier, lack of knowledge about disabilities was a recurring theme. This was particularly mentioned by several participants: “There is varying competence in disability among employees in different locations. And you almost always have to expect a special solution instead of universal solutions. The overall impression is that travel is not for "people like me"”. We noticed that some participants referred to a lack of knowledge about concrete, often overlooked disabilities. This could be perceived as very negative ("There is a lack of understanding of hypersensitivity and allergy. Many of the employees wear perfume at work, hotels do not have meeting rooms without carpeting, there are people smoking outside the entrance area.").

The open-ended question yielded other topics related to lack of resources, inappropriate or unnecessary assistance, or to the fact that some employees speak to the customer with disabilities’ companions, instead of to them directly. The project report contains further quotation examples of these topics [10].

3.2. Respondents from the tourism industry

When it comes to the demographical data, we observed a quasi-normal distribution in age, a fair distribution in terms of gender (62% women), and majority of Norwegian respondents (85%). There was only 1 respondent from Oslo, and most of them came from the region surrounding the place where the company that led the project works (Vestfold and Telemark). 82% of the participants had higher education, and 58% of them were company owners or managers, 30% full-time employees, and the rest were either half-time or temporary tourism workers. 19% of them reported having some kind of

disability (which reflects the population-wide prevalence described in the at the beginning of the article – see Introduction).

When it comes to experience with guests with disabilities, 60% have had them frequently, and 37% scarcely. The way they knew these guests had a disability was because they were "visible" (85.6%) or because the client has disclosed that information either in the reservation (37.9%) or verbally (46.2%). On some occasions, it was the travel companion who gave this information to the employees (31.1%). Motor disabilities were by far the one that employees have encountered more frequently (75%), and most of them don't know about arrangements like sunflower band (60%) or related to travel companions (43%). 46% of them claim that their companies do not have guidelines for receiving guest with disabilities, and 17% do not even know whether their companies have them.

Concerning the questions about their attitudes when they have guests with disabilities, 68% of the respondents say that they feel safe when interaction with them, but the rest of the respondents are distributed evenly between those who are afraid to say something offensive, to do something wrong, or just do not know how to act. Regarding behavior, 75% of them just try to act "just the same" as with other clients, and 20% of them "improvise", admitting that their fear to do something wrong leads often to inaction. Most of them (76%) are interested in getting more training in this topic.

There were only 29 answers to the open-ended question about what they miss in the current guidelines or training that they get. This sample size did not allow for such an extensive categorization as the one we carried out with the previous questionnaire, but we were able to identify some key topics. The participants pointed out that there is a need for more time to carry out relevant training ("We lack time for all tasks, so this gets poorly prioritized"), more strategy within the company ("[What is needed] is to get started with the continuation after the training: create a strategic plan for the way forward"), more practical knowledge in the training ("There should be a far greater focus among everyone, not just those with direct public contact."), and more structure in the content that is shown in such training.

4. Discussion

More than a quarter of the participants with disabilities have experienced discrimination to varying degrees from employees in the tourism industry. Qualitative analysis also shows that this type of discrimination is the reason why many decide not to travel anymore. This can be taken as the basis for prioritizing training at tourism companies. It should be avoided that people with disabilities should "play detective" or "have faith that fellow passengers can help" in order to find their destination. We point out that transport stages are the part of the travel process where most experiences of discrimination take place. This means that employees in transport stages must be prioritized as the target group for training courses.

In all, we can see that matching the discriminatory experiences reported by the participants with disabilities with the attitudes and behaviors from the employees, we can conclude that the fear and inaction experienced by the latter is perceived as discrimination by the former. This conclusion must be taken in consideration of the culture context (Norwegian population with local tourists, most of them retired).

The situation surrounding the lack of training on universal design was largely expected, but it was interpreted as positive that so many participants wanted to receive

training. They also answered that they were interested in all the answer options on the form, regarding the type of knowledge that training can be about.

5. Conclusion

This study aimed to survey the situation regarding the travel life of people with disabilities, with a particular focus on the attitudes of employees in the tourism industry, and how they meet guests with disabilities. We collected data using two online questionnaires, one for people with disabilities and one for employees in the tourism industry. The questionnaires were developed in several rounds together with interest organizations and company representatives through a workshop.

The data we received shows that people with disabilities struggle to relate to travel in several ways, and it seems that the personal meeting between employees and guests with disabilities is the very core of the problem. Employees are perceived as unhelpful and rude in several situations, but at the same time we observe that most of them are just afraid to say or do something wrong. Data show quite clearly that a lack of knowledge among employees in the travel industry and other service and service-providing industries is the reason why the interaction between customers and service providers ends with discrimination and refusal to travel.

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Which Accessibility for Mountain Natural Environments? The Ski-Ability Project

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Abstract. The growing desire to live experiences in naturalistic environments that are also opportunities for psycho-physical well-being has meant that the issue of accessibility is now involving environmental contexts that by their nature are often almost inaccessible due to both the morphology of the places and the meteorological-geographical conditions. It is evident that in such contexts the degree of accessibility cannot be fully satisfied by acting on the environment, it is, therefore, necessary to refer to notions such as reasonable accommodation or equivalent accessibility.
In this sense, the degree of accessibility achievable involves more organizational aspects and the provision of special aids, reducing the number and scope of interventions in the physical environment. From this point of view, the sense of limitation inherent in the definition of Universal Design (which considers the greatest number of people possible) emerges avowedly, emphasizing even more specifically the difference between accessibility and usability.
This paper aims to analyze how accessibility can be declined for places that by their nature are poorly accessible, what scope this has for the local population, and to propose an initial focus on the ongoing Ski-Ability Project research.

Keywords. Natural Mountain Environments; Ski Resorts; Cohesive and Secure Communities; Ski-Ability Project

1. Introduction

The growing desire to live experiences in naturalistic environments, mountain or otherwise, that are also opportunities for psycho-physical well-being, has meant that the issue of accessibility has come to include environmental contexts that by their very nature are often almost inaccessible, both because of the morphology of the places and because of the weather and geographical conditions.

A substantial body of evidence supports the benefits of contact with nature, including economic benefits [1]. Examining the social, physical, economic and cultural differences in the relationship between nature and health can assist in formulating targeted interventions to address disparities [2]. Such interventions aim to prevent health problems and improve lifestyles.

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Despite the aspiration to interact with natural mountain environments for recreational and therapeutic purposes, many people, particularly those with disabilities, encounter considerable obstacles to access [3]. The rugged morphology and unpredictable weather conditions of natural mountain landscapes frequently render them inaccessible, constraining participation and enjoyment opportunities. Traditional approaches to improving accessibility, linked to standards and manuals, too often focus only on physical modifications of the environment, becoming inadequate for such contexts for which hypotheses and solutions need to be formulated that consider the user and his or her peculiarities. Instead, it is essential to consider the users, their unique characteristics, and the provision of appropriate aids or facilitators to facilitate interaction with the environment. Indeed, the ICF (International Classification of Functioning) represents a comprehensive anthropological approach, describing the person in their inseparable valence of body-function-environment [4]. Such an interpretation broadens the concept of accessibility, enabling a perspective that fully analyzes the person-environment relationship concerning the activities performed.

2. Accessibility as a Person-Environment Relationship

The accessibility of spaces is in most cases referred to the built environment and takes into account that there are people who interact with the designed spaces in a different way than what is considered normal (a motor-disabled person with a wheelchair cannot use a staircase, but must use ramps with an appropriate slope, or lifts, etc.). Consequently, a variety of regulations, varying in their efficacy, govern the design of the built environment. In theory, new construction should be able to achieve a satisfactory level of accessibility for the majority of users.

However, it is well known that the regulations adopt very pragmatic and inflexible approaches, often aimed at niches of the population with standardized characteristics (the motor-disabled person in a wheelchair, the blind, the deaf), proposing specific design solutions that lead to a design for disability, thus losing sight of the issue of inclusion, as well as architectural, constructive and therefore economic redundancy, multiplying and overlapping building elements that are not integrated.

Universal Design (UD) induces the designer to formulate effective solutions starting from the complexity given by the plurality of needs and aiming to respond through a design capable of satisfying as many demands as possible. UD has a sense of limitation (it is aimed at the “greatest number of users”), both in terms of solution (any solution may pose difficulties for a specific user) and situation (the complexity of human beings cannot be reduced to immutable patterns: there will always be specific situations that require tailor-made solutions), as well as the fact that accessibility is not a product but an evolving process [5].

A further development of this theme can be seen in Inclusive Design [6], which involves users in the design process, not only to cater to as many users as possible, but also to emphasize different needs and abilities.

In such perspectives, accessibility is no longer just a requirement of the built environment to meet the needs of specific users (especially people with disabilities), but provides a broader and more inclusive response.

However, when we speak of natural contexts, the concept of accessibility must be approached in a different way, because the sphere in which we intervene cannot be considered as designable. It is therefore necessary to reinterpret the very concept of

accessibility, to understand its real limits and the possible declines that are closely linked to the relationship between person and environment. In these situations, it is therefore necessary to determine what the balance point may be between designed solutions and action on the user, who is thus transformed into an active part of the intervention. Accessibility, or rather the reduction of the handicap, is the balance between the adaptation of the person to the environment and vice versa.

Being aware of all this, working in natural contexts, which by their very nature are not accessible, and in most cases will never be accessible, if not by distorting them and thus depriving them of their peculiarities that make them attractive, becomes a complex operation that requires compromises. The UN Convention on the Rights of Persons with Disabilities itself proposes the instrument of reasonable accommodation [7] which, from the point of view of inclusion and equal opportunities, allows for different ways of accommodating users with disabilities. This last consideration concerns both the issue of accessibility of places, which is what we are dealing with here, and the possibility of providing the user with tools that enable him/her to compensate for his/her difficulties.

In the field of planning, the issue of the accessibility of the natural environment raises many considerations similar to the debate on the accessibility of cultural heritage, where the protection of the property must be balanced against its accessibility. It is well known that, even in this field, compromises have to be made in order to reconcile the two values. In this sense, the legislation of the Veneto Region in Italy introduces the notion of "equivalent accessibility" [8], defined as a requirement to be achieved through solutions or management methods of the asset or area that improve its degree of accessibility and usability, so that a person with a disability can (a) move around, even if with the help of an escort or, in the case of large areas, equipped with "light" means; (b) reach only some significant parts of the property or area and, for the remaining parts, have at their disposal appropriate information aids enabling them to know and understand them; (c) have at their disposal appropriate tactile and visual material, audio guides, etc. (facilitators).

Examples of such approaches for mountain and non-mountain nature areas include the use of the joelette, a litter pushed by two drivers, which is used to transport a person with reduced mobility along mountain paths, allowing the user to experience places that are otherwise inaccessible. Similarly, in the case of Vatnsdalur and Ting in northern Iceland, the Vatnsdæla Sagauna landscape, a vast area that also contains important archaeological ruins, the issue of accessibility and usability has been addressed by identifying viewpoints that can be reached by driveways and by using horses equipped with a special saddle to carry some people with motor disabilities to the area of the ruins or along appropriate guided routes [9].

Interventions in mountain and non-mountain naturalistic contexts require careful consideration to ensure that the following are satisfied: reachability, which expresses the possibility that any person can reach the desired place, even in different ways; accessibility, which objectively describes the characteristics of an environment so that it can be enjoyed; and usability, which reads the person-environment relationship subjectively [10], regarding the user's own conditions. For example, a hut or chalet located on a ski slope may be accessible (entrance without steps, counters at the right height, equipped toilets, etc.) but not usable by a disabled person arriving on a monoski. Accessibility therefore depends on how it is used by the user and, to return to the example, it becomes usable when there is a courtesy wheelchair that allows the disabled user to access and actually use the facility. From this point of view, accessibility and usability,

objective and subjective data [10], must complement each other so that the user can experience the environment as fully and independently as possible.

The difficulties in defining the accessibility of natural mountain areas do not only concern the possibility of carrying out recreational-tourist activities, but also have important implications for local communities. In fact, these activities are flanked by all the usual activities of daily life (accommodation, mobility, shopping, etc.) that should also be accessible, raising similar issues to those mentioned above, since they are often located in small and isolated localities where the geographical-natural conformation shapes the fabric of socio-economic activities, cultural traditions and aspirations for a sustainable future.

Existing actions are mainly based on the development of tourism, but a more careful reading of the phenomenon shows how everything that raises the level of accessibility benefits first and foremost the local population, giving rise to more cohesive and secure communities, facilitating connections with the larger centres close to them, and warding off the endemic processes of abandonment and depopulation, thus satisfying the 11th UN Sustainable Development Goal, Agenda 2030.

3. The Sky-Ability Project

When considering sporting activity, whether competitive or not, for people with disabilities, we always mean adapted physical activity, i.e. the fact that the person must be equipped with aids and assistive devices to enable them to practice their chosen sport. In the case of skiing, these aids differ according to the type of disability: for motor disabilities, the main equipment used includes skis with stabilizers, sit-skis and mono-skis that can be used independently, or with the help of an instructor who guides them. For sensory (mainly visual impairments) and cognitive disabilities, the accompaniment of a guide is required.

As mentioned above, it is therefore necessary to adapt the person in order to be able to practice sports and leisure activities on the snow. The actions to be carried out on the environment do not therefore relate specifically to the adaptation of the ski slopes, but must include all the services surrounding the skiing activity, thus becoming an essential element for the accessibility and usability of the sites.

Moreover, in these contexts, the latter is strongly conditioned by weather conditions: snow, ice and low temperatures, if not properly managed, become obstacles that render inaccessible environments that would otherwise be accessible (think, for example, of a flat route with and without snow or ice).

The proposed case study is the Ski-Ability Project, financed by the Arge Alp Community and promoted by the Lombardy Region. The Arge Alp Community involves ten Provinces, Regions, Länder and Cantons from Austria, Germany, Italy and Switzerland with the aim of "addressing, through cross-border cooperation, common problems and goals, particularly in the ecological, cultural, social and economic fields, as well as promoting mutual understanding of the peoples of the Alpine arc and strengthening the sense of common responsibility for the living space of the Alps" [11], is grafted onto the above-mentioned theme. The main aim of the Ski-Ability Project is to study the receptive capacity and accessibility in the ski resorts of the Arge Alp area, as a reference area for the entire Alpine arc, and to identify which good practices can guarantee the highest degree of accessibility of the resorts and the practice of skiing for people with disabilities, as well as the receptive capacity of all the service providers for

skiers. Based on this research, a useful model for measuring the accessibility, for different forms of disability, in ski resorts will be identified.

The research will be completed by December 2025, to develop guidelines to improve ski resort accessibility. These guidelines could be approved by the EU. Seven ski resorts from the Arge Alp Community agreed to participate in the research as benchmark locations (three Italian, two German, one Austrian, and one Swiss). Each place was picked by its respective Region.

The first survey carried out for the Ski-Ability project consisted of a questionnaire sent to the contact persons identified by the various ski resorts participating in the project. The first part of the questionnaire focused on the accessibility of the ski slopes and related services, while the second part looked at the accessibility of the resort as a whole (accommodation, restaurants, transport, personal care services, etc.), i.e. the accessibility and usability of the areas and services used by all users, including disabled users, when they are not on the slopes.

The methodology used, in this first cognitive phase, involved the application of qualitative research as part of a more specific study carried out with the participating districts, with the aim of verifying the state of affairs and possible developments of adaptive winter sports and community-based mountain organizations. This research method, based on the constructivist paradigm [12], provides a better understanding of the social realities of individuals, cultures, solutions adopted and lived experiences [13]. It is then accompanied by the study of specific objective parameters, such as the survey of the actual services offered in terms of reception, management and physical accessibility.

The first results of the survey launched (Table 1) are the answers to a series of self-assessment questions, through which the districts expressed their opinion on the *status quo* regarding the degree of accessibility offered by the facilities surveyed, both from the point of view of the services offered and from the point of view of the management. These responses provide important data for assessing not only the actual status quo of the study areas, but also the degree of understanding and sharing of the issue. The interpretation of the questions and the language used for the answers is a characteristic and culturally specific element: some areas have been dealing with the issue of accessibility for some time, also thanks to the collaboration of local administrations and associations, while others are taking their first steps, leaving the "answer" mainly to the regulatory system.

The answers obtained show, first of all, that in many cases there is no ecosystem approach to the accessibility and usability of the entire ski area; on the contrary, the management is characterized by a fragmentation of public and private bodies that act independently of each other. Another point to be considered, where it exists, is the communication of a tourist nature that is provided with regard to the accessibility and usability of the areas studied, which refers more to the summer season, confirming that winter weather conditions constitute an additional obstacle to be overcome.

Table 1. Self-assessment questionnaire on the degree of accessibility of the ski resorts involved in the project.

		SKI RESORT 1	SKI RESORT 2	SKI RESORT 3	SKI RESORT 4	SKI RESORT 5	SKI RESORT 6	SKI RESORT 7
1	Are there disabled parking spaces near the ski lifts?							
	a How far are they from the ski lift/ticket office?							
	b How many are there?							
	c Are they kept snow-blown?							
	d How often are they snow-blown?							
	e Is it equipped with a cover?							
	f Is there an accessible route?							
	g Is the route feasible with a wheelchair? With skis? Is it equipped with signage for the blind?							
2	Is there a shuttle service accessible from car parks or accommodation facilities?							
	a At what distance from the ski lift/ticket office/accommodation facility?							
	b How many are there?							
	c What is the frequency?							
	d Describe the type of service							
3	How many ski lifts are there? What kind?							
	Are there turnstiles?							
	Are there dedicated lanes for disabled persons?							
	Is there an assistance service?							
4	Are there specialised instructors?							
5	Refreshment/Refuges							
	a How many are there for each lift and each ski slope?							
	b Are they accessible? To what level? What initiatives have been implemented or are in the process of being implemented?							
	c Are there accessible toilets? How many for each ski slope?							
	d What kind of support is provided to the disabled persons?							
	e Are there sledges or other means of support?							

Legend

Insufficient Sufficient Reasonable Good

3.1. Research Questions

Based on these premises, the research takes its first steps by addressing some fundamental questions:

- How do the specific geographical and meteorological challenges of wilderness environments influence the implementation of UD principles and the achievement of equivalent accessibility within ski resorts?
- What are the most effective strategies for promoting inclusive sports initiatives in natural environments?
- What are the main barriers and facilitators to the adoption and implementation of UD strategies, inclusive sport and design in natural environments, and how can these challenges be addressed to promote equivalent accessibility for people of all abilities?
- How do the socio-economic and cultural contexts of specific settings influence the effectiveness of accessibility initiatives, and how can these contextual factors be used to improve the inclusivity and usability of ski resorts and the communities that visit them?
- What examples can be studied and adopted? Are there sustainable solutions in a broader sense?

These research questions aim to provide a comprehensive understanding of the complexities that characterize accessibility in natural environments and to identify feasible strategies to promote equivalent accessibility and inclusivity in diverse landscapes.

By achieving these research objectives, this study aims to contribute to the advancement of knowledge and understanding in the field of accessibility in natural environments and to provide practical insights and recommendations for policy makers, planners, designers and stakeholders involved in the planning, development and management of recreational spaces and facilities.

4. Conclusions

The accessibility and usability of natural mountain environments can be achieved by acting mainly on the adaptation of the person to the environment through the provision of specific aids and in the awareness that the degree of accessibility may vary from case to case in relation to the person-environment relationship that can be defined. This must be accompanied by actions that see accessibility declined above all at an organizational level to support the usability of spaces and services that, designed for skiers with disabilities, can also become an advantage for the communities that live in the ski areas.

The first results of the Ski-Ability project show a strong inhomogeneity between the different ski resorts studied. This inhomogeneity is not only related to the fact that some resorts have been working on the issue for a long time, while others have only recently started, but also to the specific context and to the way accessibility and usability are understood.

In this sense, the project will need to jointly define the concepts of accessibility and usability of ski resorts and then identify approaches to improve accessibility in adaptive

snowsports for people with disabilities, including the availability and proper use of specialized adaptive equipment tailored to the specific needs of participants with disabilities to improve the overall experience; the creation of community partnerships (local resorts, ski shops and community members); the use of event marketing strategies, social media presence with detailed and objective information; the identification of opportunities to secure grants or earmarked funds for the purchase of new equipment; and the training and support of staff, volunteers and instructors [14, 15].

In all of this, it should not be forgotten that the involvement of local communities, understood in a broad sense and thus including inhabitants, political-associative realities and recreational activities in the planning and design of environments will strengthen the sense of belonging and cohesion. Indeed, collaborative efforts in landscape planning and management can help create inclusive and health-promoting spaces as well as create new opportunities for socio-economic sustainability in mountain areas.

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A Standard on Accessibility of the Immobable Cultural Heritage

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Abstract. Architecture has always aimed to improve the quality of life for people by enhancing their interaction with the built environment. This applies not only to domestic settings but also to significant structures that represent our cultural heritage. However, the interaction between accessibility and cultural heritage may seem complex and challenging, even impossible at times. Cultural heritage is an essential part of our collective history and cultural identity. It is crucial to ensure that everyone can fully participate and enjoy it, especially when cultural heritage is integrated into people's daily lives, according to the United Nations Convention on the Rights of Persons with Disabilities. Moreover, improving the accessibility of cultural heritage objects enhances society's appreciation of immovable cultural heritage, emphasizing its significance and visibility. This conforms to the strategic objectives of the World Heritage Convention. This paper discusses the international standard known as ISO 5727 which aims to improve the accessibility of immovable cultural heritage in accordance with a Universal Design approach (UD). ISO 5727, currently under development within the framework of the International Organization for Standardization (ISO), is based on the Spanish standard, the UNE 41531 IN, published in 2018. The purpose of the standard is to provide general and technical criteria and a methodology for interventions in immovable cultural heritage to facilitate its use and enjoyment for all people. The standard should be considered in both restoration and rehabilitation projects, as well as in specific accessibility interventions. However, it should be noted that the standard does not cover accessibility measures related to management, like services, and maintenance. Nonetheless, it has been considered that these may be necessary complements or alternatives to the first. To carry out interventions effectively, it is advisable to adhere to a systematic approach towards the process and documentation involved. Firstly, accessibility objectives should be established. Then strategies to improve accessibility should be identified to focus on the purpose of the intervention. An analysis based on the current state of the cultural object, including its heritage values and accessibility conditions, would serve as a basis for establishing proposals for action. Once the options have been assessed jointly and comparatively, with the validation of all stakeholders- including users regardless of their abilities, age, or background- the proposals that can form part of an intervention plan can be decided on. The intervention plan will establish a set of measures that will configure the accessibility chain to meet the objectives of the intervention. ISO 5727 is conceived as a useful tool to enhance the conservation of immovable cultural heritage and to balance the achievement of specific social goals with the preservation of cultural values. This project is developed with the belief that accessibility can improve and expand the cultural and functional potential of cultural heritage.

Keywords. accessibility, cultural heritage, universal design, persons with disabilities, international standard

1. Introduction

Throughout history, humans have sought to meet their needs through architecture. Temples were built for the worship and glorification of the gods, while domestic architecture provided shelter, safety, and a sense of belonging. In both cases, architecture has addressed the essential human needs.

Inhabiting architecture involves establishing a harmonious relationship with place and time. Inhabiting is an act that goes beyond the concept of occupying or living in a space. It transcends our everyday activities and practices and encompasses the emotions and identities that shape us daily. In the work "Building, Dwelling, Thinking", Martin Heidegger discusses how only inhabiting can bring a place into its own. Without the act of inhabiting, there is no place.

The places that were inhabited in the past hold special significance in the present. They serve as witnesses to the legacy inherited from generations that have preceded us. As a testament to their essence, efforts, and creative abilities, these places shape our cultural heritage as an essential part of our collective history and cultural identity.

In an increasingly inclusive society, the use and enjoyment -in a broad sense- that people make of cultural heritage and its assets are achieved through the full and effective participation of all individuals.

2. Accessibility and Heritage

Leon Battista Alberti, in his work *De re aedificatoria* [1], defined an architect as "One who, with a specific method and approach..., is capable of carrying out any work that... beautifully meets the most basic needs of human beings. " Through this description of the function of architecture, accessibility is recognized as one of its objectives for the first time in history (in 1450), defining it as an inherent practice of architecture.

The 2006 Convention on the Rights of Persons with Disabilities [2], held in New York and initiated by the United Nations, recognized the right of persons with disabilities to participate equally with others in cultural life. Access to monuments and places of cultural importance should be guaranteed to all people. However, accessibility to these places should be provided to the extent possible, considering the conservation duty. The interaction between accessibility and cultural heritage may seem complex and challenging even today. And, despite the recognition of the rights of people with disabilities, the duty to preserve the assets that make up our cultural heritage prevails.

Before the UN Convention, the Council of Europe, through the Framework Convention of the Council of Europe on the Value of Cultural Heritage for Society (Faro Convention, 2005) [3], recognizes the value and potential of cultural heritage. When used wisely, cultural heritage becomes a resource for sustainable development and improves the quality of life for a society in continuous evolution. The Council of Europe also emphasizes the importance of individuals and human values within a broader and interdisciplinary concept of cultural heritage.

Cultural heritage is not just a part of our cultural life; it also influences our daily activities as citizens. We must ensure that people with disabilities have the right to participate equally when accessing a historic center, the town hall in our city for work, leisure, and other activities, or even our own homes, all of which have some level of protection.

The question is how to ensure the conservation of inherited property for present and future generations while respecting the rights of persons with disabilities as outlined in the UN Convention.

The conservation of a cultural asset is best achieved when it serves a practical function for society and adapts to evolving uses and customs. This principle is recognized in the International Charter on the Conservation and Restoration of Monuments and Sites (Venice Charter, 1964) [4], which was adopted by ICOMOS in 1965.

The charter also emphasizes the responsibility to protect the cultural asset itself and the historical significance of which it is the object. This approach enhances the values and significance of cultural assets. Accessibility to a cultural asset must consider two aspects: physical access to the place and access to the values and significance for which it is recognized.

Cultural assets that are part of the lives of all citizens will be more easily and efficiently maintained over time. It is therefore essential to achieve accessibility in a way that aligns with the conservation of the heritage values of the cultural asset. This will ensure that its functional and cultural potential is enhanced.

3. Participation of the communities and Heritage

In the World Heritage Convention, UNESCO recommends five strategic lines for the conservation of cultural heritage [5]. These are known as the "five Cs": Credibility, Conservation, Capacity Building, Communication and Communities. The Budapest Declaration on World Heritage in 2002 added the "fifth C" for "communities".

The inclusion of "communities" in the Convention emphasizes the importance of strengthening the role of communities in preserving cultural heritage. It aims to ensure that people and communities value their cultural assets as a reflection and expression of their beliefs, knowledge, and traditions. It is essential that communities and society at large feel connected to the heritage and its values.

The recognition and identification of cultural heritage requires the participation of all citizens. Individuals and groups that might be excluded from the historical record because of disability, age or sex need to be identified and involved in the preservation and enhancement of our cultural heritage.

Involving reference groups in the process of preserving and improving the accessibility of cultural heritage will be crucial in achieving the desired results. These groups should comprise users with specific accessibility needs who can contribute their knowledge and experience. This includes all aspects of the user's interaction with cultural heritage, such as perceptions, emotions, understanding and responses.

4. Technical standards as a capacitation tool

"The first mistake is that we can talk about new and old. The built form has a complex relationship with time... Using and reusing is like thinking and re-thinking." These are the words of Enric Miralles and Benedetta Tagliabue when they met the challenge of rehabilitating the Santa Caterina market in Barcelona.

More executive in nature, the third of UNESCO's "Five Cs" strategies focuses on promoting effective capacity-building measures. It aims to facilitate the understanding of the Cultural Heritage Convention and the application of its instruments.

Accessibility plays a crucial role in the revitalization of cultural heritage by ensuring that everyone has the right to access and experience culture, considering human diversity. The rich nature of cultural heritage, such as monuments, archaeological sites, historical complexes, and cultural landscapes, requires a thorough understanding and approach to accessibility. It is important to establish consistent accessibility standards across these diverse cultural assets, and to do so with rigour and balance, using a methodical and disciplined approach, rather than relying solely on voluntarism. Standardisation efforts are in line with the objectives of the Capacity Building Strategy.

Technical standards are based on three key principles: attitude, because the process must be accepted and understood by the community; knowledge, because a delicate balance must be struck between accessibility and preservation; and consensus among a broad audience, including society and directly involved stakeholders.

The development of a technical standard in the field of accessibility to cultural heritage responds to an undoubted need to address an issue of enormous importance and sensitivity. It requires the search for balance and consensus between the different disciplines to be addressed. In this context, the ISO 5727 standard "Accessibility and usability of the built environment - Accessibility of immovable cultural heritage - Principles and methodology for interventions" is being developed, following a universal design approach.

5. ISO 5727: a standard in Accessibility to Immovable Cultural Heritage.

ISO 5727 “Accessibility and usability of the built environment — Accessibility of immovable cultural heritage — Principles and methodology for interventions” is currently under development within the framework of the International Organization for Standardization (ISO). It is based on the Spanish standard, the UNE 41531 IN [6], published in 2018.

The purpose of the standard is to provide general and technical criteria and a methodology for interventions in immovable cultural heritage to facilitate its use and enjoyment for all people. The standard should be considered in both conservation and rehabilitation projects, as well as in specific accessibility interventions.

Both the principles and the methodology presented are based on international precedents, studies and accessibility interventions to immovable cultural heritage. However, it should be noted that the standard does not cover accessibility measures related to management, such as services and maintenance. Nevertheless, it has been considered that these may be necessary complements or alternatives to the first.

When providing access to immovable cultural heritage, it is crucial to strike a balance between preserving its values and meeting specific social objectives. The standard ISO 5727 lays out strategic, technical, and operational principles that serve this purpose for any cultural asset undergoing intervention.

For example, two of the strategic principles state that heritage and accessibility should be given equal importance and that a multidisciplinary approach should be taken to any intervention. One of the technical principles suggests that reversible solutions should be chosen if they offer the same level of accessibility and safety as non-reversible solutions. Finally, an operational principle emphasises the importance of considering all relevant legal obligations, constraints and rights.

To carry out interventions effectively, it is important to follow a systematic approach towards the process and documentation involved. The standard develops a methodology

that considers the significance of immovable cultural heritage and systematically applies an inclusive approach by involving user groups throughout the process.

The methodology described in this document is illustrated in Figure 1 [7]. Although it is an iterative process, different parts may not always be carried out sequentially. Each step of the process and the outcomes to be achieved are explained below.

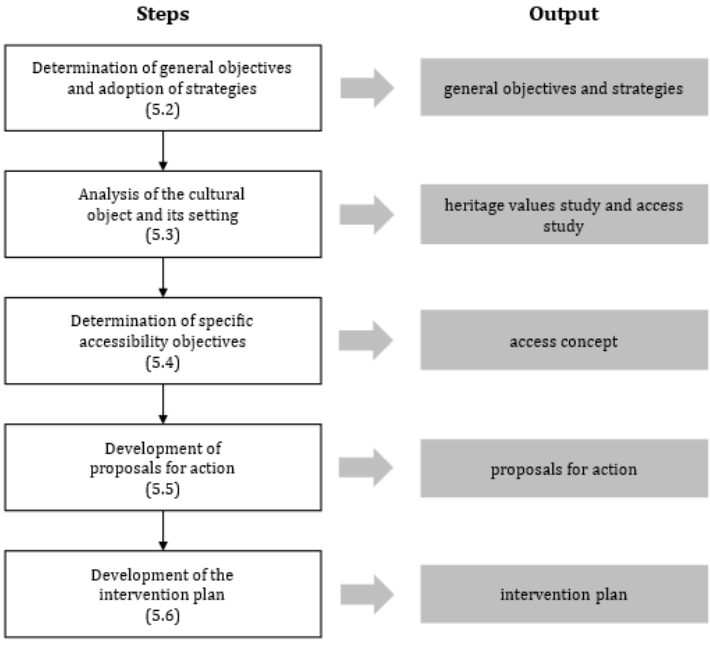


Figure 1 — Steps and outputs of the methodology

Firstly, it is important to define the accessibility objectives for the project, involving reference groups from the outset. These groups consist of users with physical, sensory, or cognitive impairments who can share their insights and experiences of accessing cultural heritage.

Factors such as the scope of the accessibility intervention, the typology, characteristics, uses and functions of the cultural asset, the potential users and their accessibility needs, the facilities and services provided by the cultural resources, and other relevant considerations must be considered in order to effectively set accessibility objectives.

Strategies to enhance accessibility should be identified to align with the intervention's purpose, and they should be implemented according to the established principles.

The analysis of the heritage values of a cultural asset is crucial to improve its accessibility within the framework of these values and to enhance its cultural appreciation and enjoyment. In addition, the analysis of the current accessibility conditions of the cultural asset is the first step in defining the accessibility requirements to be achieved by the intervention.

The analysis of accessibility conditions is documented in the Access Study. This document should provide a comprehensive analysis of the accessibility features and barriers present in a cultural asset in order to identify critical areas and elements where accessibility improvements are needed to ensure equal access and use.

These analyses, based on the current state of the cultural object, will serve as a foundation for developing action proposals. After evaluating the options together and comparatively, and with input from all stakeholders - including users of all abilities, ages, and backgrounds - the proposals that can form part of an intervention plan can be decided on. Accessibility improvements at similar cultural sites can be used as references for developing action proposals. The proven effectiveness of known measures should be considered together with potential new and innovative solutions.

Following that, the intervention plan can be formulated. The plan will include a set of actions that will shape the accessibility chain to achieve the intervention objectives. This should include prioritising and scheduling the actions, as well as monitoring their implementation and carrying out a final verification process.

The standard includes additional annexes to support cultural heritage stakeholders. The first annex focuses on the accessibility needs of potential users based on human abilities. It provides insights for defining accessibility goals and strategies. The second addresses relevant considerations for setting general accessibility goals. The third one focuses on cultural assets and the identification of their heritage values, which is crucial for recognising and analysing their full cultural significance. The last one provides examples of good practice for accessibility measures in immovable cultural heritage.

6. Cases of study for a methodology

ISO 5727 is based on international precedents, studies and interventions on the accessibility of immovable cultural heritage. Ten examples of interventions to improve the accessibility of cultural heritage are presented in the final annex of the standard to illustrate the proposed methodology.

The examples have been selected on the basis of the following criteria: the importance of the cultural object, the accessibility challenge and the process followed to determine the intervention.

The examples describe the accessibility assessment carried out to identify any physical, sensory or cognitive barriers, the issues considered, the steps taken, and the actions required to achieve the objectives.

Not all of them show the full set of actions and measures carried out, but only a part of them, but these examples show that it is possible to improve the accessibility conditions of cultural assets while respecting their values and significance.

The examples presented show that there are no single or universal accessibility solutions, and that each intervention may be different. In addition to the conditions of the cultural asset itself, other factors not entirely unrelated to the cultural asset, such as the cultural context, the geographical location, the local population, etc., have a direct influence on the solutions implemented.

7. Conclusions

ISO 5727 is conceived as a useful tool to enhance the conservation of immovable cultural heritage and to balance the achievement of specific social goals with the preservation of cultural values. This project is developed with the belief that accessibility can improve and expand the cultural and functional potential of cultural heritage.

Finally, the adoption of this standard contributes to the creation and consolidation of a culture of accessibility in the field of heritage, which is significant given that accessibility and the preservation of cultural assets have often been seen as opposing and irreconcilable goals.

The next step to be taken, once the standard has been approved and made available to interested actors, is its implementation in specific cases in order to make the necessary adjustments and achieve final validation. Nevertheless, ISO 5727 does not describe a one-way methodology; although the methodology is presented as a series of clear and distinct steps, it is an iterative process, and the different parts may not always be carried out in sequence.

As Saint Augustine said, the world was not made in time, but with time. Cultural heritage represents the intersection of the past and the future, making it especially important how we treat our legacy in the present. Our contribution to society in the present can be to facilitate the use and enjoyment of cultural heritage for all people through accessibility; perhaps in the future accessibility will be seen as a new value of our cultural heritage.

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Universal Design in Sustainable Tourism Certification Schemes

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Abstract. Universal design has played a modest role in Norwegian tourism policy, despite its potential for contributing to a more socially, economically and environmentally sustainable tourism industry. The increased interest in sustainability labeling schemes among tourism actors represents an opportunity to work towards universal design of tourism, provided these schemes encompass universal design criteria. Standards for universal design are important in creating recognizable solutions, not least for visitors who often consume services across different sectors in unfamiliar environments. Against this background, we investigated whether sustainable tourism labeling schemes include suggestions made in standards for universal design. Based on previous research on universal design in the transport sector, a coding structure was constructed and used to analyze a sample of 13 tourism-related standards for universal design and five sustainability labeling schemes used by Norwegian tourism actors. Findings show that labeling schemes for sustainable tourism to a very limited extent incorporate measures described in standards for universal design. Moreover, both labeling schemes and standards are primarily aimed at the physical environment rather than the organizational or social environments, and both dedicate little attention to employees. Nevertheless, standards for universal design comprise a much wider range of measures and user-groups. Integrating them into popular sustainability labeling schemes seems pertinent to raise awareness and foster practices that contribute to improve universal design of tourism.

Keywords. Universal design, standards, labeling scheme, sustainability, tourism

1. Introduction

Over time, policymakers have become increasingly aware of the importance of bringing in sustainability into the tourism sector [1]. Despite this trend, universal design (UD) has received little attention in tourism policy, also in Norway. Only recently, UD has been introduced, albeit briefly, in strategies [2] and roadmaps [3] envisioning the future of tourism and describing actions to realize that vision. The weak consideration of UD in tourism policies aiming towards sustainable development of the sector is surprising, as policymakers have acknowledged that UD is key in creating a sustainable society [4] and there is considerable potential for market expansions and subsequent financial gains from enabling more people to partake in tourism activities by employing principles of UD [5].

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Against this lack of focus on UD in tourism policies, voluntary industry-led initiatives may facilitate adoption and implementation of UD principles and measures in tourism and, thereby, exploit the social and economic benefits of improving UD. Sustainability labeling schemes are an example of such initiatives. Since the first sustainable tourism labels appeared more than four decades ago, their number has grown considerably and worldwide there are now more than 200 labels used by tourism business and destinations to provide information and capture demand in a competitive market [6].

However, as with sustainability policies, increased interest for sustainable labeling schemes among tourism industry actors does not necessarily need to translate into UD of tourism. For this to happen, sustainable tourism labeling schemes must at a minimum include UD criteria. Yet, to the best of our knowledge, no studies have assessed the extent to which such schemes include criteria for UD. Against this background, we investigated the extent to which suggestions made in standards for UD are included in a sample of sustainability labeling schemes used by tourism actors in Norway.

2. Body of knowledge informing the analysis

The choice of variables and documents included in our analysis builds on research on UD from the transport sector. With transport being an essential service in tourism, this body of knowledge is a relevant starting point for an analysis of UD in sustainability labeling schemes used in tourism. Prior research on UD from transport has shown that standardization is crucial in creating recognizable solutions [7]. It, thus, seems pertinent to guide our analysis of sustainability labeling schemes by contrasting the criteria posed by such schemes against recommendations issued by standards for UD.

However, standards, as well as guidelines and legislation, operate with various definitions of UD [7][8] issued by international organizations (e.g. United Nations), national legislative actors (e.g. Discriminatory Act) and advisory bodies (e.g. Centre of Universal Design). Additionally, the term accessibility is often used interchangeably with UD, despite accessibility having a much narrower scope. While accessibility is about facilitating access to buildings and areas by creating special solutions for specific groups [8], in its widest interpretation, UD is concerned with including *all* through multiple types of measures [10]. The crucial difference in a UD approach is, thus, that barriers experienced by people with disabilities *and* by other user-groups such as the elderly, children and women should preferably be addressed through measures that benefit everyone. The multiplicity of definitions implies that it cannot be assumed that UD standards and sustainability labeling schemes operate with a shared definition of UD.

Furthermore, research from the transport sector [11] has also indicated that– despite its intended broad scope – UD has mainly focused on what have been termed the *'classic'* disabilities – mobility, visual and hearing [12]. This focus has led to an over-prioritization of physical design and information measures [7][13][14] over i.e. interactional and organizational measures. While research on UD in tourism is sparse, a European study among people with disabilities, the elderly and travelers with children shows that attitudinal barriers are more frequent than physical barriers across sectors, with inaccessible toilets being among the most important barriers [5]. Further international research has also shown that people with disabilities experience barriers when meeting other people and needing assistance [16][17][18]. In Norway, research reveals a lack of training and systems to collect visitors' feedback, little cooperation with user organizations and low user participation [19], in addition to information barriers

[20] [21]. It seem, thus, relevant to assess which user-groups and needs are addressed in both standards for UD and sustainability labeling schemes, departing from a wide range of needs and user-groups [7][13] [14] [15].

Lastly, when working with UD, it is important to reflect on how barriers are understood. Contrary to the *medical* and *social* models that understand disability either as an individual condition or a social construction, the *relational* model views disability as a result of the interaction between the environment and abilities of the individual [20]. Consequently, barriers can be reduced both through environmental and individual adaptations. Aligned with this understanding, the 'capability approach' developed by Sen and Nussmann poses that wellbeing demands turning 'capabilities' and resources into 'functionings' – both 'doings' (e.g. travelling) and 'beings' (e.g. being healthy) – through so-called conversion factors: i) personal (e.g. intelligence, disability); ii) social (e.g. norms, policies); and iii) environmental (e.g. physical or built) [23]. The analysis presented in this paper adopts a multidimensional barrier perspective [15] building on the relational model [22] and the capabilities approach [23] but adding a fourth conversion factor: the organizational [15] to assess which environments are addressed in UD standards and sustainability labeling schemes.

Building on prior research, Table 1 summarizes the main variables and categories informing the analysis presented in this article.

Table 1. Key variables and categories emerging from research on UD in the transport sector.

Definitions	User-groups [7]	Measures [24]	Environments [15]
UD - United Nations	Mobility disabilities	Physical design	Physical - built, natural and digital
UD - Discriminatory Act	Visual disabilities	Information	
	Hearing disabilities	Interaction	
UD - Center of Universal Design	Cognitive disabilities	Organizational	Social - social context around service
	Psychosocial disabilities	Maintenance	
Accessibility	Digestive & urinary diseases	Essential	
	Respiratory & environmental barriers	Sensory	Organizational - how systems are organized
	Seizure-related illness		
	Age (e.g. children, elderly)		
	Gender		
	Minority (e.g. religion, cultural)		
	Language		

3. Method

3.1. Sampling of documents

The selection of standards for UD aimed covering multiple tourism products and services. Standards were identified through systematic searches on the websites of Standard Norway (SN) and the International Organization for Standardization (ISO). Relevant transport-related standards documented by Nielsen et al. [7] were also considered. The sampling and analysis occurred stepwise. The first six standards were selected based on three criteria: they i) focused on typical tourism experiences and services; ii) were not limited to specific situations such as emergencies; and iii) were a priori not restricted to particular users. This initial sample was extended by including standards for UD of more specific elements. Table 2 provides a list of the reviewed standards.

The sample of sustainable tourism labeling schemes included in the analysis consisted of both Norwegian and international schemes for destinations and businesses, to enable comparative analysis across levels (business/destination) and geographical scope (Norwegian/ international). Schemes were selected in cooperation with The Norwegian Hospitality Association and Innovation Norway's tourism department, to ensure inclusion of the most frequently used sustainability schemes among tourism actors in Norway. The five sustainability labeling schemes reviewed are listed in table 3.

Table 2. Sample of analyzed UD standards (*initial sample)

Standard	Topic	Standard	Topic
ISO 21902:2021*	Accessible tourism for all	NS 11030:2013	Personal services
NS 11036:2018*	Tourism experiences	NS 11001-1:2018	Public buildings
NS-EN 15565:2008*	Training of tour guides	NS 11005:2011	Outdoor areas
SN-CEN/TR 15913:2009*	Spectator facilities	NS 11031:2017	Transport - buses
NS-ISO 20121:2012*	Sustainable events	NS 11032:2017	Transport - passenger rights
NS 11033:2017*	Passenger transport services	NS 11022:2013	Vendor machines
		NS 11021:2013	Electronic documents

Table 3. Sample of sustainability labeling schemes included in the analysis.

Name	Level	Scope	Criteria sets
Bærekraftig reisemål	Destination	Norway	2 sets: 1 general and 1 for cruise destinations
European Tourism Indicator System	Destination	Europe	1 set including core and supplementary indicators
Global Sustainable Tourism Council	Destination	Global	1 set for each level, with some criteria overlapping across levels
	Tour Operators	Global	
	Accommodation	Global	
Miljøfyrtårn	Business	Norway	14 sets: one general and 13 sector specific
Green Key	Accommodation	Global	1 set including mandatory and advisory criteria

3.2. Document analysis

The sample of UD standards and sustainability labeling schemes were analyzed based on thematic analysis [25] using a codebook [26] reported by Landa-Mata et al. [26]. Both UD standards and sustainability labeling schemes were coded on i) which definition of UD was used; ii) which user-groups were referred to, iii) what types of measures were described; iv) and which environments were addressed. Themes were, thus, developed deductively and constitute explicit topics that build on the codebook, not latent meanings.

The codebook was initially structured around variables and categories presented in table 1 but evolved throughout the coding process. Adjustments included (but were not limited to) the inclusion of user-groups based on their role as consumers (visitors), employees and other parties (suppliers); the incorporation of a new user-group (people with language-related needs) and new measures (planning, purchase and collaborative); and an improved understanding of organizational measures.

The analysis was conducted in two stages, being sustainability labeling schemes analyzed (phase 2) after the completion of the UD standards analysis and the adjustment of the codebook (phase 1). The coding in phase 1 was conducted by two researchers, each of whom coded a subsample of standards. Cross-checking of coding was limited to situations in which uncertainties arose, particularly at the beginning of the coding process. Standards were coded and analyzed using the software NVivo. Phase 2 was carried out by a second pair of researchers who initially coded *one* labeling scheme each before meeting to assess coding consistency and splitting the remaining labeling scheme between them.

4. Results and discussion

4.1. Inconsistent use of concepts

The analysis showed that the UD standards operate with varying definitions of universal design and that the definitions applied do not always align with interpretations emerging through the standards. For instance, NS11001 states that it is based on UN's definition of UD, but presents measures aimed at improving accessibility by adding adjustments (e.g. a ramp or a lift) to non-universally designed physical environments (e.g. stairs) rather than changing their design to make them accessible for all.

The analysis further showed that criteria and indicators for UD were poorly integrated into sustainability labeling schemes analyzed. When such criteria were included, they were mainly directed at accessibility, rather than UD. Only one of the sets of the Miljøfyrtårn scheme (Facilitation for Outdoor Activities) refers to UN's definition of UD, both explicitly and implicitly (through measures included). In this sense, UD standards can inspire sustainability labeling schemes, particularly if standardization bodies manage to work towards a more consistent use of definitions.

4.2. (Under)prioritized user-groups

A substantial part of the recommendations (UD standards) and criteria (sustainability labeling schemes) are focused on a narrow set of user-groups. Both UD standards and sustainability labeling schemes dedicate very little attention to employees. Only 2 of the 13 UD standards (ISO21902 and NS11001) describe measures referring to this group through the creation of work opportunities for all, and/or implementation of physical adaptations, policy design and evaluation. In comparison, sustainability labeling schemes perform somewhat better, as 2 out of the 5 schemes (Green Key and GSTC-Destination) include criteria to create work opportunities for all and improve accessibility for employees. However, none of the Norwegian schemes included such criteria.

Findings show that needs related to gender, minority background, psychosocial disabilities, and digestive and urinary tract-related diseases are also underprioritized in UD standards, as these user-groups are only mentioned in one UD standard. The analysis revealed also very few references to people with seizure- and language-related needs. In contrast, users with cognitive disabilities and respiratory diseases are mentioned more frequently (9 and 5 out of 13) in UD standards analyzed than what has been found in prior research on UD in the transport sector [7]. Most attention is dedicated to people with mobility, visual and hearing disabilities, as expected based on previous research. Individuals with age-related needs (children, elderly and adults with children) also receive substantial attention and are mentioned in 10 of the 13 analyzed UD standards. Furthermore, we found multiple references to diverse/non-specific user-groups such as "all customers/visitors" and people with "diverse disabilities". This could be seen positive, as design for all is the goal of UD. Yet, this approach can also conceal the needs of individuals who require particular adjustments.

Sustainability labeling schemes analyzed mainly address people with diverse disabilities, although some of the international schemes also mention user-groups with no functional disabilities such as gender and people with minority background. Moreover, one set of the Miljøfyrtårn scheme (Facilitation for Outdoor Activities) mentions specific user-groups through references to established guidelines, being most frequently mentioned users with mobility and visual disabilities, followed by users with age-related

needs (mainly children and adults with prams), seizure-related illnesses, and minority-related needs. This is, thus, the criteria set that includes the widest range of user-groups and the only one based on UN's definition of UD among sustainability labeling schemes. We find, however, no clear relation between the definition employed and the number of user-groups included in our analysis of UD standards. While ISO 21902 (which, among others, uses UN's definition) is admittedly the only standard to mention all user-groups, we also find standards that do not refer to this definition and yet, include various user-groups (e.g. NS11036) and standards that refer to UN's definition, but encompass only a few user-groups (e.g. NS11030). This suggests that a broad definition of UD is no guarantee for embracing a wide array of users.

4.3. Sustainability labeling schemes fail to capitalize on the breath of UD measures

Findings from the analysis of measures described in UD standards and sustainability labeling schemes are summarized in table 4, which shows the total number of references for each measure type and the number of standards and schemes that mention each measure. This table includes the three additional measures identified during the analysis: plan, procurement, and collaboration.

Table 4. Types of measures suggested by UD standards and sustainability labeling schemes.

Type of measure	Standards for UD		Sustainability labeling schemes	
	No. references	No. documents	No. references	No. documents
Physical design	545	10	37	5
Information	284	12	18	5
Interaction	134	10	0	0
Organizational	67	9	3	3
Maintenance	48	5	2	1
Essential	54	6	1	1
Sensory	164	7	0	0
Plan	63	8	16	3
Procurement	14	6	0	0
Collaboration	30	6	3	3

As illustrated in table 4, results vary slightly depending on how occurrence of measure types is assessed. For instance, information measures are mentioned in more UD standards than physical design measures, but the latter rank highest when measured in number of references. That being said, assessments paint a similar picture: physical design measures receive far more attention in both UD standards and sustainability labeling schemes, followed by information measures. The high ranking of physical design measures is, however, not surprising in view of prior research on UD from the transport sector.

A further key finding illustrated in table 4 is that sustainability labeling schemes have a much narrower vision on how to address UD than standards, which all together cover a much wider range of measures, despite also having a bias towards physical design measures. While there are many references to sensory and interaction measures in the UD standards, sustainability labeling schemes fail to include these types of measures, as well as procurement measures. This is surprising given the importance of social relationships, multi-sensory experiences and the prevalence of product packaging in tourism. Also, essential and maintenance measures are only mentioned in one set of the Miljøfyrtårn scheme. This can create challenges in the long term, as UD measures that are not maintained (e.g. hearing loops, information systems, etc.) risk malfunctioning,

and essential measures (e.g. accessible toilets, food and drinks) are measures that all user-groups, including employees, can benefit from. Moreover, many of the UD standards refer to organizational and planning measures, but only the later received substantial attention among sustainability labeling schemes. Having said that, we also observe that measures relating to procurement, collaboration, maintenance and essential measures are mentioned to a very limited extent in the analyzed UD standards.

4.4. Limited focus on the social and organizational environments

Lastly, the analysis reveals a very limited focus on social and organizational environments. While 11 of the 13 UD standards analyzed refer to all three environments (physical, social, and organizational), there are significantly more references to the physical environment. Moreover, no references to the social environment and only a limited number of references to the organizational environment were found in the sustainability labeling schemes. This finding appears to be linked to the identified dominance of physical design and information measures, many of which – though far from all – address the physical environment.

5. Conclusion, limitations and future research

Findings show that labeling schemes for sustainable tourism to a very limited extent incorporate UD and can be improved by building on the breadth of user-groups and measures addressed in UD standards, despite their overly focus on the physical environment and *classic* user-groups. Findings also call for increasing attention on neglected user-groups, measures and environments. Including the needs of the employees and underprioritized groups and addressing the organizational and social environments is crucial to develop tourism services and experiences that can be enjoyed by all and enhance the social sustainability of tourism.

As far as we know, this is the first paper assessing integration of UD standards' criteria in sustainability labeling schemes used by tourism actors in Norway. The analysis expands previous analytical frameworks used in research on UD by identifying three new measures: planning, procurement and collaboration. This has also important practical implications, as these three measures create the foundations for providing solutions that are experienced by end-users and expand our understanding on how to approach UD. Findings imply there is a need to improve consideration of UD in sustainability labeling schemes, so that UD is not overlooked by businesses and destinations interested in becoming more sustainable. Under the increased interest for working with sustainability among destinations and tourism business, incorporating UD standards' criteria into sustainability labeling schemes can contribute to foster UD in tourism.

This paper has, however, important limitations. Findings are based solely on document analysis of UD standards and sustainability labeling schemes, and they do not reflect actual work with UD within the tourism sector. Future research should, thus, explore whether tourism actors implement UD standards, which user-groups, measures and environments they prioritize and why, as well as include the perspectives and experiences of all potential users (including employees). Moreover, the analysis is limited to a relatively small sample of UD standards. A larger sample, including UD standards used in tourism and related sectors (e.g. Scandic's accessibility standard and the Accessibility label for the cultural sector), might have yielded different results.

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Values Against Values. A Study of an Encounter Between Cultural Heritage Values and Values of Accessibility

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Abstract. In Norway the vision and principles of Universal Design have in an amazingly short time grown deep roots in public management and laws, as well as in the general attitude. This is partly due to political will and pressure, but also to the role played by the disability NGOs. The challenges come when political processes are pushed forward without sufficient involvement, be it people with various impairments or the cultural heritage sector. This paper, built upon a Master's degree in Inclusive Architecture, Aalborg University, Copenhagen, (1) is a discourse analysis of the process of making the Akershus Castle accessible, the most important historic monument in Oslo and a site of government receptions. The case illustrates the changes in law, heritage principles, and politics, but even more the dynamics of the process that went on for more than a decade, involving the highest political and heritage authorities, the importance of words and communication, and the play for hegemony leading up to the final solution.

Keywords. Discourse analysis, Cultural Heritage, Accessibility, Universal Design, Public Management

1. Introduction

Cultural heritage has many values and functions. Many uses heritage as pure entertainment, or as a backdrop to stage important events. To others, heritage is a way to reflect on existential questions related to common mem identity, and our place in history.

The question about "how accessible the cultural heritage is", is, in the deepest sense, about prerequisites for different ways of analyzing and understanding the values of this heritage.

The right to access can lead to changes of the heritage monument, and consequently a pressure on cultural heritage values. Values and rights may conflict. These dilemmas cannot be resolved by legal means alone, but through compromises where both sets of values are safeguarded to the greatest extent possible.

In this field, the use of words and expressions are important. Words are often far from neutral and can block counterarguments. The discourse on making cultural heritage available makes visible differences and similarities, and mechanisms that are important to understand what is really happening, and to find a common language.

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This article is based on a a case where the process and the trade-offs were fraught with conflict, making Akershus Castle in Oslo accessible (2). The result is celebrated by both authorities of cultural heritage and of universal design, but the long, costly, and complicated process, unveils the tactics, the use of political power, but not the least, the differences in words and values.

2. Method

The method chosen for this research is discourse analysis, which makes it possible to analyse various views and issues based on defined texts. Different layers and views encounter and change during a process. The discourse analysis used is based upon the book "Hvordan bruke teori? Nyttige verkdøy i kvalitativ analyse" (Johannessen et al, 2022) (3), where the relevant method is inspired by Rosalind Gill and Jan Grue. They define a discourse as a collective frame of understanding, meaning the underlying shared form of understanding.

The way we communicate about phenomena has consequences for the individual and society. The theory speaks about representations, which are a linguistic description of a phenomenon.

The specific texts used are transcriptions of four interviews with people engaged in the process, two from the heritage and two from the universal design side, and a number of texts from process letters, press releases, as well as articles in the public press.

Central in this work is the question of power, power to define and to decide, and in which way the power balance moves through the process.

3. The importance of the Cultural Heritage

The cultural heritage is vital for the exploration of history, and the meditation upon shared memories and common identity, be it local, national, or international. There is consensus that cultural heritage carries great values for society as well as for the individual citizen. Consequently, it must be protected against damage and falsification. The vulnerability and rarity of some of the heritage monuments and sites, make them fragile and not renewable resources.

The cultural heritage has no inherent values as such. The heritage values are defined by us humans. The sources of the defined values are in the monuments themselves, in their credibility, where the concept of authenticity is central. By law, nations recognize the values and make the cultural heritage common, democratic assets.

The right to access will sometimes lead to changes of the cultural heritage and consequently possible pressure on their values. This could be pure wear and tear, but also changes to make it possible for people with different impairments to have their share of the heritage. Values and rights may clash. The encounter between the professional fields of cultural heritage and universal design demands careful balancing and dialogue.

4. Words carry meanings

The inevitable clashes between the protection and the accessibility professionals are often about the use of words and expressions, and the meaning the participants put into these. Some words are far from neutral, and some may also block counter arguments.

Experience from decades in the heritage sector, shows that in search of practical solutions to accessibility, even arguments with great consensus become subjective when defined by individual actors. When scientific values are defined by heritage professionals, the arguments are easily seen as elitist, which by others may be seen as unacceptable.

When values are defined by the accessibility side, legal or emotional arguments are often used. Legal arguments are perceived as absolute and not up for discussion. Emotional arguments, like the word "dignity", are difficult to counter, because people with disabilities are seen as "the weak part".

The discourse about making cultural heritage accessible expose differences and similarities, and mechanisms that are important to expose, to understand what happens.

5. The right to cultural heritage

The cultural heritage is protected by national laws and international charters. The "Act concerning the cultural heritage" (Heritage Act) of Norway, 1979, (4) is a law to protect the heritage sites and monuments, and not a bill of rights. §1 says that: "It is a national responsibility to safeguard these resources as scientific source material and as an enduring basis for the experience of present and future generations and for their self-awareness, enjoyment and activities."

It seems natural that a consequence of this being "an enduring basis for the experience of present and future generations", is a right to access to the heritage for all.

The same applies to the "Venice Charter", 1964, (5) which in its preamble says: "It is our duty to hand them (the monuments) on in the full richness of their authenticity." This is also about protection, and not about the right to access to the protected resources.

The Council of Europe's "Convention on the Value of Cultural Heritage for Society" (Faro Convention), 2005, (6) however, says in article 1: "The Parties to this Convention agree to: a) recognise that rights relating to cultural heritage are inherent in the right to participate in cultural life, as defined in the Universal Declaration of Human Rights."

6. The right to access

The United Nations' "Universal Declaration of Human Rights", 1948, (7) article 2, says: "Everyone is entitled to all the rights and freedoms set forth in this Declaration, without distinction of any kind, such as race, colour, sex, language, religion, political or other opinion, national or social origin, property, birth or other status." In spite of this clear message, the rights of people with impairments were not regarded as protected.

This was the reason for why United Nations in 2006 adopted the "Convention On The Rights Of Persons With Disabilities", (8) CRPD, (ratified by Norway in 2013) where the preamble specifically mentions: "the importance of accessibility to the physical, social, economic and cultural environment, to health and education and to information and communication, in enabling persons with disabilities to fully enjoy all human rights and fundamental freedoms."

7. Akershus Castle

To comprehend this case, the involvement of the various authorities and the public interest, a brief introduction to the history of the monument is needed.

Akershus Castle dates to the years around 1300, when it was built as a fortification to protect the medieval city of Oslo. The castle soon became royal residence when the Danish Norwegian king was in the city. Between 1380 and 1814, the castle was the administrative centre of Norway.

The castle lost much of its importance during the union with Sweden, 1814 – 1905, but the symbolic function grew at the end of the period, with the rising national self-confidence leading up to Norway's independence in 1905.

A committee to rebuild the castle to its former glory was set up in 1896. The rebuilding work intensified after 1905, and the best contemporary heritage architects were engaged. The celebration of the 75th anniversary of king Haakon in 1947 introduced the castle's function as the nation's most prominent place for representation.

Today, the castle is a conglomerate of styles and building periods. The whole complex is protected by the Cultural Heritage Act, including the main entrance to the representation premises, the "Arneberg stairs", first used in 1947.

8. The discourse analysis

As a basis for the discourse analysis lies four interviews with people heavily involved in the process, one from the Norwegian Defence Estates Agency, one from the Friends of Akershus Castle, and two from two different NGOs working for people with disabilities, as well as case documents and news articles.

In this case, three distinct discourses came to light. During the process of making Akershus accessible they challenged each other. New aspects came in and altered the direction of and the relation between the discourses.

The discourses are as follows:

The cultural heritage discourse takes place in the professional heritage environment, with the goal to take care of and protect the monuments. There is a focus on the protection of the monuments' authenticity. All changes are regarded as possible threats to the genuine monuments. Adjustments for accessibility reasons may easily mean threats.

The public management discourse comes from the political bureaucratic environment, that forms rules and laws used by the public authorities. This discourse is predictable in periods of political stability, whereas in times of political and ideological shifts this discourse is more changeable.

The accessibility discourse takes place in the environments working for universal design and accessibility. Accessibility is a legal right. This discourse comes from a history of exclusion, which creates activism and will to fight.

9. A diachronic analysis

The diachronic analysis follows the development of the process, which in this case is of making the castle accessible. It is divided into three phases.

Phase 1: The period leading up to 2012

The cultural heritage discourse dominated. The monument was managed by the Directorate for Cultural Heritage (DCH) and the Norwegian Defence Estates Agency (NDEA). Improved accessibility was on the table, but the ideals of the Venice charter were predominant. The charter's paragraph 3 defines the aim of the protection as "to safeguard them (the monuments) (…) as historical evidence", while paragraph 5 says "The conservation of monuments is always facilitated by making use of them for some socially useful purpose," but adds that "such use is therefore desirable, but it must not change the lay-out or decoration of the building." This meant a restrictive practice.

The "power" was in the hands of those who had the right to interpret the Cultural Heritage Act. The necessary changes for accessibility were "not compatible with the tolerance limit" to the monument, to quote one of the informants.

Phase 2: The period from 2012 till 2017

In this phase the public management discourse challenged the cultural heritage discourse and took over the hegemony.

Scientific discourses do change over time, but it is rarely easy to find the exact time of change. In this phase the cultural heritage discourse changed due to the influence of the public management discourse, and this had specific consequences for the work on universal design and accessibility. The informants pointed out a clear "change of mood".

Looking at the international stage, there were changes both in the universal design and the cultural heritage sectors. The cultural heritage discourse changed from a strong emphasis on the protection of the original substance to the experience of and the humans' relation to the monuments. The Council of Europe adopted the Faro convention, which talked about the cultural heritage's value for society, ratified by Norway in 2008. This widened the scope from monuments and sites to include human beings and society, to put it simple. Norway's ratification of the CRPD, in 2013, is also important.

In 2012, the DCH and the NDEA signed a cooperation agreement, which led to a more regular contact between the two. That summer, the Ministers of Defence and of Environment put publicly forward a wish to make the Akershus Castle "universally designed" before the 200-anniversary of the constitution in 2014. Such wishes usually put pressure on and direct directorates and other public authorities. The following year two alternatives for access to the castle were put on the table.

In July 2016, two years after the anniversary in 2014, the Government decided to go for the so called "Blue Tower alternative". The decision was presented at a highly profiled press conference, by the Minster of Defence, who emphasised that this was to improve accessibility to both the state receptions *and* to the public who would visit the castle. The Minister of Environment, the head of a major political party, as well as the Commander of the Akershus Castle were also present. This event was important for the government's public profile, to show it cared for people with disabilities. The emphasise was on accessibility, as the heritage values were hardly mentioned.

In an interview the Minister of Climate and Environment, where the DCH belongs, challenged the representation of the heritage authorities as "not flexible" and an authority "working against practical solutions".

In reality, the DCH had been the promotor of these solutions, according to the informants, which came as a surprise to many in the conservation field, who were used to the directorate's restrictive practise of defending the monuments' authenticity.

At the press conference and in the press release, people with disabilities were absent. This was obviously a decision made "for someone" and not "in cooperation with someone". The only exception was an experienced NGO representative, who was there to secure the quality of the solution already decided. He pointed out a missing general approach in the project since it only dealt with the entrance to one building and not the access to the castle as such. The broad approach to universal design was also missing.

The government's decision was made on a principal level; the detailed solution had to be worked out by the professionals. A year later, the NDEA sent a detailed application to the DCH, since a dispensation from the Heritage Act was needed. From the cultural heritage point of view, the necessary changes, or the damages to the heritage fabric, would be directed to one point, to save other buildings and archaeological material.

What was not mentioned at the press conference was that in reality the plan was to have two entrances, (Figure 2) one with a lift, in the Blue Tower, and the other, the traditional, at the Arneberg Stairs. The capacity of a lift in the tower would not be sufficient to provide for all the guests at the state receptions. The entrances should, however, have the same dignity, and were therefore seen as equals. The Blue Tower entrance would not be a secondary "back door".

Two months later, the Friends of Akershus Castle sent a letter of concern to DCH. They were worried how the interventions would affect the historic fabric and asked for alternatives solutions. They also pointed out that this was not a "universal design solution", but only "accessibility". It seemed like the heritage discourse and accessibility discourse together challenged the public management discourse. The friends' group had in their remit both to protect the monument and secure access for the public.

In October the application for dispensation was accepted, saying the ideal of universal design had priority, if compatible with the cultural heritage values. The DCH explicitly said that the heritage monuments in general should be visited and experienced by all. DCH supported the NDEA's priority of the access to the representation premises.

In November both the Friends of Akershus Castle and the regional office of the National Trust forwarded their complaints against the dispensation. December 19, DCH sent the complaints to the Ministry. The same day, DCH made public a press release, primarily pointing out the positive sides of the decision, which was made in close cooperation with the NDEA in a project supported by the government. The forwarded complaints were only mentioned at the end of the release, without a word about their contents. The press release focused on the mediation of the heritage values, and emphasised the work done to reach the solution. "This is the only solution that gives access to all who would need it, not only the wheelchair users," followed by "universal design is about letting all have the possibility to experience this history". The priority given to the access to the representative premises was not mentioned.

Phase 3: The period from 2018 till 2021

The dominating discourses from the two first two phases were seriously challenged by the accessibility discourse, which took over the hegemony. This discourse had in phase 1 and 2 been kept in the background, not the least by the public management discourse which tried to incorporate elements of it, without sufficient success.

In this discourse the nodal point was "equality". The organisations representing the target group for the accessibility work accepted the argument that the values of the cultural heritage set limits for the *degree* of accessibility. However, there was a limit to

their flexibility of the definition of "equality". The disabled themselves had the power to define this.

2018 started abruptly with an unbureaucratic initiative taken by the trade press of the defence forces and the equivalent of a disability organisation, which brought forward new perspectives as well as new players.

The appeal deadline had been passed several weeks when representatives from The Norwegian Association of Disabled (NAD) were interviewed. The journalist invited NAD to see the premisses and comment on the solutions decided by the government. They had serious objections. The article also told that the Ministry of Defence "did not want to comment on the fact that the Minister of Defence presented a solution the disability interest organisations criticize heavily". By not being willing to comment on the objections, the ministry withdrew from the public space, and practically gave the hegemony to others.

The message from the disability organisations were twofold: The case was a bad example on "user involvement". The involvement came after the major decision was made, and it was only to advice on technical matters. Secondly, this was not universal design, but only accessibility measures. NAD also brought in the concept of a "B-entrance" that made people with disabilities "feel stigmatised and discriminated against".

The concepts "B-entrance", "stigmatisation", and "discrimination" are all powerful rhetoric. The words are taken directly from the disability discourse vocabulary. The conversation was now turned away from tolerance limits of the monuments, proceedings and who has the right to decide what, to a question of "equality" and "rights". This was a language understood by both politicians and the public.

The same day as the article was publicised, NAD sent a letter to the Minister of Defence with the following message: "It is a strong signal if the government chooses a solution that makes the disabled guests, be it monarchs, politicians, veterans or others, use the back entrance to the government's premises and arrangements".

Objectively, this is a power language no minister wish or can argue against. The hegemony of the public conversation was immediately moved over to the disability organisations. The dynamics of the case had been altered dramatically. The cases with the official complaints were never finalized.

The whole project, which had been worked on for years, was restarted with representatives of the disability organisations on board, and ended with the celebrated solution that was materialised in 2021.



Figure 1. The Arneberg stairs at the celebration in 1948. Foto: Oslo Bymuseum.



Figure 2. The courtyard of Akershus Castle. Arneberg stairs to the left, and the new addition including the lift. The Blue Tower in the background. The state receptions are held in the Christian IV gallery first floor, behind the tower. Foto: Oddbjørn Sørmoen.

10. Conclusion

The discourse analysis made from the case of making Akershus Castle accessible shows in interesting dynamic between the three discourses of cultural heritage, public management and accessibility/universal design over a decade. The authorities represented by the Directorate for Cultural Heritage, the Norwegian Defence Estates Agency and the Government played their given roles as authorities, without involving the disability NGOs, and consequently the target groups for the changes, from the beginning of the process. This delayed the process by several years and added huge costs as well as loss of prestige.

The result, however, became a huge success for all parts, even though the intention of making the whole complex comply with the ideals of universal design was not met. The universal design entrance to the government receptions had priority.

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Universal Design of ICT, Digital Accessibility and Inclusion

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Predicting Digital Accessibility Through a Self-Assessment Test of Process Traits

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Abstract. We have developed an 11-question self-assessment test that predicts whether a team is likely to develop accessible digital solutions – or not – based on the characteristics of the development processes. Our results indicate the test can predict both successes and failures with regards to accessibility of digital solutions. As such, teams and product leaders now have an easy way to identify whether the team's knowledge, practices and mindset makes them likely to deliver accessible digital solutions. Further, the test identify which changes are needed for the team to better ensure digital accessibility.

Keywords. Accessibility, Self-assessment test, Universal design, Agile software development, Best practice.

1. Introduction

Current legislation on universal design of ICT is mainly concerned with technical accessibility and tells you *what* to achieve – but not *how*. Lazar, Goldstein and Taylor [1] point out that a shortcoming in accessibility regulations is they leave out organizational aspects like enforcing the implementation of compliance monitoring and process guidelines. According to Fuglerud and Sloan [2], there is a heavy focus on adhering to the regulations and standards set forth by the legislations while there is a lack of emphasis on the development process. This article is focused on the practices within development processes of digital solutions who are being acclaimed for achieving accessibility. The paper presents an effort to identify and communicate their common key characteristics – thus supporting teams in implementing practices that will better ensure the development of accessible digital solutions. We ask the following research questions:

1. What are the key characteristics of the development processes of digital solutions that achieve accessibility?
2. Can these key characteristics help predict whether a team is likely to develop accessible digital solutions?

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2. Research Approach and Results

Our research is a qualitative, empirical, and exploratory case study. This is appropriate for studies seeking to understand how people interpret their experiences and insights into informal, unstructured and complex practices in organizations [3,4]. The research is divided into two parts. The first part is focused on providing insight into practices from Norwegian ICT-projects having successfully achieved universal design or accessibility. The first research focus is thus on investigating which practices should be implemented to achieve accessibility. The second part explores the possibilities of indicating the likelihood of achieving accessibility. This part suggests a predictive self-evaluation tool specific for UD in IT-projects. The self-assessment tool is based on a feature analysis of the findings in part one. Through prototyping an evaluation tool measuring the compliance of ICT-projects to our identified success factors, the ability to predict success is explored. Finally, the study tests the suggested self-evaluation tool to tentatively confirm or refute initial validity.

2.1. Interview Study to Identify Key Characteristics

To answer the first research question, we identified a set of creditable awards related to accessibility and universal design. It should be noted that the criteria differ between the awards, but all include accessibility as one of several central criteria. For each award, we identified digital solutions that had either won the award, or received an honorable mention or were a runner-up. Some solutions received more than one award. To make the selection criteria more transparent, an overview of the identified awards (from 2010-2017) is presented in Table 1. Two awards remain unnamed, due to traceability concerns.

Table 1. Awards from which included digital solutions winning/receiving honorable mentions are sampled

Award	Distributor	Digital solutions sampled
Public Website of the Year, Online Quality	DIFI	6
Badge for Good Design	DOGA	6
Innovation Award for Universal Design	DOGA	5
Design for All Award	DOGA/Delta Center	3
Farmand Award	Farmand AS	3
Digital Service of the Year, Online Quality	DIFI	1
Unnamed: Young design	-	1
Unnamed: International	-	1

Next, we identified individuals having a direct affiliation with the development of a digital solution winning these awards or receiving honorable mentions and reached out to them to ask for participation in a semi-structured in-depth interview. The informants consisted of 15 designers, 9 developers (front- and back-end), 2 project managers, 2 creative directors and 3 advisors; 1 senior UD advisor with developer background, 1 web advisor and 1 communication advisor. We asked all respondents what characterized their development processes while simultaneously allowing for follow-up questions [5]. Interviews were recorded and transcribed verbatim.

An initial sample included 13 participants affiliated with 12 digital solutions [6]. A thematic content analysis was used for emergent coding. Because of overlapping responses to the open-ended questions, transcripts were analyzed as a continuous text, as opposed to questions consecutively. Researcher 1 identified 103 unique codes regarding characteristics: 75 promoting and 28 obstructing and Researcher 2 identified 104 codes, 75 promoting and 29 obstructing. Inter-coder reliability was calculated, with a 98 %

overlap between the 150 promoting codes and 95 % overlap between the 57 obstructing codes [7]. The sample was increased to make findings more statistically significant. We added 18 additional participants from 9 digital solutions – totaling up to data from the development of 21 accessible solutions. Before treating all the data as belonging to the same sample, empirical background data was converted from semantic to numeric to check for significant differences between the first 13 and the subsequent 18 participants. As most variables were at nominal level, Pearsons Chi-Square was used, and no statistical differences were found. The expanded data set of transcriptions is analyzed using a directed content analysis approach [8].

The goal of qualitative content analysis is recognition of significant themes and categories within a body of content through careful coding and interpretation [9]. The directed approach does not use a strict a-priori coding scheme or a fully emergent approach. Instead, a-priori codes and categories described in [6] are used as a basis while still allowing new codes or categories to emerge. Only minor changes to coding were done based on the expanded sample (7 new codes added, 3 obstructing and 4 promoting). As the data increased, the transcripts were imported into the NVivo program, linking relevant transcript sections to categories (nodes).

Our thematic analysis of this qualitative data set identifies 86 characteristics described as promoting or obstructing accessibility. An interesting observation is that promoting and obstructing characteristics seem connected, where obstructing factors may be viewed as missing promoting factors. The characteristics were categorized across four categories: Societal, Organizational, Processual and Personal (see Figure 1) with 22 subcategories (12 promoting and 10 obstructing) and 45 sub-subcategories.

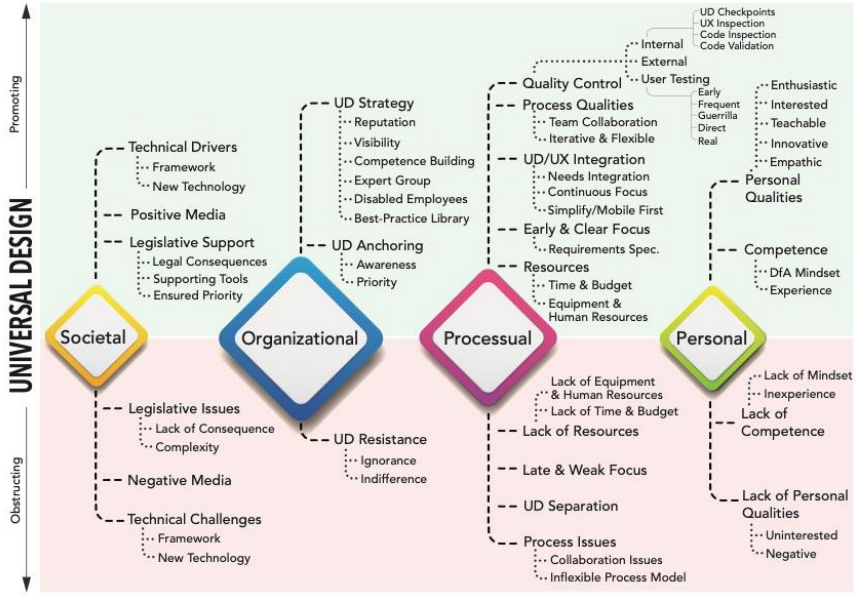


Figure 1. Characteristics of processes achieving accessibility.

Key characteristics were identified by looking at the *frequency of mentions* of each characteristic in the interview transcripts. To be as precise as possible, a key characteristic was always set on the lowest possible category-level reaching the threshold. If a sub-subcategory reaches the threshold, it is a key characteristic. If not, but its

subcategory reaches the threshold, the subcategory is a key characteristic. The threshold was set at a characteristic being coded more than 50 times in the data set *as well as* mentioned by at least 2/3 of the participants. This resulted in 15 key characteristics (see Table 2).

Table 2. Key characteristics for ensuring accessibility in the development of digital solutions

Key Characteristic (category)	Description
Legislative support (societal)	Legal consequences in place; supporting how-to tools.
Awareness (organizational)	Management levels understand and are aware.
Priority (organizational)	Positive culture, not resistance to accessibility efforts.
Competence building (organizational)	Strategic; to ensure universal design/accessibility how-to.
Requirement specification (Processual)	Early and clear focus on accessibility/universal design.
UX-needs integration (Processual)	Integrating accessibility as part of user needs/usability.
Continuous focus (Processual)	Continuous low-cost accessibility/usability testing.
User Testing (Processual)	Early and frequent, direct feedback from real users.
Internal quality control (Processual)	Early and frequent inspections of code/design/content.
Team Collaboration (Processual)	Cross-disciplinary quality discussions & (user) testing.
Time & Budget resources (Processual)	Enough time and economic resources to not obstruct.
Equipment & Human resources (Processual)	Available test-equipment, users and test support.
Design for All competence (Personal)	Experience; Knowledgeable, Design for all Mindset
Enthusiastic (Personal)	At least one person on the team enthusiastic.
Interested (Personal)	Not negativity or lack of interest to contribute/cooperate.

2.2. From Key Characteristics to a Predicting Self-Assessment Test

Inspired by the PEVS tool for project evaluation [10] a self-assessment test was iteratively developed and tested to explore if the 15 key characteristics could help predict whether a team is likely to develop accessible digital solutions based on process traits.

2.2.1. Assessment Scores for the Sampled Accessible Solutions

The final self-assessment test had a minimum score of 0 and a maximum score of 18. An initial assessment of the test's validity was conducted by the authors, scoring the sampled accessible solutions' process characteristics based on transcribed interview data. This yielded scores from 12-17 points, with an average of 14.3 points (see Table 3), which indicated internal validity [14]. Some transcripts cover several solutions, and as it was unclear which solutions were referred to, these were assessed as one.

Table 3. Assessment scores for the transcribed accessible solutions development

Solution	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Score
1	2	2	1	1	1	2	2	1	1	1	0	14
2	2	2	2	2	2	1	1	0	1	1	1	15
3	1	2	2	1	1	1	2	1	0	1	1	13
4,8,9,21	1	2	1	2	2	1	2	0	1	1	1	14
5,11	1	2	1	2	1	2	2	0	1	1	1	14
6,7	1	2	0	2	2	2	2	0	0	1	0	12
8	1	2	2	1	1	2	1	0	1	1	0	12
10	1	2	0	1	2	2	1	0	1	1	1	12
1,12	1	2	2	2	2	2	2	1	1	1	1	17
13	2	2	2	2	2	1	1	0	0	1	1	14
14	2	2	2	2	2	2	1	1	1	1	1	17
15	2	2	1	1	2	2	2	1	1	0	1	15
16	2	2	2	1	2	2	2	0	0	1	1	12
17,18	2	2	2	1	2	2	1	1	1	0	1	15
19	1	2	1	2	2	1	2	1	1	0	1	14
20	2	2	2	2	2	2	1	0	1	1	1	16
Average												*14.3*

2.2.2. Self-Assessment Scores for Low/Inaccessible Solutions

Also, we investigated whether low/in-accessible solutions may lead to low test scores. We now move from researchers assessing the test against transcribed data, to participants self-assessing their own development processes. We formulate the following inclusion criteria for participation as an assessor: 1) you were involved in the development process or accessibility efforts (e.g. as a designer, developer or project manager) of 2) a digital solution that has received negative press coverage for lacking accessibility.

Using personal connections, 20 potential assessors were identified within a private company, that had recently received a negative accessibility review by Funka. Funka is a reputable company specialized in accessibility evolutions. The potential assessors were contacted by email and asked to participate in the study, assessing their projects in retrospect using our self-assessment tool and return these per e-mail along with any comments. E-mail was chosen for convenience, to be less invasive and increased likelihood of participation. 12 assessors returned assessments for 10 low/inaccessible solutions. Returned scores were from 2-11 points, averaging at 5.25 points (see Table 4).

Table 4. Self-assessment e-mail scores for low/inaccessible solutions development

Solution	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Score
A	1	1	0	1	0	1	2	0	0	1	0	7
B	0	2	0	0	0	0	2	0	1	0	0	5
C	1	1	0	1	0	0	1	0	0	0	0	4
D	0	2	0	1	0	0	1	0	0	0	0	4
D	0	1	1	1	0	0	2	0	0	0	0	5
E	1	2	1	2	2	0	2	0	1	0	0	11
F	0	0	0	1	0	0	1	0	0	0	0	2
G	1	2	0	1	0	1	2	0	0	1	0	8
G	0	2	0	1	0	0	2	0	0	0	0	5
H	1	2	0	0	0	0	2	0	0	0	0	5
I	1	0	0	0	0	0	2	0	0	0	0	3
J	1	2	0	1	1	0	0	0	0	0	0	5
Average												*5.25*

Table 5. Self-assessment phone interview scores for accessible solutions development

Solution	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Score
1	2	2	0	2	1	1	2	0	1	1	1	13
1	2	2	2	2	2	2	2	1	1	1	1	18
1	1	2	2	1	1	1	2	0	1	1	0	12
2	2	2	2	1	2	1	2	0	1	1	1	15
3	2	2	2	2	1	1	2	1	1	1	0	15
3	1	2	1	2	1	2	2	1	1	1	1	15
4	2	2	1	2	2	1	2	0	1	1	0	14
6	2	2	2	1	2	0	2	0	0	1	0	12
7	2	2	2	1	2	0	2	0	0	1	0	12
8	1	2	0	2	1	0	0	0	1	0	0	7
8	2	2	0	2	2	1	2	1	1	1	0	14
9	2	2	2	2	2	2	2	1	1	1	1	18
12	1	2	0	2	1	0	1	0	0	1	0	8
13	2	2	2	2	2	2	2	1	1	1	1	18
14	2	2	0	2	1	1	2	1	0	1	1	13
15	2	2	1	1	2	2	2	1	1	1	0	15
15	2	2	2	2	2	0	2	1	1	1	0	15
16	2	2	1	2	1	2	2	0	1	1	1	15
20	2	2	2	2	2	2	2	1	1	1	1	18
24	2	2	2	2	2	1	2	1	1	1	1	17
Average												*14.2*

2.2.3. Self-Assessment Scores for Accessible Solutions

Furthermore, we investigated how participants having developed accessible solutions self-assess and score their own processes. First, as a trial run a focus group interview was set up with new winners of the previously identified awards. This added 2 solutions and 3 participants to the existing sample. The interview was transcribed, added to NVivo and coded using directed content analysis. The insight aligned well with the codes and categories and did not change which characteristics are considered key. The focus group ended with self-assessment tests, giving the scores: 7 (solution 22) and 14 (solution 23).

Finally, we investigated how participants in the interview study self-assessed and scored the processes which lead to accessible solutions. This was done by phone interviews with previous participants. Phone interviews balanced convenience better than focus groups, while still providing the opportunity to ask their opinions about the usefulness of the test. 16 participants were interviewed via phone, giving 20 assessments for 14 accessible digital solutions (of which 13 already in the sample, while one new fulfilling the inclusion criteria was added). Scores ranged from 7-18 points, averaging at 14.2 (see Table 5).

Self-Assessment Test for Accessibility

Step 1. Indicate if your project fulfills the UD critical success factors on the scale:	**Disagree**		**Agree**
1. There is a common understanding of UD in the project team and at all management levels (including any customer), and achieving UD is supported and viewed as positive.	**0**	**1**	**2**
2. The team has at least one person enthusiastic about UD, having a personal interest and motivation for ensuring universal usability.	**0**	**1**	**2**
3. The team has all the resources needed to ensure UD criteria; adequate time, budget and human resources; including access to assistive technologies, users and external competence.	**0**	**1**	**2**
4. The team has relevant UD competence and experience, e.g. UD principles in coding, IxD, content & visual design. Focus is on making design accessible and usable for everyone.	**0**	**1**	**2**
5. UD perspectives are integrated into all project activites; design, coding, UX/UCD & needs.	**0**	**1**	**2**
6. UD aspects are early and continously evaluated throughout the project, both through expert inspections and through user testing and real-user feedback including persons with disabilities.	**0**	**1**	**2**
7. The team embraces cross-disciplinary collaboration, open discussions and dialogue.	**0**	**1**	**2**

Step 2. Recieve 1 bonus point for:

a) A strategy for developing the UD competence in a team or organization.	**0**	**1**
b) Requirement specification includes criteria for UD, ensuring early and continuous focus.	**0**	**1**
c) An iterative or flexible process model, utilizing feedback from UD evaluations.	**0**	**1**
d) Extending internal evaluations with external inspections adds to UD quality control.	**0**	**1**

Step 3. Summarize your total:_____ point(s)

0-5 points: As you do not adhere to best practice for ensuring accessibility, you risk producing inaccessible digital solutions.
6-11 points: As you fulfill only some of the best practices for ensuring accessibility, you may not produce accessible digital solutions.
12-18 points: Gratulations! You fulfill most of the best practices for ensuring accessibility, and should be able to produce accessible digital solutions.

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Figure 2. Final Self-Assessment Test

2.3. Final Self-Assessment Test and Prediction Levels based on Score

Through a collaborative design process by the two authors, we moved from a first draft with 7 questions rated on a Likert scale from 0-6 points to a final test with 11 questions (see Figure 2). Its rating process is based on the feature analysis score model design [11-13]. For each question you receive 0, 1, 2 or 3 points based on how well your team is aligned with the identified key characteristics. The minimum total is 0 and the maximum

is 18 points. Based on the preciseness as indicated by empirically testing the scoring model´s internal and external validity [15], these tentative prediction levels are proposed:

- 0-5 points: indicates one does not adhere to best practice key characteristics and is at high risk for producing inaccessible digital solutions.
- 6-11 points: indicates one fulfill some key characteristics ensuring accessibility and is quite likely to produce an accessible digital solution – but might also not.
- 12-18 points: indicates one fulfills enough of the key characteristics for ensuring accessibility to be predicted to likely achieve accessible digital solutions.

Using these prediction levels, the test was able to correctly predict accessibility in 28 of the 35 participants self-assessments (80 % success: 19 accessible and 9 low/inaccessible). The mid-level of 6-11 points was self-assessed for 3 of the low/inaccessible solutions and 4 of the accessible solutions (thus encompassing the 20 % fail of prediction). This mid-level score may thus lead to both accessible solutions receiving awards and solutions lacking in accessibility receiving bad press.

The empirical testing of the score model against the questions also included qualitative insights on the usefulness of the test. About half of the participants felt the test would be useful to create a shared understanding in the team of what is needed to succeed with accessibility, and that early self-assessment would likely increase user testing and accessibility quality control. Eight participants stated the assessment could be useful at the start of a project: for defining requirements, planning the process and ensuring sufficient resources.

Discussion and Conclusion

Our rich qualitative data provide new insight into the relationship between factors promoting or obstructing accessibility. The final qualitative data set holds verbatim interview transcripts from 34 informants across 23 digital solutions assumed having a high accessibility, as they have won awards or receiving honorable mentions related to accessibility and universal design.

By comparing the commonalities between the characteristics of teams and processes producing accessible solutions, 15 characteristics appear key for ensuring accessibility. We formulated questions measuring the 15 characteristics and developed a scoring model based on the coded data. This was validated against 34 self-assessment tests –12 from non/inaccessible solutions and 22 from accessible solutions practices. Our work indicates characteristics related to the development process can predict the accessibility of resulting digital solutions to some degree. The validity tests show however that the prediction works best for min/max identification – those processes that lack many key characteristics, and those that adheres to most of them. It is interesting that a self-assessment test may be used to indicate a rough process quality score related to accessibility – even if the test needs a mid-level level to account for uncertainty.

The research might benefit from further validation, such as broader testing of the scoring model across diverse teams beyond these samples. When put to real use as self-assessment, questions may be interpreted differently, challenging the external validation. The self-assessment test and its question set and scoring model is ready for international testing and comparison and may be used on a free basis by everyone, including translations to other languages, adapting to business environments and so forth.

It would also be interesting to research whether the self-assessment test could support teams in improving their practices. User feedback indicates the self-assessment is fitting for a collaborative team test, and has the potential to increase UD awareness, promote best practices, aid project planning and communication and improve resource allocations. Our assumption is that a free-of-use practical contribution to measuring process-level practices key for achieving accessibility could aid product leaders, development team members and management in transferring research insights on how to ensure accessibility into the practice field. Future research could investigate this.

Our process ultimately condensed best-practice into an alignment tool. This could only be done due to a set of publicly acclaimed awards. Instead of using only technical compliance, investigating award-winners within a professional community, we tried to ascertain what characteristics may *lead to* accessibility – as it is ought to be understood.

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Universal Design of Public Services: A Case Study of the Norwegian Labour and Welfare Administration

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Abstract. This paper presents how employees in a governmental organization strive towards incorporating universal design into their work practices when developing digital solutions – and what workplace aspects helps and hinders them in their efforts to ensure the digital services they build are accessible for all users. A case study of the Norwegian Labour and Welfare Administration (NAV) indicate that ensuring universal design in organizations entails activities far beyond WCAG testing. For NAV, cross-disciplinary stream-aligned teams appears a driving factor for universal design, as is widespread collegial support and easy-to-use resources. We further hypothesize that SWOT analyses could help identify threats and opportunities for promoting universal design in organizations.

Keywords. Universal design, accessibility, enabling teams, team topologies, design system

1. Introduction

Organizations face many challenges when working to ensure their digital services are accessible for all, including lack of expertise and disadvantageous accountability and organization of work [1-3]. Organizational motivation is affected by corporate social responsibility, customers' opinions and policies [4-6]. To support efficient implementation, adoption models and checklist are proposed [7-11]. This paper is an empirical contribution from an organization that actively strives to achieve universal design in digital solutions and investigate how employees at Norwegian Labour and Welfare Administration (NAV) work to ensure universal design in their digital solutions, and which factors affect their universal design and accessibility work.

2. Research Approach

An exploratory case study was chosen [12]. NAV was selected as case as their responsibility is to provide welfare and labor-related services to a wide audience. NAV´s service strategy is “digital first”. In 2019, 49% of Norway’s inhabitants, 2.6 million

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people, received a benefit from NAV [13]. In 2020, NAV had 97 million digital visitors and 58 million logins [14].

NAV utilizes team topologies to form interaction modes between the teams [15], with agile and user-centered cross-disciplinary stream-aligned teams ("product teams") are responsible for digital services. A team's universal design knowledge and practices, or lack of such, thus directly affects the accessibility of the developed digital services. As such, product team employees are of particular interest for this case study. Stream-aligned product teams in NAV follow a set of principles for how to do agile, cross-disciplinary and user-centered development. They are supported by platform teams and enabling teams, of which NAVs universal design enabling team is particularly relevant in this study.

Research Methods

Semi-structured in-depth interviews are the main research method in this study [16]. Two overarching open-ended questions are used to: 1) provide insight into how the workers experience the impact of universal design in their own work (if at all), and 2) understand how the work itself is implemented – including external influencing factors and structures. A one-on-one format is utilized to support safe sharing of personal opinions with the researcher [17]. As the interviews were completed during pandemic regulations, they were conducted via Zoom.

A questionnaire was used to recruit participants, distributed via an internal NAV IT chat. Employees were invited to initiate contact, reducing the risk of feeling pressured to participate. The downside is the potential for bias towards participants who are interested in or feel confident talking about the research topic.

A thematic analysis was used to identify patterns in the qualitative interview data [17]. The approach is used with emergent coding, to identify overarching themes, patterns and topics related to the participants' lived experience, emotions, and perspectives. Following the thematic analysis, a SWOT analysis is applied, identifying strengths, weaknesses, opportunities and threats in the themes and patterns. The SWOT establish an awareness of internal strengths and weaknesses and external opportunities and threats [18].

3. Results

The recruitment questionnaire had 32 respondents, of which 62% are designers, 8% developers and 30% have other team roles – such as welfare experts and product owners. The questionnaire asked to which degree universal design affect one's work (Likert scale), where 63 % state it affects their work to a high, or very high, degree (Figure 1).

13 respondents were willing to participate in the in-depth interviews (40.6 %). Their ages varied, with 62 % between 18-38 years (8 participants), and 34,5 % between 39-59 years (5 participants). 7 had the team role of product designer (54 %), 3 were welfare experts (23 %), 1 a design researcher (8%), one a developer (8%) and one a product owner (8%). Among the interview participants, most were aware of how barriers, both societal and digital, hinder digital access for some user groups.

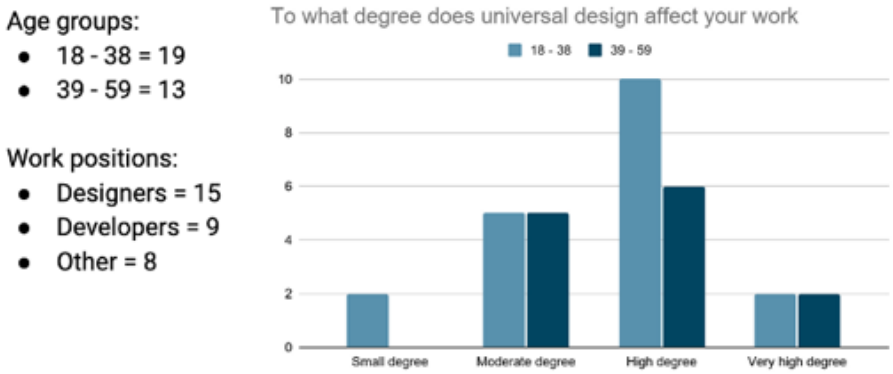


Figure 1. Degree to which universal design affects respondent's work.

Three main themes were discovered in the interview data: Organizational factors, Team factors, and Procedural factors (see Figure 2).

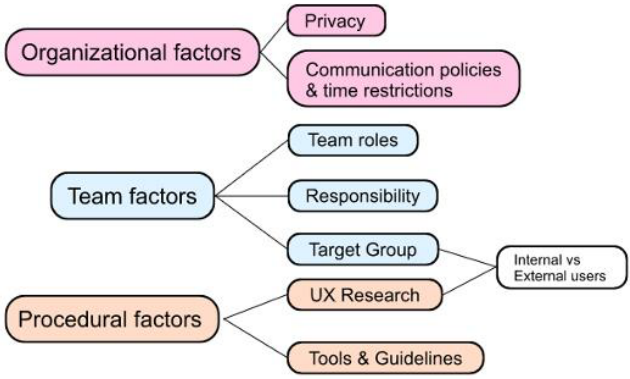


Figure 2. Main themes, their relationships and sub-themes.

3.1. Organizational Factors

Organizational factors affecting the product teams are *communication policies and time restrictions* and *privacy*. Some product teams still work with a hard deadline, although this type of project-based work is no longer a preferred approach in NAV. Such time-controlled teams balance delivering on time with other criteria, must compromise on quality, and report this affects the universal design and user-friendliness of their services. Other times, the time restrictions are due to the Parliament changing the law, with a limited window for implementation. Because of the organization's mandate, there are strict privacy policies, which hinders sharing of user information. Two participants mentioned this reduces the teams' access to user insight. Most of the identified organizational factors influence universal design negatively, see Figure 3.

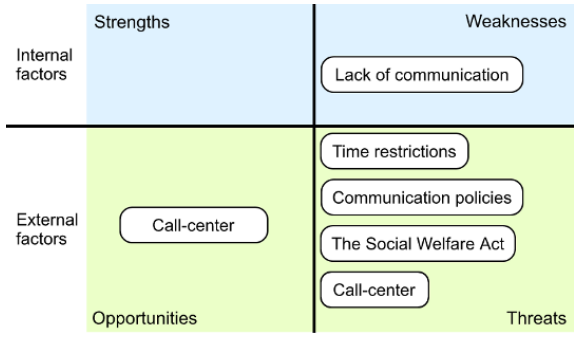


Figure 3. How organizational factors affect universal design work.

3.2. Team Factors

The different teams have slightly different work processes. 11 out of 13 participants work in a product team, while the final 2 are in enabling teams. 7 of the 13 participants view universal design as the product teams' responsibility. The product teams work with either internal or external users. Internal users are case workers or advisors. External users are all public users, or a segment of the public. The target group affect how the team may reach users to conduct user testing or gather user insights. Teams targeting internal users have access to NAV employees in different parts of the organizations.

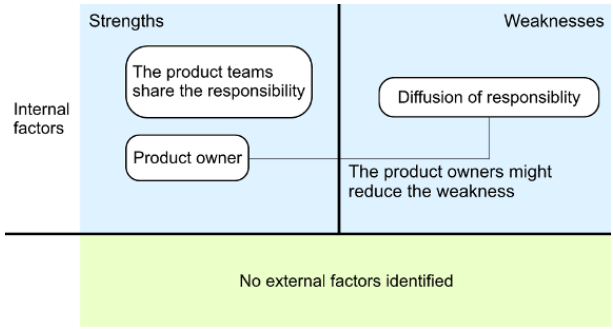


Figure 4. How team factor Responsibility affects universal design work.

The only team factor we were able to analyze in the SWOT as impacting universal design work was *responsibility* for universal design. The insights into team roles and target groups in the data set is more descriptive on how the teams organize their work in general. Looking at how responsibility affects universal design, 2 strengths are identified: shared team responsibility, combined with product owner as the formal accountable.

3.3. Procedural Factors

Procedural factors cover the methods and tools applied in the organization. We find two subthemes: *UX research* and *Tools & guidelines*. UX research spans how user insight is gathered, and user testing conducted. User insight is gathered through a range of ways,

fitting into two main groups: direct user contact (e.g. surveys, interviews and user feedback) and technical monitoring (e.g. Google analytics, Amplitude and Grafana).

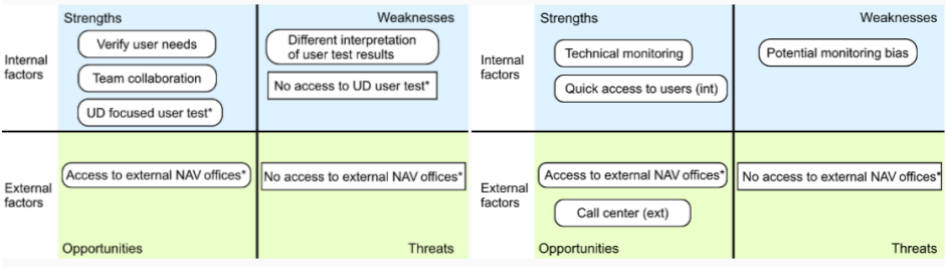


Figure 5. How procedural factors within UX research affects universal design work.

User testing focused on universal design and accessibility is a regular activity at the department and is categorized as a strength. In addition, the universal design enabling team hosts free-of-charge testing with marginalized users or expert testing using advanced assistive technologies. This provides product teams with valuable insights into how well their services fit assistive technologies and an easy way to conduct user testing.

For product teams with external users, more frequent access to anonymized user insight from NAVs offices and call centers is an opportunity for gathering user insights. Technical monitoring is identified as a strength. However, if the tools are not used properly, they could create a monitoring bias and turn into a weakness (see Figure 5).

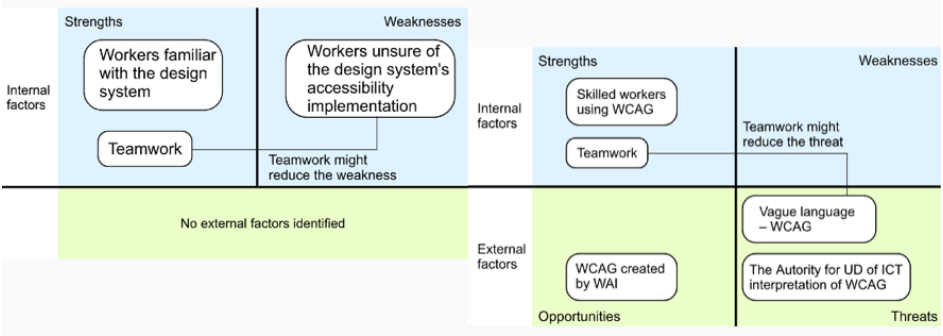


Figure 6. How procedural factors within Tools & guidelines affects universal design work.

The tools and guidelines mentioned in the interviews as important for universal design, are mainly related to NAVs Design system and the WCAG standard. A design system is a collection of reusable components and design patterns that can be assembled to build applications. Some NAV employees are uncertain of how high accessibility quality the NAV Design system elements have – and how they should utilize the components to ensure they build accessible services. Similar uncertainty can be found related to the WCAG standard. However, the universal design team seems to be able to support their colleagues in the product teams when they have questions.

The teamwork and topology structure used in NAV are strengths. Enabling teams provide product teams with support on both universal design and the Design system through enabling teams (see Figure 6). We find employees that need more training on

how to use the Design system and WCAG. This is identified as a weakness. The SWOT thus indicates NAV should further strengthen in-house training and support. The Design system and WCAG guidelines are categorized as strengths. As an external organization creates WCAG, the guidelines themselves are identified as an opportunity. Identified challenges with the guidelines are classified as external threats. This is mainly the language in which the guidelines are written and how they are presented. There is also a potential threat related to how some parts of WCAG needs discretionary assessment. NAVs teams might have a different interpretation than the Authority for Universal Design of ICT in Norway that has the final verdict, which makes their discretionary assessment a threat to the organization.

4. Discussion

Our findings suggests that NAV employees actively strive towards incorporating universal design into their work practices and develop accessible digital solutions. Identified development practices align with what Stray et al. [3] and Lush [2] identified as best practice for agile teams: ensuring accessible solutions as a united team effort and not something one person is responsible for alone, while delegation of responsibilities support creating accessible services. Our also findings align with Crabb et al. [1] in that those who are less knowledgeable on the topic of universal design acquire information on how to develop universally designed services, despite finding it challenging. Our findings complement related research by confirming that teamwork reduces experienced universal design development barriers and supports workers who are less familiar with universal design implementation. In NAV, those who experience a lack of knowledge are often helped and supported by other team members, other colleagues or are aided by NAV's enabling team. The support of enabling teams on universal design and Design system are similar to the strategies "awareness intervention" and "training intervention" for triggering universal design work, as proposed in Begnum [9].

A possible improvement of the SWOT would be to conduct this analysis in workshops with the employees, allowing NAV teams to themselves identify factors and be part of the analysis and discussion of the data, like what Crabb et al. [1] did in their study. This approach would allow for active participants with "inside lenses" in a bottom-up approach, rather than being audited by a researcher or an expert.

4.1. Limitations of the Study

It may be argued that the recruitment questionnaire did not have the desired effect, as the drop-out rate from the recruitment questionnaire to the interviews was high (59,4 %). Still, the soft prompting for participation without pressuring employees was achieved.

When conducting qualitative research and using the method theoretical sampling, saturation defines when the researcher has gathered enough data – sufficient N being no new codes or themes are being discovered when analyzing new qualitative data [19, 20]. In our study, the interview data was largely overlapping until interview 9, and as such the saturation appeared high. However, in interview 9, new perspectives were exposed. Thus, it was deemed appropriate to continue the interviews. After interview 13, no new participants had signed up for the study, and the dataset appeared reasonably consistent and saturated. However, the study interviewed a diverse group, spanning different team roles and disciplines, thus the sampling method and the N does not mitigate the risk that

some perspectives are lacking or under-represented. Further, the empirical insights into the sub-themes team role and target group were not considered sufficiently enlightened to warrant a SWOT analysis. As such, these topics needs to be further investigated.

5. Conclusion

We have used NAV as a public sector organization case to empirically investigate how universal design has been included into the design and development of public services.

The use of enabling teams as part of NAVs team topology organization promotes universal design. Overall, the findings suggest that NAV employees experience a shared universal design responsibility with their teammates, establishing a community where they work towards the same end-goal of universally designed services. Our findings complement previous research on universal design knowledge barriers by showing how teamwork and topology organization may reduce this challenge. Interviewees narrate how widespread collegial support on universal design expertise and easy-to-use resources help them overcome such barriers.

In addition, the universal design responsibility in NAV is organized in a way that both establishes a community for working together towards an end-goal of universally designed services, while counteracting responsibility diffusion though the accountable product owner role. These measures are believed to be easily implemented for organizations, and as such valuable to communicate.

We find that universal design practices in NAV is influenced by both organizational factors, procedural factors, and team factors. A SWOT show organizational factors are mainly identified as threats. In contrast, NAVs team factors are strengths. The findings indicate NAV should continue their team topology, team organization and agile, user-centered processes, and continue and further strengthen the organizational support and collegial training related to ensuring teams know how to implement accessibility guidelines and utilize the design system.

Our hypothesis is that the SWOT analysis is a suitable tool to investigate how the organizations can improve its work and be conscious of its barriers. Future work should investigate whether SWOT is in fact easier for organizations to utilize as a bottom-up way to identify factors promoting and obstructing universal design (as experienced by employees) – compared to the top-down maturity models (auditing by experts). SWOT results could also be compared to universal design best practice tests and checklists, to see whether these are overlapping or complementary methods.

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Evaluating the Accessibility of Norwegian Museum Websites

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Abstract. Accessibility of museum websites is important in an inclusive society. Despite international and national legislations and guidelines on digital accessibility for online public services, websites for museums continue to have different accessibility issues, which pose challenges for diverse visitors. This study aims to identify accessibility barriers in Norwegian museum websites and provide recommendations for improvement. In addition, by using both automated testing and manual evaluation, the study will contribute to the discussion on web accessibility evaluation methods.

Keywords. Museum, digital accessibility, manual evaluation, automated testing, WCAG

1. Introduction

Visiting local museums is often popular among tourists visiting a new city, and exploring museum websites can be useful as part of planning one's visit. Many museums provide digital information about their exhibitions, opening hours, and the possibilities to book tickets online. However, accessibility issues such as poor color contrast, inadequate keyboard support, and incompatibility with assistive technologies in these websites pose challenges to many visitors. Given the possible diversity among visitors, ensuring universal design of museum websites therefore becomes important.

The Norwegian regulations require all websites directed towards the general public should fulfil WCAG2.0 level AA success criteria, with the exception of three [1]. Thus, all Norwegian museum websites directed towards the general public must also fulfill these requirements. The Norwegian Directorate for Children, Youth and Family Affairs conducted a study on the accessibility of Norwegian museums through questionnaire and interview with museum representatives [2]. Although the main findings focused on physical accessibility, about half of the museums reported that their websites meet the WCAG 2.0 requirements. One of the limitations of the study is self-reported data by the museum representatives who may not have the expertise in universal design.

In this study we have evaluated 10 popular museum websites with both automated testing and manual evaluation based on Web Content Accessibility Guidelines (WCAG) 2.2. Through this study we seek to answer the following research questions: 1) What are the main accessibility barriers in Norwegian Museums? 2) How are the differences in barriers identified using the two different methods? This study provides indications of

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the accessibility compliance of Norwegian museums, identifies possibilities for improvement, as well as contributes to the discussion on web accessibility evaluation methods.

2. Related Work

An early work assessing museum web accessibility [3] was published in 2012 where the home pages of 14 museums in the Mid-Atlantic region, USA, were assessed by expert evaluators against Section 508 guidelines on accessibility in the U.S. Rehabilitation Act and patterns of violations across type and size of museums were identified. In recent years, the evaluation of museum web accessibility has been carried out in different countries, including India [4], Bulgaria [5], Poland [6], and Portugal [7]. Rather than using expert evaluators as in [3], these studies have used automated tools such as Siteimprove Accessibility Checker (SAC), TAW (Test de Accesibilidad Web) and WAVE against WCAG success criteria. One of the large scope studies was conducted by Vila, González & Darcy [8] where the official tourism organization home pages of 190 countries were analyzed with TAW. The study, however, did not specify which Norwegian website was evaluated. To our knowledge there is no research publication focusing on the accessibility of Norwegian museum websites and none of the publications have used manual testing to evaluate the museum websites against the WCAG success criteria.

In the EU, a monitoring methodology on the accessibility of the websites and mobile applications of public sector bodies [9] was established in 2018 which provides guidance on the assessing and reporting process. Debevc et al. [10] analyzed the good practices in evaluating and reporting web accessibility in different European countries, identified challenges in the process, and made recommendations for improving the assessment methodology. Among others, the authors emphasize the importance of in-depth monitoring which involves a detailed examination of all the requirements and criteria. Debevc et al. [10] further stated that "conformance in in-depth monitoring cannot be determined solely using automated evaluation tools; a significant degree of human manual analysis is required."

3. Method

The Website Accessibility Conformance Evaluation Methodology (WCAG-EM) by W3C's Web Accessibility Initiative [11] was used as a guideline for the evaluation process. The process consists of five main steps. In this section, we will describe the detailed activities in the evaluation process.

3.1. Defining the scope

The following ten popular museums in Norway were selected for evaluation according to the highest-ranked museums at Tripadvisor [12]: Fram Museum, Norsk Folkemuseum, Norwegian National Museum, Vigeland Museum, Troldhaugen Museum, Kon-Tiki Museum, Munch Museum, Polar Museum, Norwegian Petroleum Museum, and the Nobel Peace Center. All but one of the museums have their own website, except

Troldhaugen Museum whose webpages are managed by Kode Bergen which manages a website for a group of museums in the Bergen area. WCAG version 2.2 levels A and AA was used for the evaluation, which also included three success criteria[2] excluded from the requirements according to the Norwegian regulations [1].

3.2. Exploring the websites

The websites for the selected museums were explored to find common pages, essential functions, and to see the variety of web page types. Each website was also explored to see if they had linked to an accessibility declaration for the website, which is a requirement to all public enterprises stated in the Norwegian regulations [1].

3.3. Selecting a representative sample

The three types of pages selected as a representative sample were Home, Exhibition, and Tickets. This selection was based on the exploration of the websites for the chosen museums which showed that all museums had a Home page, a page for Tickets or planning one's visit, and current or permanent exhibitions or events. The selection was also made with the assumption that most potential museum visitors may visit these kinds of pages since they typically contain relevant information about what the museum offers as well as useful information for planning a visit to the museum.

3.4. Evaluating the selected sample

Each of the selected museum webpages were evaluated using an automated tool (WAVE) and tested manually by two persons (one junior and one senior researcher) who have experience with WCAG and WAVE. The evaluations were conducted on laptop computers, using Chrome browser and WAVE extension which provides mapping between the output and WCAG success criteria. The researchers used NVDA screen reader, keyboard navigation, and Chrome browser zoom functionality in the testing. The evaluations took place in October-December 2023, except the Kon-Tiki Museum which was re-evaluated June 2024 due to major updates to their webpages.

3.5. Reporting the findings

WAVE output presents the results in five categories: Errors (fails), Alerts (warnings), Features, Structures, and ARIA. The results from the automatic testing with WAVE were recorded to relevant success criteria, and the number of total errors, contrast errors, and alerts reported by WAVE were summarized for each page and each success criterion. The results from the manual testing were analyzed with regards to how they passed the success criteria and grouped into three main categories for reporting the findings from the manual testing: Passed, Failed, and Not Present, in accordance with the WCAG-EM guidelines. The fourth category "Not Checked" in the WCAG-EM guidelines was not included in the analysis, since all success criteria at levels A and AA were checked. Disagreements in registered results were solved by reviewing the differences and discussed between the two senior researchers until an agreement was reached.

[2] 1.2.3 Audio Description or Media Alternative (Prerecorded), 1.2.4 Captions (Live), and 1.2.5 Audio Description (Prerecorded)

4. Results

Three of the ten investigated museums links to an accessibility declaration in Norwegian: Norsk Folkemuseum, the Norwegian National Museum, and the Munch Museum. According to their accessibility declarations, all three websites have violations of the Norwegian accessibility requirements, numbers varying from 21 of 47 violations to 2 of 48. Two of the declarations have been updated within 12 months of their last update.

4.1. Findings from automated testing

According to the WAVE documentation [13], 23 of the 55 success criteria at conformance levels A and AA in WCAG 2.2 can be reported as part of the issues checked using WAVE. In the evaluated museum web pages in this study, 16 of these success criteria were reported in issues flagged as errors or alerts by WAVE. The current evaluation focused on issues reported by WAVE in categories Errors and Alerts, omitting issues reported in Features, Structure, or ARIA, thus limiting the range of success criteria that could be reported as issues by WAVE in the automated tests in this study.

Table 1. Results from automated testing summarized, showing total number of errors, contrast errors, and alerts for the Home, Exhibitions, and Tickets webpages for each museum.

	Errors			**Contrast errors**			**Alerts**		
	Home	**Exh.**	**Ticket**	**Home**	**Exh.**	**Ticket**	**Home**	**Exh.**	**Ticket**
Folke	0	0	19	0	4	10	7	5	12
Vigeland	8	5	5	18	18	27	8	63	4
Kon-Tiki	3	1	20	15	12	12	19	18	12
Polar	0	0	5	0	0	0	13	24	7
Petroleum	10	6	24	0	1	1	83	64	10
Fram	63	7	5	3	4	4	66	29	12
National	2	1	5	0	0	0	35	38	33
Troldhaug	3	3	0	0	1	1	42	67	38
Munch	2	1	1	2	1	1	33	4	4
Nobel	2	0	15	4	0	0	14	13	14

Among the tested museums, the museums with the highest number of errors reported by WAVE were Fram Museum (75 errors) and the Norwegian Petroleum Museum (40), the highest number of contrast errors was reported for Vigeland Museum (63 contrast errors) and Kon-Tiki Museum (39), while the highest number of alerts was reported for the Norwegian Petroleum Museum (157 alerts) and Troldhaugen Museum (147). See Table 1 for details.

Regarding the WCAG 2.2 success criteria reported in issues flagged as errors by WAVE across all museums and pages tested, 1.4.3 Contrast (Minimum) (137 errors) were reported most often, followed by 1.1.1 Non-text Content (133 errors) and 2.4.4 Link Purpose (In Context) (108 errors). In addition, 1.3.1 Info and Relationships and 2.4.6 Headings and Labels were both reported in a higher number of errors than the remaining success criteria in the errors reported by WAVE.

4.2. Findings from manual testing

The manual testing involved 52 success criteria from WCAG 2.2 level A and AA, including the three that are excluded from the Norwegian accessibility requirements [1]. In fact, 15 of the success criteria that were reported as errors or alerts in the automatic test by WAVE were double checked and tested both automatically and manually. Some of the success criteria, e.g., 1.4.5 Images of Text, 1.3.3 Sensory Characteristics, or 3.2.3 Consistent Navigation, are not always possible to test using automatic tools, while other success criteria need to be tested both automatically and manually. Examples of the latter include success criteria 2.4.2 Page title and 1.1.1 Non-text media. Regarding page title (2.4.2), the automatic testing tool can say whether the page has a page title or not but cannot tell if the title is meaningful. For example, the Tickets page in English for the Norwegian Petroleum Museum has a page title, but it is not meaningful ("NorskOljemuseum - NorskOljemuseum"). The same applies for alternative text for non-text media (1.1.1). An overview of the findings from the manual testing are presented in Table 2 and Table 3.

Table 2. Results from the manual testing summarized for the Home, Exhibitions, and Tickets webpages for each museum, showing the number of success criteria that passed, failed, or were not present.

	Passed			**Failed**			**Not Present**		
	Home	**Exh.**	**Ticket**	**Home**	**Exh.**	**Ticket**	**Home**	**Exh.**	**Ticket**
Folke	24	23	22	3	2	6	25	27	24
Vigeland	20	22	25	15	6	4	14	23	20
Kon-Tiki	20	24	16	15	6	11	17	22	25
Polar	23	19	19	8	5	6	21	28	27
Petroleum	23	18	19	9	11	7	20	23	25
Fram	22	21	19	11	8	12	18	23	20
National	27	22	20	4	8	8	21	21	24
Troldhaug	27	22	20	9	13	9	16	17	22
Munch	24	24	20	8	2	8	20	26	24
Nobel	22	24	20	8	2	25	24	26	3

The museum with the best results overall from the manual testing is Norsk Folkemuseum, having the highest compliance and lowest non-compliance. Also, the National Museum and Troldhaugen Museum fared well in the manual testing. See Table 2 for details. The success criteria that had the most violations (fails) are 2.4.1 Bypass Blocks (25 fails) and 2.4.7 Focus Visible (21 fails). Other success criteria that had relatively low compliance are 2.4.4 Link Purpose (In Context), 2.1.1 Keyboard, 1.1.1 Non-text Content, and 3.1.2 Language of Parts. The results summarized for each of the four WCAG principles are presented in Table 3. Principle 1 Perceivable has the highest percentage of passed success criteria, and the lowest percentage of fails, while Principle 2 Operable has the lowest percentage of passed and the highest percentage of failed success criteria.

Table 3. Results for each success criterion summarized for each WCAG principle across all museums and pages. (Percentages of total shown in parentheses)

Success criterion	Passed	Failed	Not Present	Total
Principle 1 Perceivable	259 (48)	56 (10)	224 (42)	539
Principle 2 Operable	220 (37)	109 (18)	263 (44)	592
Principle 3 Understandable	144 (40)	56 (16)	159 (44)	359
Principle 4 Robust	24 (40)	10 (17)	26 (43)	60

5. Discussion

5.1. Research questions

The results from the automatic and manual evaluations of the selected museums and webpages in this study show that National Museum and Troldhaugen Museum have the best overall results using both methods. Findings also indicate that the main accessibility barriers in Norwegian museums are related to being able to perceive and operate webpage content.

The automatic tests showed high number of errors for success criteria related to perceivability, e.g., contrast (1.4.3), missing alternative text (1.1.1), and info and relationships (1.3.1), and slightly lower related to operability, e.g., link purpose in context (2.4.4) and headings and labels (2.4.6). The manual tests resulted in a greater number of violations for success criteria related to operability, such as availability of bypass blocks (2.4.1), focus visible (2.4.7), link purpose (2.4.4), and keyboard navigation (2.1.1). Violations of success criteria related to perceivability, e.g., lack of alternative text (1.1.1), were relatively fewer in the manual evaluation. The manual testing also gave relatively high violations for some success criteria related to understandability, e.g., language of parts (3.1.2), which is not included among the success criteria tested by WAVE [13]. WAVE only checked 23 success criteria, of which 16 were reported in the issues flagged as error or alert in the automatic evaluation of the selected museum webpages. The manual evaluation checked 52 success criteria, of which 15 overlapped with the 16 reported criteria in the automatic evaluation. There is a need for manually mapping the output of WAVE to WCAG success criteria.

Although results from both methods suggest that the main barriers are perceivable and operable, the automatic testing indicated perceivability as the main barrier, while the manual testing indicated operability as being the main barrier. The manual testing also indicated barriers related to understandability. It seems clear that manual testing can test much more than automated tools, e.g., the quality of alternative text and page titles, etc. The two methods can reveal different types of barriers, those that can be programmatically evaluated vs. those involving meaning and context, such as language and quality of alternative text, link text, names, etc.

5.2. Recommendations

There is a clear need for manual testing during the development process, particularly as the results from various evaluation tools may differ. Some of the success criteria were double checked manually, such as page title and alternative text, while other criteria were only checked manually, for example some criteria related to understandability and

language. WAVE maps directly to 23 of the WCAG criteria on levels A and AA according to their documentation [13], leaving 32 success criteria on levels A and AA that are not checked using WAVE. Based on the results from our study, we strongly recommend that developers for museum websites should use both methods and pay special attention to potential barriers related to operability and those related to meaning and context.

The Norwegian legislation requires an accessibility declaration for websites from public enterprises [1], but only three of the 10 evaluated museums had this at the time of the evaluation. According to the accessibility declaration for the Munch Museum, only two success criteria are violated for the whole website. However, the manual evaluation in this study showed violation of 18 success criteria for the three sample pages, indicating that the assessment done for the accessibility declaration may be insufficient. The summarized results for the three sample pages for the Munch Museum from the WAVE automatic evaluation were 4 errors and 4 contrast errors (and 41 alerts). This discrepancy may be caused by that the museums used different browsers, tools and methods in their evaluation for the accessibility declaration. However, the accessibility declaration of Munch museum did not specify these.

Consistency across all the pages on a website needs particular consideration when a third-party develops some of the pages or services on the website. Some of the museums in this evaluation had Ticked pages developed by a third-party, with completely different design from the rest of the webpages for that museum which cause violation of consistent navigation (3.2.3) and consistent help (3.2.6). Another issue regarding consistency is language. Although only the English versions of the webpages were evaluated in this study, some of the content, e.g., error messages or parts of the text, were often in Norwegian. One such example is the English Troldhaugen Ticket page, where information is given both in Norwegian and English, but not tagged with the correct language (3.1.2), while other parts are still in Norwegian, such as the search input field.

5.3. Limitations

This evaluation did not include any user testing with people with disabilities, which severely limits the achieved results. Only a limited number of webpages and museums were included in the project, and it is reasonable to question whether the three pages from the selected ten museums are representative for all Norwegian museums. An evaluation method that can assess a large number of webpages or websites, but cover more criteria than the current automated tools might be necessary to achieve more reliable results, the researchers are however currently not aware of any such method.

Manual evaluation is to a large degree dependent on the researchers' experience with assistive technologies and how they interpret the WCAG success criteria. Although the researchers have checked examples and explanations in WCAG and discussed interpretation and how to do the testing, the possibility of differing interpretations and variations when conducting the manual checking is always present. Therefore, to reduce the inconsistency, it is important to translate the WCAG success criteria to formal rules as much as possible. The Web Accessibility Initiative (WAI) has contributed towards achieving such formal rules.

Another limitation in this study is that webpages are generally under continuous improvement. We have seen that some of the selected webpages in this evaluation have changed during the time we tested. As a consequence, some of the barriers found in the evaluation may not be there anymore.

6. Conclusion and Future Work

Technological innovation and digital transformation have provided new possibilities for cultural heritage and museums. Digital museums can be a sustainable solution for the future. As museums are increasingly providing online exhibitions/visits, for example, with virtual reality technology, it is essential that these technological solutions do not exclude visitors. Developers who develop technological solutions for museums should use manual testing in addition to automated tools and pay special attention to potential barriers related to operability and those related to meaning and context. Future work should consider user testing to identify specific barriers for specific users and user groups.

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Towards a Model for Assessing the Maturity of Organizations' Work on Universally Designed Digital Solutions

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Abstract. In this work, we propose a novel maturity model that suits the peculiarities of universal design of IT and ICT. The model is simply abbreviated as UDMM. It is domain-agnostic, targets intra-organizational application, and is free to use. Its design is influenced by maturity models in the related areas digital accessibility, usability, user experience, user-centered design, co-design and participatory design, as well as design-thinking. Besides a literature review, also interviews with stakeholders have been employed to gather insight for the model synthesis, and to ensure the model's proper theoretical foundation. The UDMM is currently undergoing further improvement iterations and will be tested and validated in practice in the future.

Keywords. Maturity model; process; digital inclusion; accessibility, usability, UX, user-centered design, design, IT and ICT development

1. Introduction

Maturity is "the extent to which an organization consistently implements processes within a defined scope that contributes to the achievement of its project goals" [1]. A maturity model (MM) is a framework that aims at helping organizations to plan and assess their current level of maturity in a particular domain, and to identify areas for improvement. While a generic definition of maturity is the state of progress from an initial phase towards the goal of being complete, perfect or ready, maturity is often viewed in relation to multiple focus areas, sometimes called dimensions, such as processes and practices, objects and assets, and people capability [2].

The concept of MMs gradually evolved during the 1970s [3], and in the early 1990s the first model targeting software development called Capability Maturity Model (CMM) saw the light of the day [4]. A large number of MMs has been developed since in a variety of domains [5]. However, to our knowledge none of those models is directly applicable to universal design of ICT. However, many organizations struggle with the implementation of the proper processes to leverage universally designed solutions, which underscores the need for such a model.

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The definition of universal design (UD) used here is the one found in Article 2 of the UN Convention on the Rights of Persons with Disabilities, or short CRPD [6]: "Universal design means the design of products, environments, programmes and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design." UD can be viewed as both a process and as the property of an asset [7]. The procedural view emphasizes the need to complement traditional digital-accessibility work with elements from user-centered design processes, in particular user diversity and testing with users with impairments [8]. It is therefore particularly useful here as MMs partly focus on an organization's processes and practices.

The contribution of this work is the development of a model draft regarding universal design of ICT, i.e., the model's scope and design. This is based on a study of the literature in related domains and input from domain experts and stakeholders[2] in relevant organizations. Our context is the research project Inclusive Digital Application, the purpose of which is to study the effects of digital universal design. The project is funded by the Norwegian Research Council under grant 336573.

The article is structured as follows. After an elaboration of the used development method, the model's scope and design are specified. This is followed by detailing the results from a literature study, after which the basic structure of the UDMM is developed. The article concludes with closing remarks and an outlook on future work.

2. Model development

In the following, we elaborate on the development of the UDMM.

2.1. Method

We have followed the double-cycle development approach as laid out in the literature [2], Figure 4, which suggests to start with *need identification*, followed by the iteration cycles *scope definition*, *model design, design evaluation*, and *evolution*. I.e., addressed here are: *need, scope,* and *design*. It was natural to start with a descriptive model as the first version in the evolutionary series of models labeled *descriptive, prescriptive,* and *comparative* [9].

For the definition of maturity levels, we have followed a top-down approach [2], where a chosen number of maturity levels is corroborated with appropriate areas and indicators. Other strategies exist, such as bottom-up [10], but we viewed the approach of following established assumptions about how maturity evolves as most appropriate. We also tried to incorporate a holistic view in order for the model to account for non-procedural aspects like technology adoption, people skills, organizational culture and attitudes, and others. To ensure the model's proper theoretical foundation, we have gathered insight from a literature study and interviews with stakeholders from relevant organizations and domain experts.

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2.2. Scope

As a large Norwegian provider of software for the health care sector was part of the project group (DIPS, *dips.com*), we wanted the model's focus to be software- and tech-specific, meaning that it should be able to apply it to development teams in all domains where IT and ICT are involved, including workplace technology, tech and applications for health and welfare, consumer tech, self-service terminals, and others. As such, the model's main stakeholders are both private and public entities, and its main target groups are management and auditors. The driver for the model's development was the rationale to be prepared for the anticipated introduction of a requirement for universally designed workplace tech in Norway within the next couple of years. We envision that self-assessment is the most often used method of application, and the model should hence be capable of reliably answering the questions how far the organization has come with deploying universal-design processes in their daily work, and what areas could preferably be improved.

2.3. Design

Regarding the design itself, we have followed the recommendations specified in ISO/IEC 33001, which state that an organization's maturity should be assessed by measuring the capability of its processes, i.e., their ability to contribute to the achievement of a given goal [1], here universally designed software. This approach implies a framework consisting of process attributes or areas, a capability scale, per-area rating scales, and a maturity scale as the main four elements [11]. Each capability level is cumulative in that it implies that also the requirements for the lower levels have been met. To reach a certain maturity level, a set of process areas must meet a specified combination of capability levels. We found this framework to be most flexible and thus adaptable to our needs.

In order to find evidence to support the population of the model with components, areas, and indicators, we conducted a (traditional) literature review [12] across related domains. It has previously been established that the concepts UD, digital accessibility, usability, and user experience are interrelated [13,14]. We added user-centered design, co-design and participatory design, as well as design-thinking, as we view them as highly relevant to our work. Both articles discussing a single MM and meta studies which in turn review multiple MMs have been considered.

2.3.1. Literature review

During our search, we have not found a model specifically designed for digital UD.

Digital accessibility

There is quite some overlap between digital accessibility and UD, as both focus on human impairment. It was hence natural to start with MMs for digital accessibility.

A combined web search and systematic literature study of accessibility MMs in educational institutions in 2023 found 25 existing MMs, of which 6 target higher-education institutions, whereas the remaining 19 are generic [15]. The earliest MM was published in 2011, and the majority is more recent than 2015. Each MM is assessed with regard to its theoretical foundation, empirical validation, dimensions and levels, data collection methods, and other aspects. The study found that the structure of the

maturity models differs significantly. Some are structured as a matrix, others based on a checklist, questionnaire, framework, or indicators, and combinations thereof. They also found variations with regard to the number of levels and number of dimensions. Both qualitative and quantitative indicators have been proposed throughout the literature. The majority of MMs is reported to lack a proper foundation, and very few have conducted evaluations with proper documentation. The work also compiled a list of 34 indicators mentioned in the literature, the top-5 of which are *responsibility, competencies & training, monitoring, resources & support,* and *testing*. However, it should also be noted that the indicator frequencies differ depending on whether the MMs target higher-education institutions or are generic. The authors also discuss transferability of MMs, such as to other domains and other organizations than those they were developed for. They conclude that, while there are some indications that the transferability is low, more research is needed.

At the time of writing, the W3C provides a draft of an accessibility MM intended for use in public and private entities of any size [16]. The model consists of seven focus areas, which in turn comprise between 12 and 36 detailed low-level indicators, 150 in total, each of which is assessed on a four-point scale. The document draft is accompanied by a spreadsheet which contains all indicators and eases the assessment process. Properly filled out, the spreadsheet translates the scale rating into (zero to three) points and calculates the achieved score for each area. It is not documented, however, what the theoretical foundation of the model is, and whether or not it has been tested and validated.

Usability

Usability and UD are closely related areas in that usability's focus on user friendliness and ease of use resembles UD's requirement that solutions "be usable by all people".

A systematic literature review of usability maturity models in 2018 [11] found 15 models, of which most are generic, i.e. not targeting specific domains / contexts. It is pointed out that many of the models are based on consolidated software process MMs, which are standardized as ISO/IEC 15504[3] and ISO/IEC 29110. Usability MMs typically take into account the particularities of usability engineering processes which, in most cases, are based on human-centered design processes, such as the one specified in ISO 9241-210. The review identified eight maturity scales, which range from three to six stages. Five stages seems to be the preferred scale, however with varying stage definitions. Most models appear to have been developed in an ad-hoc manner, and only two of them have been validated. Unfortunately, however, the authors did not analyze the models' process areas.

User experience

User experience (UX) and UD are related concepts, since the former's focus on user perception and personal sensations mirrors UD's Equitable Use principle and the need "to make the design appealing to all users" [17].

In a systematic review of literature on UX maturity models, the authors discussed eight models with a special focus on whether these models are applicable to free and open-source software [18]. The articles found are published in 2014 or later and have typically based the development on established models like the CMM, its successor CMMI, or ISO 15504. The authors pointed out that roughly half of the discussed

3 This standard has been replaced by the more recent ISO/IEC TS 33061:2021, Information technology — Process assessment — Process assessment model for software life cycle processes.

models lack the theoretical foundation, and many also lack documentation of any testing and validation. The review does not include an aggregation or comparison of indicators or areas.

User-centered design
User-centered design (UCD) is an area highly relevant area for the development of a UDMM in that it requires both a high degree of user involvement and user diversity.

A systematic literature review in the area of UCD, with an additional focus on agile development processes [19], identified 71 scientific articles since 2001, of which the majority was published in 2007 and 2008. All publications are analyzed with regard to obstacles, success factors, and best-practices for the adoption of agile UCD principles in organizations' development teams. Many of these factors could be transformed into suitable indicators, areas, and strategies in the UDMM in a straightforward manner.

Co-Design
Co-design, also referred to as participatory design, aims at creating solutions that meet the needs and expectations of users by involving them in the design process. It hereby matches the involvement of (diverse) user groups in UD work.

Blomkamp's Co-Design Maturity Model is a framework with which the co-design work of both individuals, teams, and an entire organization can be assessed, according to the author [20]. Five maturity levels are in use: *explore, understand, apply, integrate,* and *flourish*. The areas to be assessed are human resources (who to involve and how to organize them), application areas (where and in what context to apply co-design), methods (what techniques and tools to apply), and processes (how to integrate and adapt to the specific context). The author claims that the model has been tested, but neither documentation of the model's application nor results are available. Also, it is unclear how the model was synthesized and what its theoretical foundation is.

Design thinking
Design thinking (DT) is an approach to problem solving and innovation which is solution-oriented while being anchored in human-centered design. This latter trait makes MMs developed for DT also relevant for the UDMM.

A review of MMs related to design work and design thinking approaches discussed in total eight MMs with regard to different design domains, structure, levels, areas, and other factors [21]. Unfortunately, the authors have not studied the theoretical foundation of the investigated models, and whether the models have been tested and validated. It is also not always clear which areas have been assessed in a given model, and how the various indicators discussed can be measured with sufficient precision and reliability. Other than that, it appears that the discussed models vary quite a bit: Some models comprise four maturity levels, while others have as many as eight. Naturally, the definition of maturity levels also varies a lot. In fact, the authors argued that the range of perspectives and approaches of the different models justifies a categorization into 1) models that foster DT work on an organizational level, 2) models that stress human-centeredness and sustainable workplace experiences, and 3) models that overlap to a great extent with UX MMs.

2.3.2. Synthesis

We started with the recommendations for MMs for IT management [22], as this

lies close to our case with software development. The suggestion here is to use a six-point maturity scale with the stages *non-existent, initial, repeatable, defined, managed,* and *optimized*. It is compared to the earliest accessibility MM [23], which employs five stages: *informal, defined, repeatable, managed,* and *optimized*. *Non-existent* is a useful stage likely encountered in many organizations. Now, to keep the number of levels as small as possible without losing the proper degree of detail, we decided to merge *repeatable* and *defined* (because they occur in both models) to *practiced*, resulting in a five-point scale, see the table below. We also find a *not possible* stage useful as found in the literature [24], since we expect some organizations to be reluctant to work with UD. This is mirrored in our model through adjusting the description of *non-existent* rather than introducing a new stage.

Maturity		**Description**
No.	**Stage**	
1	Non-existent	There is no knowledge about UD at all and / or a neutral or even negative attitude. Activities might be actively discouraged. UD processes are non-existent.
2	Informal	There is a basic understanding of UD and a positive attitude towards relevant activities. Any UD work is non-organized and ad hoc-based.
3	Practiced	A few key personnel have an at least fair understanding of UD. A few UD work routines exist, but UD is not actively promoted. There may be some (limited) spread of UD knowledge and infrequent educational training. UD-related activities may appear in strategy and planning documents but have not received substantial budgets.
4	Managed	There is an at least fair and wide-spread understanding of UD work in the organization. The majority of management-level staff recognizes the importance of UD-related activities. UD work is part of the organizational strategy and planning, readily implemented and active part of the workflow. Relevant tools are widely used. Sharing of UD knowledge is actively practiced. Educational training of staff is often used.
5	Optimized	The quality and costs of UD work are continuously monitored / reviewed and optimized, Both tools and knowledge are frequently updated.

We then presented a shortlist of what we view as good examples of MMs to organizations' representatives. In the subsequent discussion, the majority of stakeholders pointed at an UX MM as the most appropriate in terms of a manageable number (4) of suitable areas with only few (2 – 4) reasonable subareas [25], see the table below (adapted from [25]). Now, we could define the proper descriptions of each stage in the maturity model.

Area	Strategy	Culture	Process	Outcome
Subareas	Vision, planning & prioritization, budget	Awareness, appreciation & support, competency, adaptability	Methods, collaboration, consistency	Design impact, measurement

The majority of stakeholders voted for the numerous (150 in total) so-called proof points from W3C's Accessibility MM as the best starting point for future discussions of which indicators to include in the UDMM, since they are viewed to be hands-on and detailed enough. Also the accompanying four-point capability scale for the assessment of each indicator, with the levels *not implemented, partly (little) implemented, partly (mostly) implemented,* and *fully implemented,* was well received.

3. Conclusion

We have presented the first steps of the development of a novel maturity model for universal design of ICT, dubbed UDMM. The model is heavily influenced by MMs in related areas such as digital accessibility, usability, user experience, user-centered design, co-design, participatory design, and design-thinking. A literature study has provided the foundation for discussions with domain experts and organization representatives. So far, the model comprises a five-point scale for the maturity, and a hierarchical structure with four main areas and two to four subareas each.

The UDMM's development is currently in its early stages, with future work planned to improve the model further through more iterations with stakeholder and domain expert participation. This implies not only deciding on the number and type of indicators to include in the model, but also a weighting of their importance, appropriate measurement methods, and deploying and testing the model in practice.

This work represents an important step towards helping organizations improve their UD practices. By providing a clear and theoretically sound framework for assessing and improving UD maturity, the UDMM has the potential to drive significant advancements in the field of universally designed digital solutions.

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Digitalisation and Elderly Society – Universal Design as Detailed in Standards

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Abstract. The paper discusses the role of standards to achieve the objective of Universal Design, with the case of equal access for elderly people in the digital society. The concrete background is the launching of 4 standards regarding different aspects of the digital society at present and in the future, their consequences for elderly persons and persons with disabilities and how to ensure diversity and inclusion for all through Universal Design. Our hypothesis suggests that well-conceived standards, developed collaboratively by all stakeholders, including individuals with various functional disabilities, could be an essential tool in ensuring that Universal Design is an integral part of technological development.

Keywords. Elderly, digitalization, design, AI, standardization

Introduction

Digital inclusion is a formidable challenge for today's society, which seeks to prevent segments of the population from being excluded—especially in critical domains such as employment and education. The advent of new technologies offers vast possibilities for creating better and more accessible products and services, not least through Artificial Intelligence (AI). However, without a thorough implementation of Universal Design (UD) principles, these same advancements could paradoxically lead to further exclusion, among others of elderly, including those with functional variations.

There is a noticeable lack of focus on UD principles among those responsible for designing and developing new technologies.

Digitalization is increasingly pervasive across many types of work, driven by Information and Communication Technology (ICT). Additionally, digitalization is prominent in other aspects of society, such as living in smart cities or using technologies connected with the Internet of Things (IoT). It also poses challenges for procurers in both the public and private sectors. This leads to a critical inquiry: Will new technology create new barriers, especially for workers with permanent or age-related functional impairments? Or can UD principles—through requirements set in standards—provide a robust enough tool to mitigate or eliminate such barriers?

By 2024, Norway will have published the last in a series of four standards focused on the application of UD to facilitate the participation of elderly individuals, including those with functional variations, in the digital society [5]. This paper aims to delve into some of the specific topics addressed by these standards, as a comprehensive review is not feasible within the constraints of this article. Two issues that resonate across most of

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the standards are the significance of design in achieving UD and the integration of UD principles within the rapidly proliferating field of AI. Additionally, we will examine the impact of standards on legislation and provide examples illustrating how standards can specify the means to achieve the goal of equal access to goods and services [6].

Methodology

Qualitative methodology is used, comprising the study of secondary sources, as well as web-based discussions and interviews with several experts engaged in the various projects that underpin this paper. The sources studied include literature related to the topics discussed herein.

Terminological aspects

Our understanding of UD is that it refers to "the design of products, environments, programmes, and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design." This definition is taken from the UN Convention on the Rights of Persons with Disabilities [10].

The importance of this definition lies, among other aspects, in its emphasis on design – of various products and services covered by the standard – and the consequential significance of the design process itself in achieving a result usable by all people. Hence, our focus on the design process in this paper.

Hypothesis

Our hypothesis is that a multi-thematic approach to the UD of digital products and services—as opposed to initiatives that focus on single issues—is essential to ensure that elderly individuals, including those with functional variations, can fully participate in the digital society.

One compelling argument for a multi-thematic approach is the fact that UD involves more than just access to digital work tools, home appliances, and other hardware and software. It also encompasses services, digital literacy training, and the user interface between diverse technologies, such as work-related and assistive technologies. This approach places demands on an enterprise's management systems and policies—encompassing training, procurement, and mainstream human resources.

To prevent the creation of barriers within the digital society, there is a significant responsibility on the shoulders of management at workplaces, city administrations, procurement offices, and the like. They must ensure that software and hardware, automated systems, and other equipment comply with the standard requirements of UD.

But what assistance can standards provide?

Standards can play a crucial role in enhancing outcomes for vulnerable consumers. They outline best practices for a variety of stakeholders—governments, public authorities, manufacturers, retailers, service providers, and even users themselves. Standards encourage organizations to consider UD and diversity at every stage of a product's design, development, and delivery, as well as processes and services. Fundamental principles of UD should be integrated into organizational culture and mirrored in systems, policies, and procedures. Moreover, standards can define exemplary practices in accessible design, including but not limited to digital products and services,

as demonstrated by these new four standards. By doing so, they can assist organizations in providing products and services that are addressable, understandable, and usable by the broadest possible range of users [7].

About the four standards

The four standards that we take as point of departure are:

Table 1. Overview of new standards on digitalization and Universal Design and their scope

Title	Scope
NS11038 Universal Design and Digitalization – Internet of Things [1]	Sets out accessibility requirements to ensure equal access to technology covered by the Internet of Things.
NS11039 Universal Design and Digitalization - Smart Cities [2]	Sets out requirements to ensure equal access to technology used in smart cities.
NS11041 Universal Design and Digitalization – Inclusive Labor Market [3]	Describes requirements for digital work tools and support functions, to ensure equal opportunities and accessibility in an enterprise [9].
NS11042 Universal Design and Digitalization – Procurements [4]	Sets requirements for the processes of procurement of digital products and services. How to specify UD regarding announcements, negotiations, evaluations and user participation. It is also relevant for suppliers.

Given that the four standards encompass a wide spectrum of topics related to digitalization, we have focused here on three case studies to illustrate the practical importance of standards in supporting equal access to digital products: design and development, AI, and the use of standards as support for legal initiatives.

Case 1: The design and development process and it's importance for UD in digitalization

A critical aspect of all the new standards, especially those concerning the Internet of Things and Smart Cities (NS 11038 and NS 11039), is the stipulation of design and development *processes* aimed at achieving universally designed products and services. These processes are visually represented below, highlighting the elements involved and the interconnections between them. At the core of the model is the goal of enhancing the user experience for elderly individuals with functional variations. As Figure 1 demonstrates, a multitude of subject areas, tools, methods, processes, and standards comes into play during design and development, all of which can incorporate principles of UD. Within the standards, the various elements and their attributes are delineated.

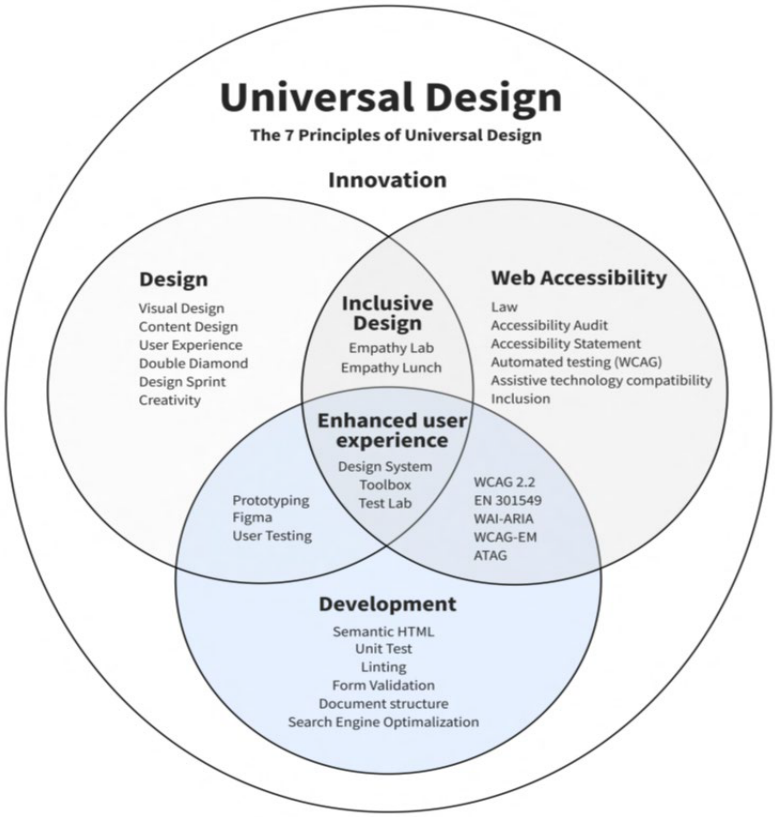


Figure 1 Elements necessary to enhance and improve user experience (Source: Kari Anne R. Andersen)

Improved user experience

To optimize user experience, we must recognize that UD is an interdisciplinary field. Success depends on every professional involved in design and development having a thorough understanding of UD principles. Moreover, enterprises should integrate these principles from the outset of their projects, to avoid high costs through incorporating them later in the process. A comprehensive toolbox, equipped with a design system and resources on best practices, is crucial for effectiveness. This toolbox consists of a compilation of insights from various professions, aid organizations and others, in developing more refined, universally accessible, and cohesive products. It may include a brand and visual identity reflecting the enterprise's vision and values, in addition to the enterprise's design system and information on best practices.

The design system

The design system serves to distribute and manage design and front-end elements efficiently. Its aim is to simplify the day-to-day operations of product teams. By facilitating the integration of UD requirements, the system ensures consistency with the enterprise's brand, saves time using pre-built modules, and minimizes uncertainty, risk,

and costs—all while enhancing speed and workflow. Within the scope of the four standards, user involvement from, in our case, elderly persons with functional variations is also emphasized as a crucial component of the design process. Another key aspect is prototyping, which typically falls into two categories: low-fidelity and high-fidelity. These categories describe the extent to which prototypes resemble the final product.

Therefore, the design system in product development is a repository of design choices and modules utilized in both design and front-end development. This system draws inspiration from the principles of Atomic Design, which is predicated on the notion of assembling small, discrete modules to construct larger, integrated units [12]. It is a systematic approach to designing front-ends that can be shared across multiple product teams and centrally maintained [11]. The framework of the design system comprises five hierarchical levels, all of which are relevant, and important to consider for UD results:

1. Styling - This level consists of some of the most granular modules within the design system. It includes essential design choices that digital products should follow, such as color palettes, typography, and more. Through specialized tools, styling guidelines are disseminated to designers via a library.
2. Components - These can be considered the more basic modules of the design system and include user interface elements like buttons, text fields, checkboxes, and others. Components are usually global and not specific to any one product. They are distributed to designers through a library, again using specialized tools.
3. Compositions - Compositions are building blocks made up of styling, components, and logic. They are larger and more intricate units that may serve multiple functions and are often linked to one or more products. Menus, forms, step indicators, and date pickers are typical examples of compositions.
4. Patterns - This level outlines how full pages or sections of pages are assembled to adhere to certain cognitive models, utilizing specific building blocks (styling, components, compositions, and logic).
5. Product Briefs - In addition to the modules, there is a necessity to detail the principles and guidelines for products. Each product may have distinct requirements for navigation, information architecture, interactions, and content strategy. A product brief compiles all these rules and guidelines for each product.

Using the design system, it must be clearly stated which decisions are system-related and which fall within the product teams' area. The levels in the design system (1 - 5) can be placed on a scale that explains the connection, and UD clauses be checked.

Case 2: AI and UD

AI is receiving increasing focus, both as a very important tool and as an emerging barrier for, among others, elderly individuals with functional variations — if programming and algorithms do not consider the variations and challenges faced by these individuals. This is particularly studied in the NS 11041 standard regarding inclusive workplaces.

AI is a concept that is garnering unprecedented attention due to its significance in work, education, science, and cultural life—essentially, in most aspects of our daily lives. AI is defined as a branch of computer science devoted to developing data-processing systems that perform functions normally associated with human intelligence, such as reasoning, learning, and self-improvement [6]. This includes tasks such as image recognition, natural language processing, decision-making, problem-solving, and much more. AI can be implemented using various approaches, including machine learning, deep learning, and rule-based systems. There are two types of AI [11]:

- Software AI: This includes virtual assistants, image analysis software, search engines, and speech and facial recognition systems.
- Embedded AI: This type is found in robots, autonomous cars, drones, and the Internet of Things.

There are many areas where AI is employed that are vitally important to people with disabilities in their daily lives. For example, AI is extensively used to provide personalized recommendations during online shopping, drawing from individuals' previous searches, purchases, or other online behaviors. Furthermore, AI is incredibly significant in the realm of commerce: it is instrumental in optimizing product offerings, planning inventory, and improving logistics, among other functions.

Another, and for our purpose more relevant area, is digital personal assistants, where smartphones use AI to offer services that are as relevant and personalized as possible. Virtual assistants that answer questions, make recommendations, and help organize daily routines have become ubiquitous. Machine-based translation is important to many; language translation software, whether based on written or spoken text, relies on AI to deliver and improve translations. This also applies to features such as automated captions.

In addition, we have generative AI, which is a technology that generates content such as text, images, programming code, and the like, traditionally created by humans and associated with human cognitive abilities, such as the capacity for learning. Generative AI is a subcategory of AI, which focuses specifically on generating new, original data or content. This type of AI is designed to engender content or data that is creative and novel.

Generative AI models, such as GPT-3 and similar systems, are capable of producing text, images, video, music, and other types of content based on patterns and knowledge they have assimilated from extensive datasets. Generative AI is often employed in areas such as generative art, text generation, and even some creative industrial applications. While AI is a broad term that includes all varieties of AI, generative AI specifically pertains to those segments of AI responsible for the generation of new and inventive outputs.

Given the numerous applications of this technology in nearly all areas of society, ensuring equal access, among others elderly, through UD is essential. In the context of AI, accessibility should address a variety of factors, ranging from labeling and risk analysis to the accuracy of text-to-speech tools, navigation aids, and many other elements.

The EU's Artificial Intelligence Regulation

"AI should be a tool for people and be a force for good in society with the ultimate aim of increasing human well-being," states the introduction to the European Commission's

proposal for a regulation on harmonized rules for AI (Artificial Intelligence Act of 2021, COM(2021) 206 final).

This regulation pays particular attention to the rights of various groups, including elderly with functional variations, and ensures it does not conflict with existing EU anti-discrimination legislation. Provisions have been made to minimize the risk of algorithmic discrimination. This term refers to the biases in algorithms that can, for instance, affect the operation of machinery by for instance elderly workers. This issue is particularly crucial when it comes to the design and quality of datasets used to train AI systems. Coupled with these concerns are requirements for persistent testing, comprehensive risk management, detailed documentation, and consistent human oversight throughout the lifecycle of AI systems.

Specific areas stand out when considering UD in AI. It is crucial for AI systems that observe their environment and make decisions to incorporate a sufficiently large and representative training dataset. This inclusion maximizes precision and facilitates the recognition of operating patterns for different types of conditions, such as various physical disabilities. Precision entails minimizing errors related to observation, which might influence technical functions like reading text, barcodes, and more. For instance, real-time speech-to-text translation functions for deaf and hard of hearing elderly workers must accurately transcribe spoken words for users. Similarly, AI used as an aid for reading text, scanning barcodes, describing the surroundings, and recognizing faces must reproduce information as precisely as possible.

Additionally, companies should ensure that when AI is used to generate content, perform tasks, and other activities, this content is labeled to indicate whether it has been created with AI and has undergone human quality assurance. This should be part of their policy of age-inclusive workplaces.

It may be advantageous for companies to establish and follow their own ethical guidelines for AI development and distribution, which prioritize fairness and non-discrimination, including the adoption of UD principles.

Similarly, enterprises that employ AI systems with employee interfaces should ensure these systems provide equal access and are understandable, in accordance with the EU's forthcoming AI Regulation. They should also implement techniques to ensure fairness — in terms of both equal access to AI-based solutions and the development of solutions using AI tools. This approach allows companies to identify and mitigate discrimination stemming from biases in datasets and to monitor the AI systems' impact on different individual groups. It is important to note that companies cannot collect personal data related to, for example, disabilities among their employees.

Expertise in accessibility, specifically in the context of AI systems, is essential to guarantee equal access for all users.

Furthermore, accessibility has and will continue to be a relevant consideration in many other areas. For example, one of the four standards discussed in this paper is NS 11041, which focuses on digitalization, UD, and inclusive working life for elderly with functional variations.

Case 3: Standardization, procurement and legislation

Another aspect concerns international standards, particularly the harmonized standards in Europe that possess a quasi-legal status as "soft law." Adhering to the provisions of these standards assists in meeting the legal requirements for accessibility

outlined in EEA legislation. This also is important for securing user interest for elderly users with functional variations, in procurement. NS 11042 focuses on this topic.

European harmonized standards are those recognized as fulfilling the relevant essential safety requirements (ESRs) outlined in European product directives. Initially, the EU formulates broad safety objectives through directives, but these objectives require detailed specification. Standards provide this specification, effectively operationalizing the regulations.

In Norway, standards typically do not carry legal weight unless they are explicitly referenced, for instance in contracts. However, with the transposition of the Web Accessibility Directive into the Regulation on UD of information and communication technology (ICT), Norway has incorporated such a harmonized standard. This trend will continue as the European Accessibility Act and its six harmonized standards come into force in 2025.That will be a high point for standards to assist equal access for elderly persons with functional variations.

To conclude

Standards are crucial in the pursuit of ensuring that products and services can be accessed and used equally by everyone. They provide detailed guidance on best practices for organizations working with the topics addressed by each standard. Ideally, these standards are developed through collaborative efforts involving all relevant stakeholders, from public authorities to end-users and consumers—a process reflected in the standards discussed herein. However, a standard's presence alone does not automatically guarantee visible effects. It must be actively utilized by organizations as an instrumental means of achieving universal access. This may involve a meticulous design process, tapping into specialized expertise for the technical aspects under consideration, undertaking initiatives to raise awareness, and—critically—cultivating the political will to ensure compliance with the detailed provisions of the standards to attain specific, inclusive goals for the collective good. Through the presentation of just a select few examples embedded in the new national standards, this paper has illustrated effective practices for facilitating equal access to the digital society for everyone.

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[3] NS11041 Universal Design and Digitalization – Inclusive Labor Market
[4] NS11042 Universal Design and Digitalization – Procurements
[5] https://www.standard.no/standardisering/komiteer/sn/snk-592/
[6] ISO-IEC-2382-1 Information technology — Vocabulary
[7] https://digileaders.com/the-business-case-for-accessibility-and-inclusivedesign/ - this is a website describing the benefits for an enterprise if they ensure that their products and services are accessible.
[8] https://bighack.org/literature-review/ is an overview of literature on the benefits of accessible products and services, both of them from United Kingdom.
[9] https://www.telenor.no/openmind/ and https://www.telenor.no/openmind/modellen/ are Norwegian webpages in a projects run by the Norwegian telecom company Telenor, which is including disabled persons through the use of digital tools to prepare them to enter or reenter the labour market.
[10] Convention On The Rights Of Persons With Disabilities (CRPD).
[11] Based on interviews and meetings with experts in NAV ICT.
[12] See for instance 5 UI Components in Atomic Design - by UXPin

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Towards Recommendations for the Universal Design of Online Authentication Systems

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Abstract. There is a growing body of research on the problems older and disabled people face with authentication systems and a range of solutions have been developed. However, this research has not been integrated across user groups and solutions usually only target one or two groups. This research has attempted to integrate the empirical research findings across studies conducted with people with visual, physical, and intellectual disabilities, people dyslexia and older people. It proposes an initial set of 15 recommendations for the universal design of authentication systems. Four recommendations are about authentication systems in general, six about password authentication, two about CAPTCHAs and three about biometric authentication. 40% of the recommendations address problems experienced by at least two different user groups and over 25% address problems experienced by three groups. However, much further work is needed to validate and refine the recommendations and integrate them into a universal design approach.

Keywords. People with disabilities, authentication, universal design, recommendations

1. Introduction

As more and more services move online, the number of online accounts we are all are required to use continues to grow. Often the information stored in these accounts is personal and valuable to us, be it financial information or personal photos, so ensuring the information is secure is vitally important. Therefore, we need to authentication ourselves when logging into online accounts and take appropriate measures to make sure our accounts and data are secure.

There are now numerous forms of authentication, including:

- Passwords, which often include complex requirements (e.g. the password must be 8 characters long and contain at least one capital letter, one number and one special character from a specified set) and password strength meters to inform users whether their proposed password is sufficiently strong;

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- CAPTCHAs (Completely Automated Public Turing test to tell Computers and Humans Apart), which can involve reading distorted letters, finding all the examples of a particular object in a set of phones (e.g. click on all the photos with a car in them), or solving a puzzle;
- two factor and multi-factor authentication, in which the user must enter more than one form of identification, often including a one-time code, for example I enter a password into an account login and the account then sends me a code on a different device I have registered, such as my smartphone, I must then enter this code before I get access to the account;
- biometric authentication, which may be via fingerprint, face, voice or iris recognition.

Some of these authentication methods are difficult even for young, able-bodied people to use and people with disabilities and older people face many additional difficulties, as well as anyone with a situational disability, for example a broken arm, a slow internet connection or a very small screen. Inevitably, as in other technological areas, these methods are only designed with able-bodied, computer literate users in mind, inclusive options are very much an afterthought and are often less than optimal. However, there is now a growing body of research about the problems encountered by older and disabled people with authentication systems and a range of solutions to these problems, usually proposed to support one specific user group. The research in these two areas is outlined briefly in the next section.

The main purpose of our research is to review the evidence on the problems that older and disabled people encounter with authentication and to propose recommendations to support the universal design of authentication systems. The motivation for the work is twofold. Firstly, the evidence of the problems older and disabled people encounter is dispersed through many research papers and needs to be drawn together. Not only is this corpus of research of interest in itself, but one of the interesting aspects of the research is that while people with very different disabilities have different problems, the solutions we can offer can often address more than one group. This is an important observation which does not seem to have been made about the body of research. In our previous work, we found this economy of solutions was often the case in web accessibility problems [10]. Secondly, this is a very important observation to communicate to developers of systems, who we have found are often overwhelmed by the prospect of meeting the needs of people with many different disabilities. But the task facing them is not as daunting as they may think, and sophisticated implementations can often solve numerous accessibility problems. Nonetheless, the set of recommendations presented here are only a preliminary version, which require further research and validation, plans for which will be discussed briefly at the end of the paper.

2. Background

In this section we concentrate on research which has directly engaged with older and disabled people. We have not yet documented our literature search as a systematic review, however, we have been collecting literature on this topic for some time, and augmented our collection with searches in the ACM and IEEE Xplore digital libraries and Google Scholar for papers with a wide range of keywords. We will continue to expand our search

into a systematic review, appropriately documented. A number of papers have addressed the issues of the accessibility of authentication systems from a theoretical perspective, analysing systems using what is known about the characteristics of the different user groups [3, 20, 29]. While useful, this research may miss the actual lived experience of older and disabled people and the problems they encounter. Instead, we reviewed research which has used focus groups, questionnaires, interviews and contextual inquiry to directly ask people about the issues they face in order to provide an empirical basis for the recommendations.

Research documenting the problems encountered by older and disabled people has been strongly focused on the problems encountered by visually disabled people (particularly people using screen readers). Research has highlighted a range of problems including the inaccessibility of visual CAPTCHAs [21, 39] and other authentication components which are visual [21, 39], systems which time-out too quickly for screen reader users [21, 39], an inability to determine whether the authentication has been successful [11], and concerns about "shoulder surfing" (either visually or auditorily) [2, 12]. Recent research [34, 40] has shown that although auditory CAPTCHAs are now common, they are not widely available and even when they are, often still create problems for visually disabled users.

There is much less research which has engaged with other disabled user groups. Several studies with people with dyslexia [23, 36] have found that they have difficulties creating and using passwords, due to the need for precise ordering of elements; problems with CAPTCHAs, particularly if they involve reproducing distorted letters and other authentication systems which require pattern recognition. Several studies with people with a range of intellectual disabilities [19, 27] found that people had difficulties creating and using passwords, but also frustration that systems did not provide more specific error messages (e.g. whether it is a username or password which is incorrect). One study with people with upper limb disabilities [26] identified problems with both passwords (e.g. long, complex passwords can be difficult to enter) and biometric authentication, for example the need to remain still, the need to position oneself correctly in relation to the camera or sensor. Only one paper could be found which engaged with people with hearing disabilities [9] but no specific information about the problems they faced was reported. Finally, several papers [8, 33] with older people found that they had problems understanding the requirements, creating and remembering strong passwords (although many solved this problem by writing them down in a secure place).

Research on solutions to authentication problems has also been mainly concentrated on blind people. The most important development has been that of auditory CAPTCHAs [e.g. 22], which are the only alternative authentication mechanism to be widely adopted. However, implementations are not without their own accessibility problems [34, 40]. Other alternatives have been proposed for visually disabled people using tactile authentication [4, 5, 13, 24, 44] and an audio one-time password system [15]. The latter could also be helpful to older people, people with intellectual disabilities and dyslexia. A password manager accessible to visually disabled people has also been proposed [6].

A number of solutions have also been proposed to make authentication easier for older people. These include using graphical passwords to reduce the cognitive load of remembering passwords and adapting them with age-appropriate materials (e.g. older faces) to improve performance. Solutions have also been proposed involving users own doodles, handwriting [37] and musical motifs [17, 28]. Graphical passwords have also been proposed for people with dyslexia [12]. Finally, several solutions have been

proposed to help people with physical disabilities including brain-computer interfaces [38] and a system based on recognition of cardiac rhythms [25].

3. Towards recommendation for universal design of online authentication systems

Table 1: Initial recommendations for a universal design approach to online authentication

Recommendation	Groups supported	Source/s of evidence
GENERAL		
Make the flow in complex authentication tasks clear and explained, logical in a screen reader	Visually disabled people People with dyslexia Older people	[34] [23] [33]
Make it very easy to increase time limits in authentication process	Visually disabled people Older people People with dyslexia	[21, 39] [33, 42] [12, 23]
Ensure all elements of the system are accessible and identifiable to screen readers (e.g. edit fields, error messages, feedback that authentication is successful)	Visually disabled people	[11, 34, 40]
Mitigate against auditory "shoulder surfing" for screen reader users	Visually disabled people	[11, 45]
PASSWORDS		
Support people in creating strong, secure passwords based on familiar concepts	Older people People with dyslexia	[8, 37] [12, 36]
Make password construction requirements ("policies") clearer	Visually disabled people Older people People with dyslexia	[18, 43] [33] [12, 32]
Provide alternatives to character-based passwords	Visually disabled people People with intellectual disabilities People with upper limb disabilities	[6, 14, 19] [27] [24]
In graphical password systems, allow use of age appropriate elements	Older people	[30, 31]
Provide better support for creating passwords which meet requirements	Older people	[33]
Provide better education on strong passwords and how to create them	Older people	[33]
CAPTCHAs		
Offer alternatives in CAPTCHAs	Visually disabled people People with dyslexia	[21, 39] [23, 32]
If using audio, make sure the source is clear	People with visual disabilities	[34, 40]
BIOMETRIC AUTHENTICATION		
For biometric authentication, ensure that there is auditory/tactile information about where to place finger/face	People with visual disabilities	[7, 11, 16, 35]
Provide alternatives to iris recognition for people without eyes or who cannot open their eyes	People with visual disabilities	[34, 40]
Provide alternatives in biometric authentication which requires the user to be still for a period (e.g. at registration)	People with motor disabilities	[16, 21]

Table 1 summarizes the initial version of the proposed recommendations for the universal design of online authentication systems. It comprises 15 recommendations, four recommendations are about authentication systems in general, six about password authentication, two about CAPTCHAs and three about biometric authentication. The

user groups addressed comprise people with visual, physical and intellectual disabilities, people with dyslexia and older people. 40% (6/15) of the recommendations address problems experienced by two or more different user groups and over 25% (4/15) of the recommendations address problems experienced by three different user groups.

Some of the recommendations might easily apply to other user groups. For example, the recommendation about password authentication in relation to older people, "Support people in creating strong, secure passwords based on familiar concepts" could also support people with intellectual disabilities, but as we did not find empirical evidence for that problem with that user group, thus for the moment we have refrained from including it. Another recommendation in relation to older people, that "In graphical password systems, allow use of age-appropriate elements" is based on research with older people using older and younger faces [30, 31]. It could well be that people with intellectual disabilities would find elements from categories they are familiar with also beneficial, that would be an interesting possibility to research. Finally, these recommendations could be extended beyond the needs of older and disabled people to include other diverse user groups, such as users of different ethnicities and cultures (so for example, culturally and ethnically appropriate elements would a useful extension of the recommendation of "age-appropriate elements" to "age-appropriate and culturally and ethnically appropriate elements"). Finally, examples provided with the recommendations could include those involving situational disabilities, to illustrate the broad application of their use.

Some of the recommendations can also benefit from further elaboration and examples. An example is "Make it very easy to increase time limits in authentication process". Visually disabled screen reader users in attempting to use auditory CAPTCHAs can find that there is not sufficient time allowed between listing to the auditory message and navigating to the field in which the answer needs to be entered, causing them to be timed out. Thus, it is not just the overall time limits that are important, but the time limits on individual steps in the authentication journey. Another example, again for visually disabled screen reader users, is "If using audio make sure the source is clear". Of course, developers do not have control over the environment in which an audio CAPTCHA is used, so this does not refer to noise in the environment. However, there may be a temptation to distort the audio source in analogy to the distortion of a visual CAPTCHA or to use naturally captured audio material which may not be clear (Google appear to have done this), but combined with uncontrollable environmental conditions, these manipulations would adversely affect the effectiveness of the audio CAPTCHA.

4. Conclusions

In this paper we have presented an initial set of recommendations for the universal design of authentication systems, covering the needs of older people and a range of people with different disabilities. However, much further work is needed to validate and refine these recommendations. Some of the empirical research on which the recommendations are based is now over a decade old, and authentication systems have evolved considerably since then. It is notable that none of the recommendations deal explicitly with two or multi factor authentication, although these types of authentication are now widely used. In addition, none of the recommendations deal with single sign-on or federated identity management systems, also now widely used. We have not found any empirical research with older or disabled users in those areas yet. In addition, some of the research

understandably is based on very small samples of participants, so may not be typical of the whole user group, particularly as these user groups are very diverse in themselves. Thus, our future work will be to valid and refine the recommendations by further research with the user groups to establish how representative and severe the problems underlying the recommendations are, both using questionnaires and testing of simulations of authentication systems exhibiting the problems. The recommendations also need to be scrutinized for any aspects which would involve compromising the security of the authentication, as this would defeat their purpose. Other research could investigate extensions of specific recommendations to other user groups for which we did not find any empirical evidence. Finally, this research has taken an essentially bottom-up process, looking for the empirical evidence from users of the problems they have. It will now be interesting to combine this with a top-down approach, starting from the basic principles of universal design and applying these to what we have learnt about the problems encountered.

A general principle which emerges from the review of research and the recommendations is the need for flexibility and personalization in authentication systems. In researching this paper, we encountered a very interesting example of a proposal for a multimodal authentication system [1], which would incorporate visual, verbal and spatial cues (and could easily be extended to incorporate auditory cues). Although this system was not targeted at older or disabled users, an implementation of such an authentication system developed using some of the recommendations could be an excellent exemplar of a universally designed authentication system.

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Accessibility Influencers: A Netnographic Qualitative Study

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Abstract. Accessibility influencers play a pivotal role in the broader accessibility movement, leveraging social media to raise awareness and shape public opinion. This study explores the distinct goals, communication styles, and approaches these influential figures employ to make complex legislative content more accessible and engaging. Utilizing netnography for data collection and conducting thematic analysis of interviews, this research highlights the crucial role of accessibility influencers in disseminating knowledge, advocating for universal design, and enhancing digital accessibility. The findings emphasize the importance of integrating accessibility principles into educational curricula, ensuring the development of a workforce capable of creating inclusive environments. Moreover, the study underscores the need for continuous professional development and systemic inclusion of accessibility training across all educational levels.

Keywords. Accessibility Influencers, Digital Accessibility Universal design.

1. Introduction

The topic of accessibility has become increasingly prominent in the design field, driven by recent international legislation [1], well-established guidelines and standards [2], [3], [4] as well as a growing body of research on the topic [5], [6]. Accessibility is now supported by a legislative mandate derived by policymakers as well as an essential area of scholarly inquiry. However, there appears to be a disconnect between the provisions outlined in formal regulatory content and the practical realities of implementation. It can be challenging to distil the concrete steps needed from the abstract language of official documents. Accessibility influencers translate complex political topics into more understandable terms for all.

Like Persson et al., in this study, accessibility will be defined as ‘‘the extent to which products, systems, services, environments and facilities are able to be used by a population with the widest range of characteristics and capabilities (e.g. physical, cognitive, financial, social and cultural, etc.), to achieve a specified goal in a specified context,’’ [5] with a particular emphasis on cognitive capabilities. It means that accessibility, similar to inclusive design, ensures all individuals have equitable opportunities to accomplish specific objectives within contexts. Accessibility is closely linked to the universal design (UD) goals and vision. While the specific approaches and methodologies may differ, both accessibility and UD share the overarching aim of ensuring usability and inclusivity for all users. Seen this way, accessibility and UD aim

for inclusivity from the outset. Accessibility refers to attending to a diverse population's usability of products, systems, services, and environments. UD, similarly, aims to ensure that technology is accessible and usable to a broad user base, promoting inclusivity and equal access to information and services.

The aim of this study is twofold. First, we mean to explore and understand the topic of accessibility from the accessibility influencers' point of view. In other words, we are interested in knowing how accessibility influencers perceive different issues, categorize or dismiss certain subjects and navigate their influence within the limits and affordances of social media platforms. Second, we mean to map the most prevalent concepts and courses of action that come to the fore when accessibility is the main subject of discussion and debate. The goal is to identify strategies to connect accessibility legislation with user-centered design [5]. This study addresses the following research question: How do accessibility influencers perceive accessibility and bring it to the attention of many? Answering the question requires qualitative data collection and analysis. We review the literature on the impact of influencers and accessibility awareness and briefly explain our data collection method, netnography, and thematic analysis. The results, discussion, and conclusion sections follow.

2. Impact of influencers

Influencers play a vital role in translating complex information into relatable insights, making formal content more approachable and understandable for the public [8]. These individuals build loyal online followings by sharing engaging content and translating complex discourses into relatable insights. This makes the topics they handle more approachable for the public and connects professional discussions with practical, real-world applications, fostering more profound understanding and encouraging solutions. Social media surpasses traditional media in influence, with influencers advocating for accessible design and sharing best practices to drive meaningful conversations. Influencers are entities that adapt to the dynamic social and technological contexts online, effectively translating different topics into everyday language. The impact of influencers is significant in cultural power. Their ability to build trust and engagement within their communities illustrates how they develop and monetize their brands while fostering trust and engagement with followers [8], [9] [10]. Influencers can build an audience on social media by cultivating trusted relationships through opinion-sharing and active audience interaction [8]. Social media has increasingly developed into a natural environment for social debates, evoking strong emotions that affect people's lives in many ways [11], [12]. While it offers users opportunities for interaction and the formation of collective identities, it also presents new challenges. The internet, particularly social media, has expanded communication possibilities, contributing to people's participation in various social discussions [11], [12].

3. Understanding accessibility

Accessibility has become a comprehensive field that addresses various user groups, devices, and contexts. Initially termed "Web accessibility," it focused on making

websites accessible, driven by initiatives like the Web Accessibility Initiative [4] (WAI) and the Web Content Accessibility Guidelines (WCAG) [2]. European Accessibility Act (EAA) [1] now extends to all digital systems, including electronic kiosks and e-books, ensuring equal access for users with diverse disabilities. Despite significant progress, web accessibility challenges remain. Despite progress, challenges remain as accessibility extends to all digital systems, ensuring equal access for users with diverse impairments [13]. Accessibility increases to include personal computers, laptops, and mobile phones and extends to various technologies beyond desktop and mobile computing. It is essential to make accessibility universal. This strategy must incorporate continuous legal efforts, integration of accessibility into educational curricula for future technologists, stringent corporate policies that enforce usability testing and accessibility verification, and a culture of accountability and transparency among employees. Achieving accessibility and inclusivity requires a multifaceted approach, including legal frameworks, educational initiatives, corporate policies, and the development of accessible technologies. Legal mandates like the EAA enforce compliance and inspire innovation. Educational efforts foster awareness and skills, while corporate policies ensure products and services are usable by all. Commitment to advancing accessible technologies promotes full societal participation and inclusivity for individuals with disabilities [14].

4. Qualitative Netnographic Research

This study follows the principles of netnography expounded by Kozinets [15]. Netnography is a qualitative research paradigm built upon the pillars of ethnographic research. It uses qualitative methods such as observation, field notes, detailed diaries, and interview material. However, its domain of inquiry, different from that of ethnographic research, is not a physical context. Instead, it is oriented and calls attention to what transpires in the digital domain [15]. We use netnography to understand influencers' perspectives by observing them on social media, i.e., what they write, sharing texts, videos, and other materials, and how they use the communicative tools offered in the current online environment to create influential content. We first followed accessibility influencers on social media (table 1).

Table 1. Overview of participants' country and their active social media platforms

Influencers	Country	LinkedIn followers	Social media
5	Sweden	800–1900	LinkedIn, Slack, Facebook, YouTube, Meetup
2	Austria	3500–7400	LinkedIn, Facebook, Blog, Instagram
1	England	1400	LinkedIn, Facebook
1	Holland	4000	LinkedIn, X, YouTube
2	USA	6000–6300	LinkedIn, Facebook, Blog, YouTube, X (Twitter)

After that, we contacted them and asked for an online interview. Influencers have various job titles, such as user experience designers, developers, accessibility experts and advocates. Selection criteria included influencers actively engaging on social media about current accessibility topics, with at least several hundred followers and connections with other influencers, primarily in Europe and the USA. During the study, we employed

a snowballing technique [16] to expand our network of accessibility influencers, increasing the number of interviews from seven to eleven. Before the interview, we obtained consent from all participants to record the conversation; then, the interviews were transcribed and anonymized [8]. We then used thematic analysis because it offers a balance of simplicity and depth, making it a valuable method for qualitative research across various fields and contexts [17].

5. Analysis

The thematic analysis of 11 interviews reveals complex accessibility influencers. Key themes include influencer networking, legislative impacts, social media advocacy, continuous education, technological advancements, personal motivations, and community engagement. Insights emphasize balancing technology with human oversight, legislative support, educational reforms, and collaboration to foster an inclusive society. Influencers and networking promote accessibility through collaboration and information sharing. Legislative efforts like the EAA drive developments. Social media aids networking and advocacy by tailoring messages. Continuous education equips professionals with accessibility. Personal experiences drive advocacy. In the following, we present the identified themes and key insights, highlighting the researcher's role in pattern identification and theme selection [17].

5.1. The Role of Influencers and Networking in Promoting Accessibility

Accessibility influencers and networking are crucial for promoting accessibility. Collaboration and information sharing among influencers help bridge gaps in awareness and implementation. Interviewee (IV) 1 discusses the need to stay active on LinkedIn, while IV 10 highlights the role of influencers in educating and promoting accessibility on various social media platforms. IV 9 describes maintaining a vast global network that facilitates information exchange primarily through community-driven insights and social media platforms. This network is pivotal in staying updated without actively searching for news. Emphasis is placed on the value of interactions, such as meetings and conferences, to strengthen connections and share information effectively. Highlighting the importance of online networking in various professional settings, these connections facilitate knowledge sharing and collective action, which are essential for availability initiatives and raising awareness.

5.2. Transformative Power of Legislative Efforts in Accessibility

Reflections from IV 4, 3, and 7 collectively point to the transformative power of legislative efforts in accessibility. IV 4 offers insights into the European Accessibility Act (EAA), highlighting its substantial impact on improving accessibility and the resulting benefits for businesses and individuals. IV 3 emphasizes the maturation of the digital landscape due to legislative frameworks, while IV 7 advocates for consistent adoption of accessibility practices through more precise guidelines. IV 3 is optimistic about the EAA, acknowledging its role in driving interest and improvement in accessibility while also recognizing the challenges due to ambiguities in the regulation.

They believe these efforts enforce compliance and inspire continual improvement and innovation, contributing to a more inclusive society.

5.3. Strategic Use of Social Media for Accessibility Advocacy

Social media is a potent tool for advocacy, allowing activists like IV 6, IV 7, and IV 10 to promote accessibility effectively. Each uses platforms tailored to their audience: IV 6 utilizes X (Twitter), Facebook, and LinkedIn to rally support, while IV 7 focuses on education and updates. IV 10 strategically uses LinkedIn for professional outreach to policymakers, blogs for in-depth policy discussions, and Facebook for grassroots engagement, tailoring her message to suit each platform's audience. This approach showcases the versatility of social media in advancing accessibility and engaging different societal segments. All accessibility influencers in this study strategically use social media to spread accessibility awareness and engage with a broader audience. They point out that each platform offers unique benefits, making it essential to tailor the approach to maximize impact. Several of them use LinkedIn more because they say it is more professional, and others use X because it is more accessible.

5.4. Importance of Integrating Accessibility in Educational Curricula

Integrating accessibility into educational curricula is essential for cultivating a workforce skilled in creating inclusive environments. Continuous learning and proactive curriculum development are vital for equipping professionals with the necessary skills to implement accessibility effectively. IV 4, an advocate for comprehensive accessibility education, criticizes the current approach, arguing that accessibility courses should be introduced earlier and not confined to higher education. She highlights a significant gap in training for UX designers, graphic designers, editors, and project managers, noting most graduates lack adequate exposure to accessibility issues. IV 3 echoes IV 4's concerns, emphasizing the importance of specialized courses in designing IT systems for people with disabilities. He suggests such education should be standard rather than exceptional, advocating for systematic inclusion of accessibility training at all education levels. IV 9 further supports this argument, stressing that accessibility needs to be a fundamental part of the curriculum from the beginning of educational journeys, not merely an occasional topic at the university level. All interviewees underscored the significance of education in advancing accessibility. They believe we must integrate accessibility principles into our educational systems, starting in elementary education and extending through professional development programs. By embedding these principles into the curriculum, the next generation of professionals will be conscious of accessibility needs and possess the expertise to create accessible environments. This educational framework will prepare professionals across various fields to consider accessibility as a core work element.

5.5. Potential and Challenges of AI in Enhancing Accessibility

Some of the accessibility influencers mention that Artificial Intelligence (AI) has the potential to enhance accessibility significantly. However, they mean it requires careful implementation and human oversight. IV 5 talks about the use of speech-to-text dictation programs and the potential of AI to assist users in dictating text and control their computers using voice commands. IV 8 sees AI as a future enabler but acknowledges its current limitations. IV 2 speaks enthusiastically about the role of AI in enhancing

accessibility, sharing insights from his experiences at his workplace. He means that AI helped him with accessibility issues in his work.

Furthermore, IV 2 critically examines the limitations of AI, cautioning against excessive dependence on its potential to mislead and the risk of companies overstressing AI's capabilities. He stresses the importance of a balanced approach when integrating AI into accessibility efforts, recognizing its advantages while remaining mindful of its constraints. Technology, especially AI, holds significant promise for enhancing accessibility, offering new tools and solutions to transform everyday interactions. From practical use for voice control to envisioning AI as a future cornerstone of accessibility, the potential is clear. IV 2's experiences at [company] further illustrate AI's role in creating inclusive environments and the enthusiastic response from various sectors. However, all interviewees agree on the necessity of cautious implementation and continuous human oversight to mitigate AI's limitations and prevent overreliance on technology that might not fully understand human needs. Ultimately, a balanced approach that combines the innovative capabilities of AI with informed, practical management will be vital to realizing its full potential in accessibility.

5.6. Personal Experiences, Community Engagement, and Networking

Personal experiences greatly influence commitment to accessibility advocacy, with community engagement and networking being crucial. IV 11's involvement is driven by her family's experiences with disabilities, which give her unique insights and fuel her dedication. IV 10's hearing loss motivates her to advocate for users with hearing impairments. IV 7's journey started in marketing, where she learned the importance of using 'Alt-text' to describe images. This experience highlighted the role of accessibility in social media and educational content. IV 3's journey started as a web developer, influenced by an academic course on IT systems for people with disabilities. IV 4's advocacy is rooted in her user experience (UX) design work and family experiences with disabilities. These connections emphasize the importance of empathy in creating inclusive digital environments. Engaging with a supportive community and networking are essential for advocacy and professional growth. IV 2 values the collaborative environment in the accessibility community, while IV 3 benefits from the (a11y) Slack community and Accessible EU networks. These connections offer resources, support, and collaborative opportunities, enabling knowledge sharing and advancing advocacy efforts. Such involvement enhances professional development and amplifies the impact of accessibility initiatives, fostering collective efforts towards creating inclusive digital spaces for all.

6. Discussion

This study explores accessibility from influencers' perspectives, highlighting their critical role in the accessibility landscape. Influencers gain loyal followers by posting engaging, authentic content on social media, which is crucial for spreading information and promoting inclusive design.

Digital accessibility is essential for inclusivity, impacting various aspects of life, including education, employment, and social interaction [5]. Historically, digital accessibility focused on making websites usable for all, with initiatives like WCAG setting foundational standards [2]. Despite technological advancements, challenges in

digital accessibility remain due to varying design interpretations and technological and institutional limitations, such as a lack of awareness and expertise. However, as all interviewees mention, AI offers new opportunities, but it has limitations and offers challenges [13].

Regarding legislation that promotes digital accessibility, Influencers from the EU emphasize the EAA [13] to ensure equal access to all digital systems and has advanced digital accessibility significantly. The legislation mandates compliance, raises awareness, and encourages prioritizing accessibility. Achieving an equitable society requires a comprehensive approach, with inclusive, universal, and human-centered designs crucial for creating accessible digital environments. All accessibility influencers show that they play a complex and essential role in promoting accessibility by bridging gaps in awareness and mobilizing support through social media platforms. They foster a community of advocates pushing for better standards, driving positive change and supporting initiatives that enhance digital accessibility. This networked approach clarifies the impact of accessibility efforts and supports a more inclusive digital environment. By leveraging their reach and influence, influencers drive positive change and support initiatives that enhance digital accessibility for all [8].

Continuous education and professional development are vital for advancing accessibility. Influencers emphasize integrating accessibility into educational curricula to ensure future professionals are skilled. Workshops and certifications help maintain high standards and keep practitioners updated with new developments and best practices.

Accessibility influencers emphasize that AI offers promising avenues for enhancing digital accessibility. They mean that AI can enhance user interfaces, provide personalized experiences, and support various assistive technologies. However, addressing gaps in accessibility for speech and hearing impairments remains crucial. Future research should focus on consolidating existing knowledge and addressing fragmentation in accessibility research. While AI can streamline processes and offer innovative solutions, it may also create new barriers, necessitating further study to identify problems and solutions, especially with the experience of actual disabled people [18]. Continuous evaluation of emerging AI is essential to enhance accessibility and prevent new user barriers. Influencers use social media to raise awareness, educate followers [9], and drive positive change in accessibility, advocating for improved accessibility and highlighting new technologies' challenges and potential solutions.

7. Conclusion

Accessibility influencers play a pivotal role in advancing digital accessibility by leveraging social media to raise awareness, translate complex legislative content, and advocate for user-centered design. Their efforts bridge the gap between policy and practice, driving compliance with frameworks like the European Accessibility Act and fostering continuous improvement. Integrating accessibility principles into educational curricula is essential for developing a skilled workforce to create inclusive environments. At the same time, AI promises to enhance accessibility, and careful implementation and human oversight are necessary to prevent new barriers. Influencers' personal experiences and community engagement underscore their commitment to advocacy, highlighting the importance of collaboration and information sharing. Despite challenges like sample size limitations, the findings stress continuous professional development and systemic inclusion of accessibility training at all educational levels. True digital accessibility

requires a holistic approach, considering diverse user needs from the start, with influencers driving positive change.

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Mastering Gesture-Based Screen Readers on Mobile Devices - Exploring Teaching and Practice Strategies

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Abstract. Gesture-based screen readers like VoiceOver or TalkBack provide visually impaired users with a means to interact with digital content. However, there is a significant lack of both strategies and resources for teaching the use of these screen readers, and standardized teaching guidelines are notably absent. Furthermore, there is no free, universally designed, and accessible app for practicing gestures in mobile screen readers. This study aims to identify best practice strategies for teaching and practicing the use of gesture-based screen readers among visually impaired users, based on observations from an IT course directed at visually impaired individuals. Moreover, we present common challenges related to usability, attitudes, emotions, technical aspects, and user guidance and education, as well as key traits and facilitators for learning gesture-based screen readers. Lastly, we assess the feasibility of an app to practice gestures and propose a framework for a gesture practice app to enhance user accuracy and patience.

Keywords. Visual Disability; Screen Reader; Gesture; Adult Education; Mobile Technology; Accessibility; Usability; Universal Design

1. Introduction

Screen readers, such as VoiceOver (Apple) and TalkBack (Android), are key tools for visually impaired users in mobile technology [1–3]. These tools enable interaction with digital content through audible narration of textual and graphical elements, employing various finger-swiping gestures like swiping, tapping, or rotating for functions such as reading, writing, navigating, or adjusting settings [1–5]. Although these gesture-based screen readers offer numerous benefits and advantages, and their gestures are presumably simple and natural, certain limitations persist [6–10]. Mastering these gestures requires practice and patience, with the goal of ingraining these movements into the user's muscle memory for increased comfort and consistency [6–9]. Despite the availability of various training resources from producers, institutions, and public authorities for learning and using gesture-based screen readers [1–5,11,12], these resources are often not widely

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known, difficult for beginners of screen readers to access, and lack proper educational formatting. Likewise, research provides only a few strategies to teach gesture-based screen readers, including strategies based on auditory and verbal feedback and gamification [6,13–15]. Thus, significant challenges remain, related to the absence of consistent and standardized guidelines and strategies for teaching gestures in gesture-based screen readers [6,16]. Also, a free, and universally designed practice app for visually impaired people has not been identified so far [6,14].

This study aims to identify the best strategies for teaching and practicing gesture-based screen readers to visually impaired users and assess if a gesture practice app can simplify learning and boost comfort and skill. We obtained insights from silently observing an IT course for the visually impaired.

This article outlines our data collection and analysis methods. We will then present our qualitative findings and discuss potential future research directions.

2. Methodology and implementation

We participated in a four-day in-person IT course, facilitated by the Norwegian Association of the Blind and Partially Sighted (NAPB) at their continuing education center located in Northern Norway. The course emphasized the use of digital media and screen readers tailored for individuals with visual impairments. Two main instructors and six assistants oversaw one-on-one and group training sessions. All of them were peer supporters, either having disabilities or being closely related to visually impaired individuals. Fifteen participants attended the ICT course, aged late twenties to seventies, with visual impairments ranging from total blindness to residual vision. Their experiences with ICT varied from beginner to expert levels.

The research team, consisting of three members, attended the course in-person as non-intrusive observers, monitoring individual sessions and conducting informal, unstructured interviews with instructors, assistants, and participants during breaks and free time. We scrutinized both attendee learning and instructor teaching methods during each session. The data from these observations and interviews were compiled and thematically analyzed, identifying recurring patterns among attendees. The patterns were cross-examined among the researchers, leading to the extraction of themes related to strategies and challenges in teaching screen reader gestures, and the potential of a gesture practice app. We focused primarily on iOS's VoiceOver due to its popularity among individuals with visual impairments, as also confirmed by the NABP. These themes were subsequently organized and summarized.

All participants were members of the NABP, a partner in the research project [17]. Participants were informed about the project’s scope, team, objectives, and data type, and were aware of their voluntary participation and right to withdraw consent. To ensure participant privacy, no personal data or audiovisual recordings of the participants were collected. Thus, all collected data was anonymous.

3. Teaching-strategies for gesture-based screen readers

A few weeks prior to the IT course, instructors conducted remote sessions with participants to understand their motivation, assess their skills, inquire about commonly used technology and assistive devices, and discuss expectations and desired outcomes. Depending on the participant's comfort and familiarity with technology, these sessions

were conducted via video conferencing or phone. Instructors individually engaged with each participant at the start of the four-day course, adjusting learning objectives based on their preferences and needs, and demonstrating basic functions in VoiceOver. Specific learning goals were set as informal agreements between instructors and participants.

Participants had two or three individual training sessions per day, each lasting either 45 or 90 minutes. Breaks were scheduled for activities, practice, or socializing, during which many participants shared their experiences, learning from and teaching each other. At the end of each day, common topics were discussed in joint sessions, including useful apps or devices, assistive technology, digital skills training funding schemes, and online security strategies. Each learning session focused on achieving previously set goals, usually practicing specific functions. To teach gestures, instructors demonstrated in the air, on a flat surface, traced on the participant's body, like the back of the hand or shoulder, or guided the participant's finger.

For beginners, instructors began with the fundamental concepts of VoiceOver: navigation, actions, and gestures. Navigation involves selecting functions and elements, actions pertain to executing tasks like messaging, and gestures are finger movements used for navigation and action execution. They differentiated VoiceOver from Siri, Apple's digital assistant, underlining that they operate differently and independently, requiring separate learning. Participants were then taught to de/activate VoiceOver and basic gestures like swiping and tapping, with practical examples. For more experienced users, advanced functions like the reverse "Z" gesture, and rotor function were covered. The VoiceOver rotor function, activated by a two-finger rotation, provides advanced shortcuts like direct navigation, and typo correction for experienced users. Throughout the learning sessions, participants had the opportunity to ask general questions or adjust their learning goals.

4. Common challenges when using and learning screen readers

The study identified various challenges encountered by participants and instructors.

4.1. Usability

Users faced usability challenges with VoiceOver gestures due to the similarity of multiple movements and their executions. Gestures such as double-tapping with two or three fingers or triple-tapping with three fingers were often mixed up, leading to unexpected phone behavior and incorrect actions. The confusion occurred because users frequently thought they were making one gesture, while the phone recognized it as a different one. Likewise, precisely performing gesture was challenging when initial finger placement was incorrect, inappropriate swiping speed, or swiping beyond the intended screen area. The complexity of performing actions in the user interface with VoiceOver, often required multiple steps and multiple and varied gestures across applications. This presented significant challenges, leading to users desiring more streamlined processes for performing similar actions.

The identical default voices of Siri and VoiceOver often led to confusion among users of both VoiceOver and Siri. Some users stated that they would prefer different voices to distinguish between these two functions. Moreover, many users were unaware of the auditory feedback provided by VoiceOver, such as sounds indicating skipped elements or reaching the end of a page or menu.

Frequent updates to apps and software, which alter functionality and user interfaces, were overwhelming and challenging for blind and visually impaired users who must adapt to new interfaces and relearn app navigation and functions.

4.2. Attitude and emotions

Participants often showed impatience or hastiness while interacting with VoiceOver, leading to skipping over crucial elements, accidental activations, and a loss of orientation due to swiping too quickly or not waiting for full readouts.

Privacy concerns arose from VoiceOver potentially exposing sensitive information when used without headphones. Similarly, users felt exposed and embarrassed by the audible reading of personal data and desired a headlines-only option for privacy in public settings. While some preferred headphones or earplugs to minimize disruption, others worried about losing them.

Participants exhibited varied emotional responses, including feelings of irritation, stress, anxiety, discomfort, and embarrassment. Frustration led some to disable the feature, while others experienced anxiety when unable to perform tasks or faced with unfamiliar notifications like update requests. Excessive text read-outs or surrounding noise overwhelmed some participants.

4.3. Technical challenges specific to VoiceOver

VoiceOver occasionally failed to fully read on-screen content due to apps and websites not being universally designed for screen reader use, often requiring assistance from more knowledgeable individuals or those without impairments.

Users found the autocorrect function in VoiceOver challenging, as it was often imprecise and difficult to use for correcting misspelled words, leading some to delete and retype words entirely. Moreover, adding words to the dictionary was difficult for many participants.

Users often found it imprecise and cumbersome to use the screen keyboard with VoiceOver, specifically the default setting to double tap for each letter, and to remember to shift focus away from the keyboard to conduct other tasks.

The VoiceOver rotor function was often triggered accidentally due to incorrect execution of other gestures. This frequently resulted in unintended changes, such as switching languages and altering reading speech. Lastly, VoiceOver's grouping behavior option confused users by consolidating all menu items under one single heading, which resulted in skipping the reading of some options. Changing settings for VoiceOver was frequently challenging and confusing as many users were unaware of the accessibility settings and how to modify them.

4.4. User guidance and educational challenges

The participants desired more opportunities to practice. Although Apple provides a practice area within the VoiceOver settings, it is somewhat hidden, assumes users already have basic knowledge of the available gestures and lacks pedagogical support. The practice area consists of a plain canvas that only verifies and verbalizes performed gestures without offering explanations or guides. This often led to confusion, and several participants abandoned the feature,

Although manuals exist [1,4,18], many participants found them lengthy and inaccessible. Learning about screen readers often paradoxically requires using the same screen reader. They preferred a short, clear user guide or "cheat sheet." Such a "cheat sheet" could list key functions, explaining which fingers are used for different gestures, ideally presented in an accessible format with audio descriptions.

The lack of suitable feedback mechanisms in the practice area left participants often uninformed or unaware when an error occurred. Auditory feedback often did not clarify why gestures did not produce the expected outcome. Moreover, there was no straightforward way to report functionality VoiceOver issues to Apple.

Many municipalities reportedly lack sufficient digital skill training ICT courses [19]. Despite being mandated by law, the availability of dedicated experts to assist and support individuals with (visual) impairments varies. At the same time, many visually impaired individuals are reluctant to ask for help, fearing loss of dignity.

5. Key traits and facilitators for learning gesture-based screen readers

Using gesture-based screen readers requires precision and patience for accurate gesture execution and attentive feedback listening. Without patiently listening to auditory feedback correct gesture execution cannot be confirmed, and erroneous gesture execution cannot be detected. Instructors suggested that participants could practice precision and patience by selecting apps for daily use such as checking the weather. Repeated practice, suggested with the screen curtain on to avoid reliance on residual vision, aims to commit gestures to muscle memory.

Participants favored instructor-led training for its guidance and interactive nature. Seeing even experts struggle at times alleviated their tech and performance anxieties, and they appreciated skilled and didactically proficient instructors. Likewise, participants favored one-on-one instruction to avoid overwhelming beginners or under-stimulating advanced users in mixed-level groups. Casual break-time discussions were also seen as valuable for skill development.

6. Feasibility and design of a gesture-practice app

While participants favored personalized training, they expressed curiosity towards a gesture practice app as a supplementary self-study tool following formal training. They saw potential in such an app as a reference source, containing key information and tutorials to reinforce their practical skills. Recognizing the benefits of repetition, they also stressed the necessity of universal design within the app.

Participants proposed features for a gesture-practice app based on Apple iOS's current practice area, emphasizing universal design, accessibility, and usability for all, including those with minimal experience with gesture-based screen readers. They recommended high contrast, readable text, adjustable font sizes, and read-aloud functionality. Apple's plain canvas approach for free gesture practice could be extended by adding detailed explanations and guides of available gestures, clarifying how and where to use them, and making them searchable. Participants also requested a comprehensible and searchable gesture glossary, or "cheat sheet," accessible both in the practice area and during general device use, possibly via a dedicated on-screen button activated by a gesture or voice command. The practice area could offer instructional guidance, including step-by-step walkthroughs for specific gestures and options for

repeated practice, incorporating examples of specific actions like pressing buttons or opening links. Participants suggested using auditory or vibrational feedback for correct finger placement and gesture execution. Additionally, an optional feedback system should be available to clarify unsuccessful gestures and guide correct performance. Incorporating gamification and reward elements into the app could counter monotony in repetitive gesture practice. Participants advocated for a gradual learning approach, progressing from simple to complex gestures with milestones along the way. Challenges like timed navigation to specific app parts or error-free gesture execution could make learning interactive. Auditory badges or music snippets could serve as a sense of achievement.

Participants proposed a stepwise approach for a possible gesture practice app, progressing from basic to complex screen reader gestures, as categorized by participants and instructors. They suggested four levels based on relevance, frequency, and complexity: basic beginner, practical usage, advanced shortcuts, and expert users, with many advanced gestures replaceable with simpler combinations. The gestures listed below were identified as the most essential for VoiceOver [5,11,12]. Similar functions could be chosen for other screen readers.

1. Level One - Beginner's basics:
    - Turn VoiceOver on/off: Triple-click the "Home" button or the side/top button. The initial setup through settings is required.
    - Turn the screen curtain on/off: three-finger triple tap.
    - Mute/unmute VoiceOver: Three-finger double tap.
    - Home gesture: Swipe up from the screen's bottom edge to return to the home screen on newer devices without a "Home" button.
2. Level Two - Practical usage:
    - Select the previous/next item: Swipe left or right with one finger.
    - Activate a selected item; Double tap with one finger.
3. Level Three - Advanced shortcuts:
    - Scroll left/right: Three fingers to the right and left, respectively.
    - Scroll up/down: Three fingers down and up, respectively.
    - Back: two-finger Z gesture.
4. Level Four - Expert techniques:
    - Choose a new rotor function: Two-finger rotation to the left/right.
    - Change value of rotor setting: Swipe up or down.
    - Turn dictation on/off: Two-finger double tap in a text field.

7. Discussion

While previous research has discussed the benefits of gesture-based screen readers for visually impaired individuals [6–9,13], this study focused on effective learning for these tools including educational best-practices, challenges, and facilitators. In our study, we chose to focus on Apple products due to their popularity among visually impaired users in Norway[2] [1,20]. Nevertheless, our findings are applicable to other gesture-based screen readers, such as Android's TalkBack. In our opinion, best practices can be transferred between brands with minor adjustments. Our study suggests standardizing

[2] As reported by the NAPB, iOS products, favored for their accessibility and ease of use, are preferred by most screen reader users in Norway. However, it is recognized that in other regions, the preference might lean towards Android products, largely due to cost considerations.

teaching methods for gesture-based screen readers through a blend of one-on-one training, self-study, and peer support from visually impaired experts. Participants favored this approach over pure self-study using an app, valuing group practice and expert guidance for basic setup and gestures. After initial training, they found independent app practice beneficial.

Teaching gesture-based screen readers is challenging due to the inherent difficulty of learning new technology and the possible lack of general digital skills among visually impaired individuals. This issue is intensified as visual impairments often correlate with aging, a group that generally struggles with new technology. Hence, instructors often begin with general ICT skills, and then carefully balance this with specific screen reader instruction to avoid overwhelming the learner.

Our study highlights the urgent need for municipalities to invest more in the digital skill training of visually impaired individuals. Many Norwegian municipalities, despite their responsibility, fail to provide digital skills training due to a lack of experts and resources restricting their ability to supplement this training - a challenge also faced by civil-society organizations [19]. Therefore, it is crucial for research to propose concrete solutions, such as organizing workshops and awareness seminars for municipality employees, as well as improving skills and training for relevant personnel. We specifically recommend municipalities to prioritize raising awareness about the needs of visually impaired individuals and enhancing their digital training programs. Engaging politicians in this issue is also essential as they hold decision-making power over the allocation of funds. Improved digital skill training not only meets legal requirements but also fosters inclusion, curbs exclusion, and could be cost-effective, aligning with prior research [17,19]. Investment in training boosts visually impaired individuals' independence, digital participation, and social engagement, reducing both their assistance needs and potential loneliness.

In the meantime, developers could co-create a gesture-practice app together with visually impaired users. One idea is to use an open-source approach to avoid relying on enterprise resources that are difficult to access. Finally, developers and designers must ensure the adherence of their solutions to legal standards and guidelines, such as the Web Content Accessibility Guidelines (WCAG) [21], given that the lack of universal design in websites poses a key challenge for all screen readers.

8. Conclusion

Screen reader training is essential for enabling visually impaired users to interact with mobile technology. Our research underscores the need for a safe practice space, feedback, and support as key to successful training. This study can serve as a foundation for the standardization of instruction methods for gesture-based screen readers. It also proposes a gesture practice app setup to complement personalized training and general online resources. Our study indicates potential interest in such a training app among both instructors and users, as it supplements one-on-one training by allowing repeated practice to improve precision, repetition, and patience.

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Empowering the Visually Impaired: Advancing Digital Skills in Mobile ICT as Motivator and Enabler

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Abstract. Mobile ICT, such as smartphones and tablets, has become integral for everyday tasks like finance, communication, and entertainment. While these technologies offer significant opportunities for integration and combating loneliness, visually impaired individuals still face challenges. These include practical barriers due to poor universal design, motivational hurdles, and inadequate lifelong education. In this paper, we aim to identify both the motivational and educational facilitators, as well as the technical and societal inhibitors, to digital skill development in mobile ICT among visually impaired individuals. Our approach involved participating as silent observers in an IT course for visually impaired users. Our study underscores that visually impaired individuals value mobile ICT for enhancing their daily lives. We identify opportunities, including key motivations to learn about ICT, and compile a list of useful apps and devices for visually impaired people. Simultaneously, we identify challenges related to technical and universal design, competence and societal issues, motivation, and attitudes, as well as security, privacy, and fraud concerns.

Keywords. Visual Disability; Digital Skills; Mobile Technology; ICT; Motivation; Facilitator; Inhibitor; Accessibility; Usability; Universal Design; Adult Education

1. Introduction

Smartphones and tablets have become integral to daily life, serving numerous purposes including work, personal finance, communication, education, and entertainment [1]. The Covid-19 pandemic has further accelerated this reliance on technology [2]. On the one hand, mobile technologies pose unique challenges for individuals with disabilities, primarily in terms of accessibility and usability challenges in both hardware and software applications [3]. Further, visually impaired individuals often face higher levels of loneliness than the general population [4,5]. On the other hand, ICT provides immense advantages to visually impaired individuals [3]. Studies show that the development of digital skills can enhance self-sufficiency and social contact among people with disabilities [5–8]. Despite this, significant motivational challenges exist, particularly

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among the elderly, often due to insufficient universal design [8,9]. Additionally, digital skills training varies greatly among local authorities, with many Norwegian municipalities not meeting national legal requirements [8].

In this study, we identify both motivational and educational facilitators, along with technical and educational inhibitors to digital skill development in mobile ICT among visually impaired individuals. Our approach involves participating as silent observers in an IT course for visually impaired users, organized by The Norwegian Association of the Blind and Partially Sighted (NABP), to obtain firsthand insights.

This paper details our research methodology, findings on ICT's potential and limitations for the visually impaired, followed by a thorough discussion and brief conclusion summarizing our research.

2. Methodology

We followed a four-day in-person IT course, organized by the NABP at their continuing education retreat center in Northern Norway, focusing on digital media and screen reader use for individuals with visual impairments. A diverse group of fifteen participants, ranging in age from late 20s to 70s, participated in the ICT course. Two instructors and six assistants from NABP were present to conduct the teaching, in addition to three silent observers from the research group. The instructors and assistants were peer supporters, i.e., individuals with impaired vision themselves. Thus, all attendees were individuals with varying degrees of visual impairment, some of whom were completely blind, while others had some residual vision.

The ICT course was structured around individual one-on-one sessions, each involving a single participant and either an instructor or an assistant in the role of an instructor. These sessions lasted either 45 or 90 minutes, with periods of free time built into the schedule. In addition, joint sessions were held at the commencement of the course on the first day and at the conclusion on the last day. Each day also ended with a communal session. The content of each individual session was tailored to each participant, based on their specific needs and goals determined in consultation with the instructors before or at the start of the course. Topics during individual sessions typically included general digital skills, questions about specific apps or devices, or practicing with screen readers. The joint sessions covered broader topics related to useful apps and websites, how to obtain support and assistive devices, and internet safety.

The participants utilized their personal devices during the course, predominantly Windows PCs and iOS iPhones. Some used iPads with iOS, and a few had Android Samsung phones. Participants had varied experiences with ICT. Most participants had prior experience with computers, tablets, and smartphones.

The researchers attended the course in-person as silent observers during individual sessions and conducted informal and unstructured interviews with instructors, assistants, and participants during breaks and free time. During each session, we observed attendee learning and instructor teaching processes. Notes from these observations and interviews were then thematically analyzed and cross-compared among the researchers. From our direct observations and notes, we extracted related themes. This was achieved by identifying common patterns among the attendees, as observed by the researchers. The themes were then structured and summarized.

3. Results

We identified themes in three areas: motivation, opportunities, and challenges of using ICT for visually impaired people. The themes include internal and external motivators for skill development, useful apps and devices as opportunities, and challenges such as technological constraints, competency and societal barriers, motivation- and attitude-related obstacles, along with security, privacy, and fraud concerns.

3.1. Key motivations to learn about ICT

Participants of the ICT course expressed various motivations to learn and improve their ICT skills. The majority sought everyday independence, wanting to use smartphones to manage everyday tasks such as reading, sending messages and emails, or accessing their online banking. Some participants wanted to use their devices for personal finance management like online banking and mobile payment services. Other participants used their mobile devices as a safety measure when out and about, serving as a backup in case of emergencies. Despite acknowledging the potential challenges and frustrations of learning about ICT, they believed the long-term benefits were worth the effort.

Entertainment was a key motivation, including listening to podcasts and audiobooks, watching videos, or reading. Especially participants with age-related visual impairments, such as those with Age-related Macular Degeneration (AMD), expressed a desire to use screen readers for being able to continue reading digital content. Many participants wanted to use their smartphones to browse the internet. Some wanted to read the news, while others were interested in finding cooking inspiration and recipes online. Additionally, some participants with residual vision enjoyed viewing images sent by family members and preferred devices with larger screens, like iPads.

Communication and connectivity were another big motivation for participants. Most used their phones for calls to maintain contact with friends and family and wanted to learn how to save contact information, messaging via text or Messenger, and having their phones read aloud incoming messages and reply to them. Likewise, many participants wanted to learn how to send, receive, read, and organize emails. Some had specific goals such as sorting emails from certain senders into a separate folder or learning about filters in Gmail for automatic email sorting. Additionally, some participants wanted to learn about social media platforms like Snapchat and Facebook, either to receive messages from family members or to post their own content.

Lastly, many participants wanted to learn specific functions, like dictation, emoji use, and using VoiceOver for reading or controlling assistive devices like hearing aids.

3.2. Opportunities of ICT for visually impaired people

Our study indicates that visually impaired individuals view mobile ICT as an aid to simplify and enhance their daily lives. They see smartphones, with their myriads of applications, as a universal and comprehensive assistive tool that encourages self-reliance and increases self-sufficiency.

3.2.1. Helpful apps for visually impaired users

Applications, or "apps" are computer programs that perform specific functions to facilitate everyday activities. The App Store features a section titled "Apps that Support VoiceOver," which contains a list of useful apps for visually impaired people:

- *Authorities use public communication apps* to communicate with their citizens, like Digipost, Helsenorge or Hjelp113 in Norway [10–12].
- *Entertainment apps* offer a variety of podcasts and audiobooks, like Tibi (formerly Lydhør), Spotify, Apple Podcasts [13–15].
- *Personal finance apps* can be used to pay online or in-store. Vipps, a mobile payment service in Norway with a particularly good reputation for universal design, has been championed by the instructors. International apps can also be used like Apple Pay or Google Wallet [16–18].
- *Image and video interpreting apps* like Be My Eyes, TapTapSee, and SuperSense assist visually impaired people in interpreting images [19–21]. Cash Reader and SeeingAI can identify money, Lookout can read text, and other apps can help in identifying light sources and colors [22–24].
- *Mobility apps*, such as BlindSquare, provide GPS functionality, and others like Avinor for flights, or Ruter and Vy for public transportation in Norway, aid in travel [25–27]. Apps like ut.no can identify outdoor trails for daily walks [28].

3.2.2. Helpful devices for visually impaired users

Instructors highlighted how smartphones can control other electronic aids and devices to simplify everyday life for visually impaired individuals. They noted that phones can connect to devices via Bluetooth, providing more options as this technology becomes cheaper. They recommended considering Bluetooth compatibility when purchasing new equipment. Useful devices that can be controlled via a smartphone include:

- *GPS location devices* can be used to locate luggage and other objects like AirTags [29]. Using an app, the tags can make a sound, allowing users to locate them. On iPads and iPhones, AirTags can be combined with the "Find My" app, showing a map and the position of the AirTags [30].
- *Screen mirroring devices*, such as an HDMI adapter, can link a smartphone to a TV or projector, replicating the iPhone's display and audio. This can be paired with other aids like magnifying glasses to enhance readability.
- *Text reading aids*, like OrCam MyEye, can be utilized to scan and read text, offering assistance with text perception and comprehension [31].
- *Headphones and earplugs*, such as AirPods, can be used for screen reader output in public settings [32]. Alternatives include Shokz's Trekz Titanium, a headset that sits outside the ear and transmits sound through bone conduction, allowing users to stay aware of their surroundings [33]. Additionally, there are earphones by Sony that offer control through finger movements [34].
- For users who prefer tangible typing over dictation, *keyboards for smartphones and tablets* are recommended.

3.3. Challenges of mobile ICT for visually impaired people

Challenges faced by visually impaired individuals in utilizing ICT fall into several categories. First, technical limitations can partially or fully impede their ability to use mobile devices and other technologies. Second, competency-related and societal challenges arise when visually impaired individuals lack adequate ICT training in their municipalities. Third, personal attitudes and motivation towards learning new technology and their motivation to overcome challenges also play a significant role in their ability to utilize ICT. Last, security, privacy, and fraud concerns can pose obstacles to ICT use by visually impaired individuals.

3.3.1. Lack of universal design and technical challenges

Visually impaired users face various technical challenges and barriers due to the lack of universal design in smartphones and apps. *Inconsistent button placement across different apps* can lead to confusion, particularly for visually impaired users who prefer a uniform and consistent layout across all apps. For instance, the confirmation button and "Back" button might be in varying positions. Likewise, some users experience confusion due to *inconsistent button labels across different apps*. They express a preference for a standardized naming convention for buttons like "Ok," "Done," or "Next" across all apps. *Poor contrast, small font sizes, and complex background images* can impede text readability for users with residual vision. To mitigate this, users suggest using plain black backgrounds and increasing the font size across the entire device. The *dictation function* may be challenging for users with strong dialects or accents. Many websites and apps *lack a feedback function* for users to report issues, although this is part of the newly implemented Web Accessibility Directive (WAD) for websites in the public sector [35]. Furthermore, *functionality can vary across different versions of operating systems*. For instance, Apple's 2021 iPad update replaced the home button with a screen swipe, a change that could prove challenging for some users.

3.3.2. Competency-related and societal challenges

Visually impaired and blind individuals face several structural challenges to fully utilize mobile ICT. First, many municipalities lack life-long education offerings, possibly due to personnel shortages or lack of competence. Second, useful apps often come at a high cost, which public funds may not fully cover. Third, the rapid pace of technological change can overwhelm users with the constant need for knowledge and system updates. Fourth, managing identification and passwords due to security and privacy requirements can also pose challenges. Last, participants expressed a need for technical support and found accessing it difficult, pointing out limitations in courses and helplines for everyday usage.

3.3.3. Challenges related to motivation and attitudes

Participants reported several limitations related to attitudes, motivation, and personal experiences. Some exhibited *general skepticism towards ICT*, but still enrolled the course due to the aforementioned benefits. Even when aware of these potential benefits of tech use in emergency situations, some participants were *content with limited/minimal technology use* to avoid distractions and increase mindfulness of their surroundings and nature. Similarly, a few resisted *over-reliance* on mobile devices to avoid mobile dependency. Other participants reported *discomfort* when using touch screens on mobile ICT. A sense of *dependency* on others like family and friends for digital tasks, such as email registration, was also reported. Several participants saw no need for mobile ICT as they prefer familiar surroundings in the real world. Some participants had *privacy concerns* and were apprehensive about sharing too much personal information online as discussed further below. Additionally, some participants found learning new things more *challenging with age*.

3.3.4. Security, privacy, and fraud challenges

Digital opportunities also bring challenges like security and privacy concerns, especially for vulnerable groups like the visually impaired. They may be more susceptible to online

scams and fraud, due to limited accessibility of security mechanisms. This inaccessibility can prevent them from independently confirming the legitimacy of digital content. Additionally, their limited ability to access and interpret graphical materials may impede their detection of visual indicators that suggest security threats. Furthermore, the inadequacy of accessible security mechanisms sometimes forces visually impaired users to share sensitive information such as passwords or security codes to gain access [36]. Challenges include phishing and identity theft, where criminals deceive users into disclosing personal information for unauthorized access or loans. Countermeasures include sender verification, cautious personal data handling, and managing online visibility in social media and search engines. Dating frauds are another issue, where fraudsters pose as attractive individuals and trick users into sending money. A healthy skepticism and intuition trust are recommended. Additionally, frauds often come from abroad, suggesting precautions like region-locking bank cards and avoiding returning calls to unknown foreign numbers[2].

4. Discussion

First, our research indicates that visually impaired users perceive mobile ICT as an opportunity to simplify and enhance their daily lives. They view smartphones, with their multitude of apps, as a comprehensive assistive tool promoting self-reliance. Users with visual disabilities described mobile ICT as a universal assistive device that consolidates functionality in one device that previously required many different standalone assistive devices. This underscores the value of digital skills training, as it can lead to a decrease in the necessity for producing, instructing on, and servicing numerous specialized assistive devices. Furthermore, the potential of ICT to enhance communication with friends, family, and the world, offer entertainment options, and enable support for daily tasks like economic transactions, navigation in public spaces, and image recognition is a significant motivational factor for learning.

Second, our findings show various apps and devices catering to visually impaired individuals' needs, significantly enhancing their quality of life by facilitating everyday tasks and promoting safety. Although some of the apps are specific to the Norwegian community, we could identify equivalent apps in international settings. However, the cost of these apps could be a barrier for some, particularly those dependent on welfare or public funding for assistive devices.

Third, the study affirms that technical barriers and accessibility issues are the primary inhibitors to ICT access for people with disabilities. Many of these barriers could be mitigated by adhering to international standards like the Web Content Accessibility Guidelines (WCAG) that are already obligatory for many public-targeted ICT solutions. Consequently, there is an urgent need for consistent implementation of these rules and increased competency in universal design among ICT developers, as well as their enforcement by relevant authorities.

There is a notable deficiency in adult education offerings for visually impaired individuals, particularly in rural areas, due to limited resources or a lack of qualified personnel. The reasons for this shortage might include a municipality's limited financial resources, mismanagement or inappropriate allocation of existing funds, lack of

[2] While instructors highlight the prevalence of frauds originating from abroad, recent trends indicate a significant increase in domestic frauds as well.

awareness about the obligations a municipality has towards individuals with disabilities, or a lack of qualification among those responsible. Even with user organizations offering courses, there is a significant need for more capacity, support and funding for courses, and training for qualified instructors. Moreover, there is a need for enduring and subsequent support options to reinforce the knowledge and competence of both individuals with disabilities and instructors after completing relevant adult education courses. This is in line with previous research [9].

Our results indicate that personal concerns, such as digital privacy and security, must be addressed when teaching ICT skills to visually impaired individuals. While ICT can promote integration and combat loneliness, it is important to respect the choice of some individuals who consciously opt not to learn about mobile ICT. One participant, for example, observed their sighted spouse frequently using a mobile phone when bored and expressed a desire to avoid losing their current contentment and mindfulness by becoming "addicted" to mobile ICT.

5. Conclusion

Our study confirms that visually impaired individuals recognize the value of mobile technologies in enhancing their daily lives, by consolidating numerous applications previously scattered across multiple devices. They view smartphones as universal assistive devices that promote self-sufficiency and social contact. Furthermore, our study identifies key motivations related to communication, connectivity, entertainment, and convenience for day-to-day activities. For these purposes, we compile a list of useful apps and devices. However, challenges persist due to the lack of compatibility with assistive devices in many apps, and the variability in the quality of digital skills training across municipalities. Our study highlights challenges including substandard universal design in apps, societal issues, and security and privacy concerns for visually impaired users of mobile ICT.

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AI and XR

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Exploring the Use of AI for Enhanced Accessibility Testing of Web Solutions

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Abstract. Artificial Intelligence (AI) holds significant potential for enhancing accessibility and user experience across digital products and services. However, mainstream web solutions commonly used by the general population still face accessibility barriers, hindering equal participation in the information society for people with disabilities. This article explores several promising applications of AI that can be used to create accessible solutions for people with disabilities. We also present our research, which aims to explore and demonstrate how various AI-based techniques can enhance and streamline accessibility testing for web solutions. We selected four success criteria from the Web Content Accessibility Guidelines (WCAG) that currently require extensive manual work and developed four prototypes using open-source machine-learning models to enhance conformance testing. While the prototypes need further optimization and evaluation, the results suggest that AI-based techniques can significantly reduce the need for manual work in accessibility testing.

Keywords. Accessibility, WCAG success criteria, AI, computer vision (CV), machine learning (ML), natural language processing (NLP), prototypes

1. Introduction

Artificial intelligence (AI) is increasingly recognized for its potential to enhance the accessibility and usability of digital services for a diverse range of users. For example, AI is expected to offer new opportunities that can contribute to a more inclusive work life [1,2]. Moreover, it is pointed out that AI has enormous potential to improve accessibility and user experience for people with disabilities in a wide range of digital products and services [3]. One illustration of this is how automatic speech recognition can be used to create subtitles for video content, and for real-time transcription of conversations and translation into other languages. This can be useful for people with impaired hearing, people with intellectual challenges, and for non-native speakers. Applications that use speech recognition, such as voice control and dictation solutions can provide new opportunities for people with mobility impairments and writing challenges. Image recognition and object recognition can be used to create image descriptions and object descriptions that can increase accessibility for people with impaired vision. AI-generated summaries of digital content can help break down long texts into more manageable parts and can be a benefit for people with reading challenges

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and cognitive challenges. Facial recognition and other biometrics can make authentication more accessible for people who have difficulties using passwords.

In addition to the solutions mentioned above, which can increase accessibility and quality of use in general technology for broad user groups, research is ongoing into how AI can enhance and create new types of aids for specific user groups [3]. For example, AI is being utilized in systems for recognizing gestures and sign language, and in speech and communication solutions for individuals with speech and communication difficulties [4]. Additionally, researchers are exploring how AI can generate easy-to-read versions of texts [5]. Moreover, investigations are underway into various navigation solutions for people with visual impairments and those with poor orientation skills.

However, despite existing legislation[2], individuals with disabilities still encounter barriers when using web-based solutions. To promote the inclusion of people with disabilities in the information society, it is crucial that mainstream solutions prioritize accessibility. In our research we have investigated how AI can enhance and streamline accessibility testing for web solutions, aiming to develop effective tools that can detect and potentially address accessibility issues, benefiting both legal bodies and developers.

In the next section we examine related research on the use of AI to increase accessibility of software and web-solutions for people with disabilities. Subsequently, we present our work with prototypes to explore the use of AI in detecting accessibility issues in web solutions.

2. Related work

AI is utilized in various ways to enhance accessibility in the development of software and web solutions. For example, programmers can use AI to generate code that creates more accessible user interfaces, although the suggestions provided by AI are not always reliable [6]. AI is also employed in tools known as overlays, which are placed between an application and the user for automatic improvements of an application's accessibility [7]. Advancing technical accessibility within publishing tools is also crucial. Better and more advanced built-in support to enhance accessibility makes it easier for content creators to produce accessible materials efficiently. AI can, for example, convert inaccessible PDF documents into text that complies with accessibility requirements [8].

For employees and software developers with disabilities, it is important that AI tools themselves are accessible. A quick check with the browser extension of the Wave Web Accessibility Evaluation tool [9] indicates that widely adopted AI tools, such as ChatGPT and Copilot have accessibility issues. However, social media discussions reveal that these solutions are adopted by people with disabilities. This is likely due to their relatively simple interfaces, which allows for navigation and use despite some accessibility issues. In contrast, solutions that generate still images, audio, and video seem to face greater accessibility challenges, especially for visually impaired people. Fortunately, there are several examples of AI-based solutions that have been developed to be accessible for people with disabilities. For example, a voice interface has been created for ChatGPT [10], and a solution has been developed to make the selection and generation of AI based images more accessible through rich image descriptions [11].

[2] The W3C's Web Accessibility Initiative maintains an extensive list at *https://www.w3.org/WAI/policies/*.

AI can also be used to simulate how users interact with websites, and thus help in optimizing the design, including navigation options [3]. This could lead to more intuitive interfaces, and thus quicker access to information and improved user satisfaction.

When exploring how AI can benefit the development of software, one must also examine potential ethical issues and unintended consequences. Research indicates that today's AI often perpetuates biases, reinforcing stereotypes and discriminating against minorities and people with disabilities [1,3,12]. This could be an issue with user simulation software.

Securing funding for developing more accessible solutions remains a challenge [3]. While current research on AI for accessibility has predominantly centered around solutions for people with visual impairments, it is also important to address the needs of other user groups [3]. To truly enhance inclusivity through the use of AI technologies, further development and adaptations are required in various areas, including managing informal spoken language, dialects, sign language, and minority languages [13].

2.1. Tools for automatic testing of web accessibility

The Web Content Accessibility Guidelines (WCAG), developed by the W3C Web Accessibility Initiative, is designed to ensure that web content is accessible to everyone, including people with disabilities [14]. WCAG has evolved through several versions — 2.0, 2.1, and the latest 2.2 — to address the changing needs of web accessibility. These guidelines are embedded in legislation across many countries, including in the EU [15], underscoring their importance for web accessibility. However, evaluating conformance with the WCAG guidelines manually is time-consuming, especially for large websites. Therefore, various tools to help developers assess WCAG conformance have been developed. The tools, which are often referred to as WCAG checkers, are software programs or online services that help in determining if a web solution meets the WCAG guidelines. The results of existing WCAG checkers differ from one tool to another, and they often cover different subsets of the guidelines [15,16]. While there are great expectations for the use of AI to enhance and extend accessibility testing tools [17], there is currently little research in this area [18].

Researchers with similar ideas to ours conducted a pilot study to investigate the potential of a large language model (LLM) to evaluate certain web accessibility success criteria [18]. They focused on three WCAG criteria that traditionally require manual assessment: 1.1.1 Non-text Content, 2.4.4 Link Purpose (In Context), and 3.1.2 Language of Parts. To this end, they developed LLM-based scripts to evaluate conformance to these criteria and compared the results against existing WCAG checkers. They found that the LLM-based scripts could effectively identify accessibility issues that the current WCAG checkers overlooked. They suggest that further research should attempt to replicate the same tests using open-source models.

3. AI-based WCAG check: Our approach

We selected four accessibility success criteria from the Web Content Accessibility Guidelines (WCAG) that traditional WCAG checkers have been unable to test reliably, but which could be automatically verified using open-source machine-learning models. Moreover, the selected guidelines are particularly important for enhancing accessibility for users who depend on assistive technology. Improved compatibility with assistive

technology will have huge benefits for these users [19]. We selected four guidelines, two of which were the same as tested by [18]:

1.1.1 Non-text Content (Level A): Checking whether the use of "alt text" for images is descriptive. This helps users who rely on screen readers to understand visual content. For this, we took advantage of recent advances in multi-modal deep learning, which connects computer vision and natural language processing.

1.4.5 Images of Text (Level AA): Checking whether there is text inside images, and whether or not the text is embedded as regular text elsewhere on the page. If not, assistive technology like screenreaders (which convert a webpage into synthetic voice) cannot detect it. Consequently, the users will not have access to the text. For this, we used methods for Optical Character Recognition (OCR) to detect text in images.

3.1.1 Language of Page (Level A): Checking whether the correct language is specified for the entire page. This is important to ensure that screen readers and other assistive technologies can correctly interpret and vocalize the content. For this we combined traditional testing with Natural Language Processing (NLP) based automatic language detection.

3.1.2 Language of Parts (Level AA): Checking whether the correct language is specified for all text parts. This will help users who rely on assistive technologies to understand multilingual content accurately. For this we combined traditional testing with NLP.

4. Results

For the prototypes, we chose to use several open-source libraries where the AI models are already pre-trained. In the following, we describe the four prototypes that were developed, illustrating the application of the specified techniques:

Prototype 1.1.1 calculates a score for the descriptiveness of alt text in images on a website. We utilized CLIP (Contrastive Language-Image Pre-Training) [20] a neural network that has been trained on image-text pairs. The model consists of an image encoder and a text encoder that were trained on image-text pairs.

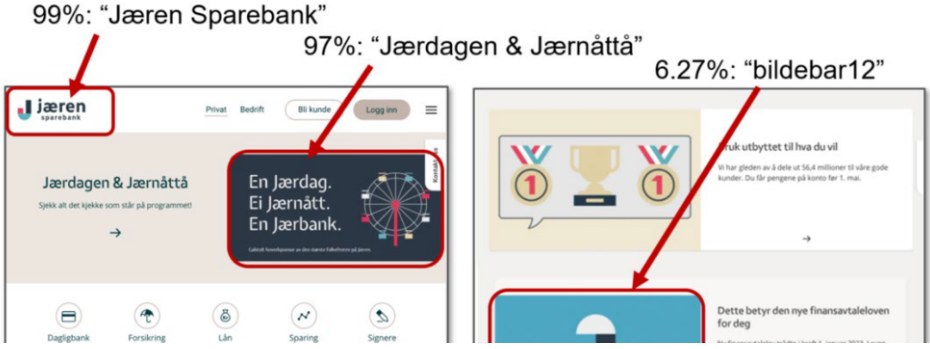


Figure 1: Prototype 1.1.1 Estimating how descriptive an alternative text is

During training, for each image the model is tasked with predicting which text description out of a large set of descriptions belong to the image. In other words, the model is tasked with creating similar text encodings and image encodings for image-text pairs. Using a pre-trained CLIP model, we can extract the image encodings from images from the website and text encodings from the associated alt-text (if available). By comparing the encodings, we can get a measure of how similar the image and the associated alt-text are. For example, in the first image in Figure 1 the similarity score between the alternative text "Jæren Sparebank" and the predicted image description is 99%. For the image in the lower right corner, the similarity score between the meaningless alternative text "bildebar12" and the image of a question mark is only 6,27%. Both similarity scores seem reasonable.

Prototype 1.4.5 extracts text from images, which can then be used to check whether the page includes this text if it is deemed important. Optical character recognition (OCR), extracting machine-readable text from images of text, is used in many different fields and hence there are many models easily available. We chose the EasyOCR Python library, which supports 80+ languages and multiple models for text detection and recognition. When the text is extracted, it can be compared to the text on the website using NLP methods. We found that the models implemented in EasyOCR performed well, meaning that they could convert the text in images to plain text with high reliability.

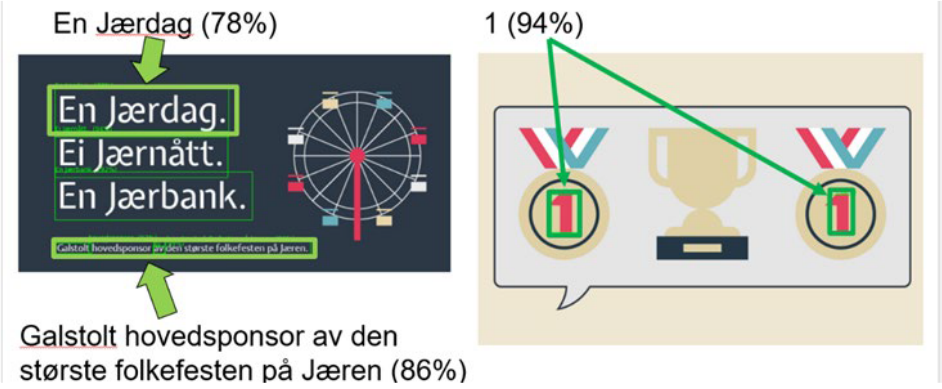


Figure 2: Prototype 1.4.5 Extracting text from images

Figure 2 shows examples of text extracted from images with an estimated detection score in parenthesis, which measures how certain the model is that the text has been correctly parsed. All the text in the example is identified correctly. If the text in the image is very small, such as a logo on a laptop in the background or a quote on a T-shirt, the models may correctly identify that text is present, but the text is not necessarily parsed correctly. However, in most of these instances, the text is not meant to convey information to the reader. Hence, we chose to discard text that covered less than a pre-determined portion of the image. We also discarded very short text snippets, such as the number "1" in Figure 2.

Prototype 3.1.1 detects the language for the main text on a website. This is then compared to the specified language coding, if available, of the web page. We chose to use the LanguageIdentifier Python library, which implements language identification using pre-trained neural models. These models return the detected language as well as a detection score, which can be read as the likelihood that the language was detected correctly. We extracted the text from the websites, divided the text into segments (e.g.,

lines) and ran these segments through the language detection model. We then compared the detected language against the language attribute in the HTML. This allowed us to determine whether the page has the correct language specification.

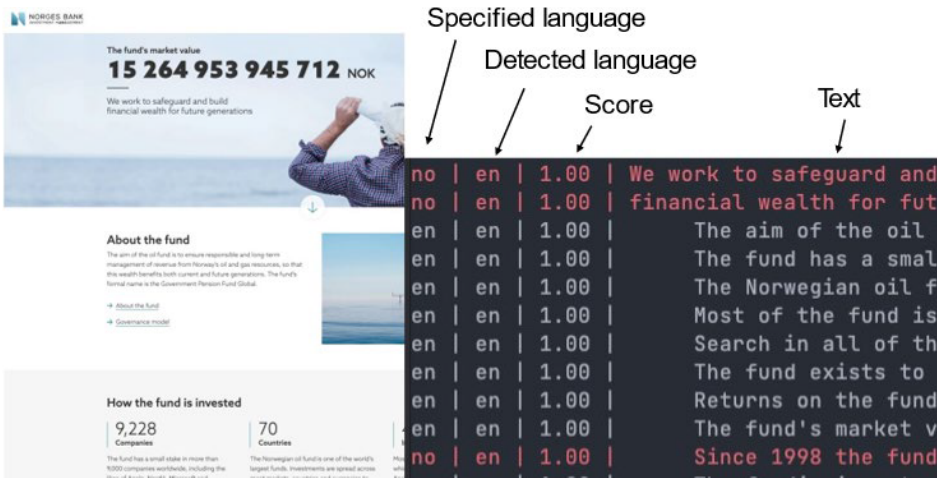


Figure 3: Prototype 3.1.1 Detecting language of text parts and language coding on a web page

Figure 3 shows a screen shot of a web page together with the corresponding table from prototype 3.1.1. For each language part on the web page there is a line in the table with specified language, detected language, a certainty score, and the actual text part. Lines with mismatch between specified and detected language are highlighted in red. We found that the model performed quite well, meaning that in most cases the language could be predicted with 100% confidence.



Figure 4: Prototype 3.1.2: Detecting language of text parts on a web site

Prototype 3.1.2 detects the language for text parts on a web site. We used pre-trained language detection models, similar to those in prototype 3.1.1: extracting text segments from the page and checking the language using the LanguageIdentifier library.

The algorithm displays the likelihood of a word being from a non-Scandinavian language using a colour scale, as illustrated in Figure 4. However, the colour scale itself requires some work to be more accessible. We observed that the language identifier model had difficulty distinguishing between Scandinavian languages in short text segments. Therefore, we merged the scores for Norwegian, Swedish, and Danish. Thus, the prototype may be suitable for testing if Scandinavian web pages have text parts in other languages.

5. Discussion

While we obtained good results with prototypes based on open-source machine learning models, they have been tested on a limited number of websites. In further work, a systematic evaluation should be conducted to provide more information about the accuracy of the prototypes. Although the prototypes can be improved in several areas, they demonstrate great potential in enhancing existing WCAG checkers. This is in line with the findings of [18], where LLMs were used to test three WCAG criteria, two of which we also tested.

Despite the significant improvement in automation, human verification of the algorithm results is still advisable. For instance, Prototype 1.4.5 generally detects text in images correctly but cannot always determine its relevance to the webpage content. However, as the fields of computer vision and natural language processing advance, verification accuracy will likely improve.

Furthermore, these techniques can not only be used to check if WCAG criteria are met, but also suggest improvements to accessibility of web sites. For example, the algorithms used in prototype 1.1.1. can be used to suggest better alternative texts.

6. Conclusion

After reviewing AI-enhanced solutions for digital accessibility and usability, we presented four prototypes for identifying accessibility issues on webpages using open-source machine learning models. While operational, these prototypes require further fine-tuning to reduce false positives and negatives. Currently, Prototype 1.4.5 processes OCR images without analyzing if the detected text appears elsewhere on the page.

These prototypes demonstrate the potential of AI-based techniques in developing universally designed ICT solutions. They can estimate the risk of violating specific WCAG criteria and, with further work, suggest improvements. In conclusion, AI-based techniques could significantly reduce the need for manual checks in accessibility testing.

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Universally Designed Virtual Reality: Creating Inclusive and Immersive Learning Experiences with 'VRinDanger'

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Abstract. This paper presents the design and implementation of VRinDanger, a universally designed (UD) educational virtual reality (VR) application aimed at providing an inclusive and immersive learning experience focused on the world's deadliest animals. A mixed-methods study involving participants with diverse ages, skills, and abilities was conducted to evaluate the application's accessibility, usability, user experience, and educational effectiveness in terms of learning outcomes. The findings demonstrate that integrating UD principles into VR design significantly improves accessibility, enhances user satisfaction, and promotes engagement and retention of educational content for diverse audiences. Furthermore, the study highlights the need for cost-effective, cross-platform VR solutions and the development of VR-specific accessibility guidelines. These insights contribute to the advancement of inclusive VR design and its broader application in educational technology.

Keywords. Virtual Reality, Universal Design, Accessibility, Usability, Inclusive Learning

1. Introduction

The integration of Virtual Reality (VR) in educational settings has gained significant momentum in recent years, marking a transformative shift in the delivery and perception of learning experiences. VR's potential lies in its ability to provide immersive, interactive experiences that traditional methods cannot match. Kavanagh et al. (2017) and Freina & Ott (2015) highlight VR's role in enhancing understanding, engagement, and motivation. VR allows users to explore virtual environments, interact with complex concepts, and experience otherwise inaccessible scenarios.

However, VR adoption in education faces challenges. High costs of proprietary equipment and logistical issues make VR prohibitive for many institutions and students (Vats & Joshi, 2023). Additionally, complying with national (Lovdata, 2018) and international mandates (Kanter, 2006) demanding accessible learning materials to all students, including those with disabilities, is an existing challenge for VRs adoption in educational settings.

VR is often perceived as a barrier maker to accessibility due to its reliance on visuals and its focus on gaming. Game design typically challenges and rewards users' skills and abilities, which contrasts sharply with the inclusive design principles. Predominantly visual VR experiences can exclude users with visual impairments. However, as outlined

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by Chong et al. (2021) and Mott et al. (2019), VR's multisensory nature, when designed with user-centered principles, can facilitate inclusion rather than creating barriers.

Recognizing this gap, Heilemann et al. (2021) reviewed accessibility guidelines for games and VR applications, including the Game Accessibility Guidelines (n.d.) and the XR Accessibility User Requirements (O'Connor et al., 2021). While these guidelines focus on accessibility and users with special needs, they do not address broader considerations such as hardware costs, scalability, availability and user diversity within the same design for all required for inclusive educational settings. National mandates (Lovdata, 2018) require Universal Design (UD) for learning environments, educational materials, and applications, but the intersection of UD and VR remains underexplored in educational technology research.

UD is a framework for creating products and environments accessible and usable to as many people as possible, regardless of abilities (Björk, 2009; Story, 1998). In VR, UD ensures technologies are immersive, educational, inclusive, accessible, and usable for a diverse userbase (Dombrowski et al., 2019). Despite these unique opportunities, the intersection of UD and VR remains a relatively unexplored domain in educational technology research.

This paper aims to contribute to this area by showcasing how UD-guided development of educational VR applications can provide an inclusive learning experience without compromising educational quality or user appeal. The paper contributes to the knowledge base on making VR universally accessible, aligning with the broader goal of creating inclusive educational environments in the digital age. The paper is structured to present (1) implementation (considerations, technological framework, feature and design choices), (2) user validation (user experience, digital inclusion, educational value), and (3) discussion for future research, emphasizing the need for integrating UD in educational technology design and its challenges.

2. The Universal Design of 'VRinDanger'

The development process involved several key steps: 1) mapping user needs, skills, and abilities with Universal Design (UD) principles to create a solution for a diverse user base suitable for the educational theme; 2) aligning technological features and limitations with UD to build a requirement specification; and 3) iteratively refining and updating prototypes through small-scale testing (2-3 users) until achieving the final form. While the detailed development process is beyond this paper's scope, this section provides an overview of the VR application's Universal Design.

Educational Theme and User Needs: The application aims to educate users about the world's deadliest animals, providing both factual and numerical knowledge. It combines a VR gallery with 3D data visualization techniques to create an immersive learning experience. This approach enables users to explore and understand detailed information about dangerous animals within an engaging and interactive virtual environment. Accordingly, the design should adapt to various demographics such as age, skills, digital literacy, motor, sensory (visual, auditory) and cognitive (memory, dyscalculia (Jerin et al., 2020), dyslexia (Wessel et al., 2021)) abilities, preferences regarding the context of use and preferred hardware. To meet user needs, UD and its seven principles (Björk, 2009; Story, 1998) has been chosen as a design aid.

Technological Framework: High development costs, expensive hardware, and limited hardware availability are significant barriers to VR adoption for both developers

and end-users. To overcome these challenges, A-Frame, an open-source web framework for building virtual reality experiences, was chosen (A-Frame, n.d.). A-Frame development requires a code editor and knowledge of HTML and JavaScript, eliminating the need for specialized software.

The resulting web-VR application ensures cross-device and cross-platform compatibility, making it usable on various devices, including proprietary head-mounted VR devices, smartphones, tablets, and desktop PCs, if they have a compatible web browser. This approach creates a universally accessible, low-cost VR solution, significantly reducing the costs and hardware barriers for VR in education.

Design Implementation: VRinDanger aims to create an interactive learning environment where users gain knowledge about the deadliest animals and understand the annual number of victims they cause.

The following section details the design implementation of these features built in the seven principles of UD and manifested in supporting:



Figure 1 - A) HMD interaction with the app, B) Application interface, C) Volume visualization, D) Posture chart, E) Cross-platform compatibility, F) Info block, G) Circular VR scene

1. Equitable Use: Providing equal means concerning educational content (same factual and numeric information), multimodal information communication (including audiovisual and tactile feedback), interaction (various modes for navigation, action trigger (touch, pointer)) to cater to users with different motor and sensory skills and preferences (see Fig.1.A,E).

2. Flexibility in Use: Offering various user interaction options, including handheld and head-mounted modalities (see Fig.1.A,D,E). Ensuring cross-platform compatibility (VR headsets, PCs, mobile devices) to accommodate user comfort and available hardware (see Fig.1.E). The application provides consistent access to the same information across all platforms, regardless of hardware cost or quality.

3. Simple and Intuitive Use: The streamlined information architecture combines the user interface and VR content in identical scenes, eliminating submenus and ensuring all essential functions are accessible within the user's immediate environment. The number

of visual elements in the user's field of view is maintained at 5±2 to ensure simplicity (See Fig.1.B). Affordances are designed to enhance the predictability of application functions with clear audiovisual feedback and easy navigation. In HMD mode, no controllers are needed; users trigger actions, walk, and interact using the headset as a head mouse, with immediate audiovisual feedback from UI elements. In handheld mode, the application uses a familiar mobile interaction scheme, utilizing the device's gyroscope for pointer interactions. In desktop mode, users navigate the VR environment with standard methods, such as a mouse, keyboard (WASD keystrokes), or both, providing a simple and intuitive experience regardless of previous VR experience.

4. Perceptible Information**:** Important text is presented with high-contrast colors and sans-serif typeface for readability. High-definition render textures remain sharp up close (see Fig.1.F). Text is paired with synthetic audio narration to aid users with visual impairments or reading difficulties, like dyslexia. Numerical information is conveyed through numeric symbols, auditory descriptions, and visually with 3D red dots in the sky (see Fig.1.B, C). This multimodal approach aids users, including those with dyscalculia, in understanding volumes and numerical differences. Information is grouped into thirds to provide clear structure and enhance contrast and visibility, as shown in Fig.1. F.

5. Tolerance for Error: Providing rapid self-correction mechanisms via the pointer to undo or redo actions, allowing users to recover from accidental triggers without disrupting the application. Ensuring user safety in VR mode by implementing navigation pads (see Fig.1.B, F) for 'teleportation' to reduce the mismatch between vestibular and visual sensory systems, preventing simulator sickness (Martirosov et al., 2022).

6. Low Physical Effort: Achieved by minimizing the effort required to wear a VR headset (head-mounted mode), hold a smartphone (handheld mode), or sit in front of a PC, as shown in Fig.1.A, E.

7. Size and Space for Approach: Minimized by compatibility with various device sizes and accommodating user preferences and physical postures, including standing, sitting, or lying down, while still providing the full experience, as shown in Fig.1. D.

3. Design Validation

The methodology for the summative design validation was crafted to evaluate the effectiveness and inclusivity of 'VRinDanger'. The focus was to assess how users from various backgrounds and with differing abilities interacted with and experienced the VR application.

Participants: The study involved 11 volunteers from the university campus, aged 18 to 65 years, representing a diverse cross-section of the population. The age distribution was: 35-44 years (36.4%, n=4), 18-24 years (27.3%, n=3), 45-54 years (18.2%, n=2), and 65+ years (18.2%, n=2).

Regarding daily ICT device preferences, 90.9% (n=10) preferred smartphones, while one preferred laptops or desktops for learning. Self-assessed learning capabilities were: 45.5% (n=5) average learners, 36.4% (n=4) fast learners, and 18.2% (n=2) slow learners.

Reported impairments included visual impairments such as myopia (45.5%, n=5) and cognitive impairments such as dyslexia and dementia (18.2%, n=2). The majority (54.5%, n=6) had no noted impairments.

Participants' VR experiences varied: 72.7% (n=8) had no experience, 9.1% (n=1) had moderate experience, and 9.1% (n=1) were experts. This selection ensured the study's findings were representative of a broad user spectrum, aligning with the UD principles that 'VRinDanger' was designed to uphold.

Study Procedure and Materials: The study was organized into phases to understand participants' experiences, feelings, and attitudes towards 'VRinDanger.' After obtaining consent, participants were briefed on 'VRinDanger,' focusing on the world's deadliest animals. They first engaged with the content using a Merge AR/VR headset (Merge Education, n.d.), with adjusted straps and lenses. 'VRinDanger' was then demonstrated in handheld mode (Google Pixel 6) and stationary mode (MacBook Pro 14 M1) to showcase flexibility and compatibility. Participants were encouraged to verbalize their thoughts and interact freely for genuine feedback. Next, participants chose their preferred modality or a combination for the learning session, limited to 15 minutes to prevent VR-induced discomfort, with most completing it in 5 to 8 minutes. Afterward, participants completed a survey to share their insights about the application and VR in education and answered a multiple-choice test on the deadliest animals to measure short-term recall. The study concluded with a brief semi-structured interview to reaffirm the researchers' observations.

Data Collection and Analysis: The study employed a mixed-methods approach, integrating quantitative and qualitative data. Quantitative data were gathered through a post-experiment survey, assessing user experience, preferences, inclusion, and opinions on VR in education, and a short-term information recall test on the deadliest animals. Qualitative data were collected through participant observations and brief semi-structured interviews, providing verbal feedback and insights. All participants were informed of the study's purpose, and consent was obtained prior to participation. The study adhered to ethical standards regarding privacy, confidentiality, and participant well-being.

4. Results

User Experience: Participants of various ages, skills, abilities, and VR experience levels expressed high engagement with the application. Specifically, 72.7% (n=8) reported being "highly engaged," 18.2% (n=2) were "moderately engaged," and one indicated a "neutral" level of engagement. All participants appreciated the immersive nature of the application, which stimulated interest in the educational content and maintained user engagement. This suggests that the application's inclusive design does not sacrifice appeal or engagement.

On a scale from 1 to 10, participants rated the intuitiveness of 'VRinDanger' with an average rating of 8.55. Out of the 11 participants, six rated it a 9, one rated it a 10, three rated it an 8, and one rated it a 6. This indicates that the majority found the application intuitive, with 81.8% (n=9) rating it 8 or higher. Regarding the clarity and understandability of the user interface, participants provided highly positive feedback. Nine participants found it "very clear and easy to understand," and two found it "somewhat clear." These responses suggest that the user interface is easy to comprehend, enhancing the overall user experience.

When asked about ease of navigation and interaction, most participants responded positively. Nine (81.8%) found it "very easy to navigate and interact," one found it "somewhat easy," and one was "neutral." This suggests that the application is user-friendly and easy to navigate, contributing to a positive user experience.

The overall user experience received a high average rating of 8.45 on a scale from 1 to 10. This rating underscores the application's effectiveness in providing an engaging and satisfactory user experience, with 81.8% (n=9) of participants rating their experience as 8 or higher, showcasing the positive impact of UD Principle 3 (Simple and Intuitive Use).

Preference for Interaction Modality: Despite the application's cross-platform compatibility, a notable majority of participants (82%, n=9) preferred the head-mounted VR experience for its enhanced immersion and "feel of presence." When asked about interaction modalities, 55% (n=6) preferred both HMD and handheld options, 36% (n=4) preferred VR only, and one participant preferred neither. This underscores the importance of UD Principle 2 (Flexibility in Use), adapting to user needs and preferences.

Inclusivity and Accessibility: All participants (n=11) successfully achieved their goals, interacted with, and learned from the application, as well as managed the information recall test. Features like audio narration and data visualization were especially appreciated by users with specific needs, including those with visual impairments (45%, n=5) and dyslexia (18%, n=2). One participant with dyslexia expressed gratitude for these features. The effectiveness of UD principles, such as Equitable Use (Principle 1) and Perceptible Information (Principle 4), in enhancing accessibility and inclusivity was evident. When asked about accessibility features, nine participants (82%) stated they were "not aware of accessibility features" or felt no need for them. This feedback suggests that accessibility features were seamlessly integrated into the VR experience, enhancing both accessibility and usability, and facilitating inclusion.

Educational Value: Seven participants (63.6%) found the application "highly informative and interesting," while four participants (36.4%) found it "somewhat informative and interesting." This indicates that most participants perceived the application as an effective educational tool.

When asked about the likelihood of recommending 'VRinDanger' to others, 72.7% (n=8) indicated they were very likely to recommend it, 9.1% (n=1) were somewhat likely, and 18.2% (n=2) were neither likely nor unlikely. These findings suggest that VR, when designed with UD principles, can offer an engaging and effective learning experience.

Learning Effectiveness and Recall: The post-use short-term recall test revealed that most participants were able to effectively remember and recount information about the deadliest animals by nearly all respondents (10 out of 11 for Mosquito and 11 out of 11 for Shark), with some errors about middle-rankings. This finding suggests that 'VRinDanger' is not only engaging but also effective in facilitating learning. Participants rated varying levels of confidence in their knowledge after using the application, with many (64%, n=7) feeling confident about their responses, while 36% (n=4) felt neutral.

5. Discussion and Conclusion

This study demonstrates the effectiveness of UD principles in creating an inclusive and immersive learning experience through a cross-platform Web-VR application. This

application is accessible, usable, and engaging for a wide range of users, regardless of their skills and abilities.

The findings align with existing VR literature on the efficacy of VR in education by Radianti et al. (2020). The immersive qualities of VR, combined with educational content, create a rich learning environment. The preference for head-mounted VR experiences reaffirms findings from Martín-Gutiérrez et al. (2017), emphasizing the unique sense of 'presence' that VR headsets offer. This indicates that while cross-device availability is crucial, the immersive quality of head-mounted VR is unparalleled.

Moreover, the positive feedback on the application's inclusivity demonstrates the practical applicability of UD principles in VR design. It supports the argument presented by Dombrowski et al. (2019) that VR, when designed with accessibility in mind, can cater to a diverse range of users. The application thus exemplifies how educational technology can be both immersive and inclusive.

The study revealed several previously underexplored aspects, such as reducing cost and hardware requirements, thereby lowering entry barriers for educational VR by offering cross-device and cross-platform compatibility without the need for proprietary HMD devices. Notably, 55% of users preferred this flexibility. This finding is significant because VR is often perceived as being reliant on specific, high-cost devices. Future VR research should further explore alternative mobile (handheld) VR integrations, similar to mobile augmented reality (MAR) solutions (Szentirmai, 2024).

The chosen Web-VR framework (A-Frame) offers easy access via URL and cross-platform compatibility but has limitations. Web applications can appear suspicious to operating systems, requiring more resources than regular websites and triggering security warnings, which may deter users. Browser updates can also disrupt functionality, requiring changes to privacy settings and application code.

An urgent issue for future research is the role of Web-VR in complying with inclusion mandates, which is currently a gray area. Web-VR must be universally designed, but UD's abstract nature can lead to inconsistent evaluations. There is no specific VR framework or success criteria for UD, and WCAG (2.1) lacks guidelines for Spatial 3D interfaces (W3C, 2023). The XR Accessibility User Requirements (O'Connor et al., 2021) are still aspirational rather than a practical framework. Consequently, developers lack established VR guidelines for creating inclusive solutions, and evaluators have no established criteria to assess compliance.

In this study, UD significantly aided in creating an inclusive VR experience, aligning well with VR's spatial aspects. Although UD was originally developed for physical environments, its principles can be adapted to virtual environments. Principles such as size and space for approach and low physical effort are more crucial in VR than in traditional 2D interfaces. The design choices in this paper can serve as guidelines for similar interactive VR gallery applications, but more practical implementations and VR coverage within UD are needed. This would help develop evidence-based recommendations, best practices, and success criteria for inclusive VR applications.

In conclusion, 'VRinDanger' serves as both an educational tool and a model for universally designed VR applications, catering to a wide spectrum of users' needs and preferences.

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Universally Designed Augmented Reality as Interface for Artificial Intelligence Assisted Decision-Making in Everyday Life Scenarios

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Abstract. This paper presents a conceptual prototype that integrates Artificial Intelligence (AI) and Augmented Reality (AR) with the principles of Universal Design (UD) to enhance decision-making in everyday scenarios for a diverse user base, eliminating the need for conventional text or voice AI interfaces. The study employed a mixed-method approach, including surveys, user testing, and interviews with eight participants from various age groups. The focus was on user interaction styles (head-mounted, handheld) within three everyday scenarios: 1) medication assistance, 2) food and beverage assistance, and 3) sustainability advocacy. Findings revealed that AR as an interface for AI was well-received for its intuitiveness and practical utility. However, users expressed concerns about privacy, the discomfort of wearable technology, and potential over-reliance on AI. This study demonstrates the potential of integrating AR as an interface for AI, combined with UD principles, to create inclusive, context-aware solutions, adaptable to users with diverse skills and abilities.

Keywords. Universal Design, Augmented Reality, Artificial Intelligence, Accessibility, Usability, Context-Aware Interfaces, AI-Driven Decision Making

1. Introduction

Artificial Intelligence (AI) has been a major focus in computer science and industry for decades (Duan et al., 2019; Brynjolfsson & McAfee, 2017). However, it has only recently become mainstream, now accessible and integral to everyday life for the public (Rivas, 2024; Araujo et al., 2020). AI excels in analyzing vast datasets, identifying patterns, and providing data-driven recommendations, significantly aiding decision-making (Duan et al., 2019). It is embedded in various mainstream applications such as web search engines, conversational interfaces like chatGPT, and voice assistants like Alexa, Siri, and Google Assistant (Arora et al., 2020; Tulshan & Dhage, 2019). AI also powers personalized recommendations on platforms like Amazon, Netflix, and Spotify, and enhances smart home devices like Nest thermostats and Ring doorbells (Rivas, 2024; Brynjolfsson & McAfee, 2017). Proprietary AI devices, like Humain AI and Rabbit, further enhance decision-making by offering data-driven insights (McCracken, 2024). This data-driven nature helps mitigate human biases, improving decision quality (Carlson, 2018).

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Despite these advancements, AI applications predominantly rely on text and voice commands for interaction, which often leads to a less intuitive user experience due to inherent limitations (Araujo et al., 2020). Text prompts require an input mechanism, adequate space, and literacy skills, while audio interfaces raise privacy concerns due to overheard conversations. Additionally, situational and environmental distractions like noise can compromise input quality, creating situational disabilities that hinder users' ability to achieve their goals (Morris, 2020; Wobbrock, 2019). Current AI solutions, such as assistants, chatbots, and mobile or proprietary devices, often lack context awareness. These systems require users to provide extensive context, describe tasks, explain situations, or take pictures of objects to gain information (Adamopoulou & Moussiades, 2020), which can be a hurdle. Accordingly, the main bottleneck in leveraging AI capabilities is the lack of context awareness and a suitable interface for effectively communicating simultaneous AI-generated information.

Overcoming these challenges lies in adopting context-aware, multisensory (audio, visual, tactile) spatial interfaces to capture and communicate information seamlessly. AR can complement AI in this regard (Szentirmai, 2024; Xu et al., 2023). AR is a context-aware digital technology that overlays digital information onto the user's physical environment in real-time (Billinghurst et al., 2015). By integrating AR with AI, devices can capture, analyze, and comprehend the user's context, environment, and personalized needs, and provide information in real-time without manual input (Zhang et al., 2022; Mambu et al., 2019). Examples of AR as an interface for AI include, visual screen readers (Szentirmai, 2024), real-time translations, overlaying navigation directions, and interactive training simulations that adapt to the user's environment (Xu et al., 2023). These concepts eliminate the need for voice commands or typing text prompts as primary input methods.

Integrating AR with AI for the general public requires a user-centered approach to address the broad needs and diverse skills and abilities of users (Morris, 2020). However, there is a common misconception that AR is merely a visualization tool and a barrier, especially the visually impaired (Naranjo-Puentese et al., 2022; Herskovitz et al., 2020). Contrary to this belief, AR's multimodal, context-aware features, when designed with a user-centered approach, can facilitate use for individuals with diverse abilities rather than act as a barrier. Achieving this is where the practice of Universal Design (UD) becomes crucial (Coughlan & Miele, 2017).

UD advocates for creating products and environments that are accessible and usable by all people, to the greatest extent possible, without the need for adaptation or specialized design (Story, 1998; Björk, 2009). Integrating UD with AR and AI, interfaces can bridge existing gaps in accessibility, usability, and user diversity, however this approach is not widely researched yet.

This study aims to bridge the knowledge gap by presenting "guARdAIn," a novel concept that integrates AR and AI features. Designed to adapt to a diverse user base, the prototype adheres to the UD heuristics for AR developed by Szentirmai and Murano (2023). The paper explores how universally designed AR can enhance the user experience and perception of personalized AI recommendations for everyday decision-making, effectively blending audio-visual cues within the user's environment.

2. Design Implementation

The development process involved several key steps: 1) Mapping use-cases, user needs, skills, and abilities for a diverse user base; 2) Selecting a technological framework that aligns with UD implementation; and 3) Implementing the prototype using UD, iteratively refining and updating through small-scale user testing (2-3 users) until achieving the final version. While the detailed development process and its steps are beyond the scope of this paper, this section provides a high-level overview of the process and insights.

Use-cases and Technological Framework: To select the baseline everyday use cases for the prototype, a survey of 23 respondents (16 female, 7 male), primarily aged 44 to 55+, was conducted. Users indicated their preferred AI features, allowing multiple votes. The three most prominent topics were 1) medication assistance (17 votes, 74%), 2) food and beverage assistance (11 votes, 48%), and 3) sustainability advocacy (10 votes, 43%). Medication assistance focused on managing medication schedules and information, while food and beverage assistance provided nutritional information and dietary recommendations. Sustainability advocacy offered environmentally friendly suggestions to reduce kitchen waste.

To ensure users could achieve their goals, the design should adapt to various abilities, such as digital literacy, motor skills, sensory abilities (visual and auditory), and cognitive abilities (memory, dyslexia). Additionally, it should accommodate user preferences regarding the context of use and preferred hardware, such as an AR headset or a smartphone. Reflecting on these considerations, key requirement specifications were set, including context-aware multimodal AR overlays, accurate AI-driven recommendations, and multimodal interaction (handheld, head-mounted) and information (audio, visual, tactile) presentation.

To reduce cost and hardware requirement, Unity v.2017.4 (Unity Technologies, 2020) was chosen as the development environment to produce a universal application. This allows the prototype to be exported to various devices, such as smartphones and tablets, while also supporting immersive head-mounted experiences using low-cost cardboard. Feature requirements, including object recognition, tracking, and augmentations, were implemented using the Vuforia engine v7 (Vuforia, n.d.).

Implementation of Universal Design Specification for AR as interface for AI: utilized explainable AI recommendations from Xu et al. (2023) and UD heuristics for AR from Szentirmai & Murano (2023), based on the following aspects:



Figure 1- guARdAIn: This figure illustrates the overlay of real-time audio-visual clues superimposed onto the user's environment, aiding their decision-making from A to C captured in head mounted perspective. Panel D shows the interaction modalities, including head-mounted and handheld modes

1. Equitable Use: By providing equal multimodal information through visual overlays and audio narration, the system accommodates both sighted and visually impaired users

(Fig. 1). The prototype is compatible with system-level assistive technologies like voice commands and screen readers, allowing users to start the application seamlessly.
2. Flexibility of Use: By supporting various interaction modes (Fig. 1.D), accessible via the hamburger menu, including handheld (portrait and landscape) using a smartphone or tablet, head-mounted using AR cardboard, and stationary utilizing the device's front-facing camera, users can place their objects as needed. This flexibility allows the system to adapt to user preferences and hardware equipment.
3. Simple and Intuitive Use: By using the user's physical world and real objects as the interface (Fig. 1.A, B, C), the system provides an inherently intuitive experience, allowing users to be present in reality without the application acting as a middleman. Digital clues are automatically augmented upon recognition without requiring touch or other input. For options, a hamburger menu is available in the top left corner of the screen.
4. Perceptible Information: By inbuilt audio, visual, and tactile cues. Visual overlays are enhanced by sans-serif text, high-definition, high-contrast textures (Fig. 1) to ensure readability in dynamic environments. To improve visibility in dark conditions, a night vision mode using the device's flashlight is implemented into the hamburger menu.
5. Tolerance for Error: The application features robust automated object recognition and error prevention mechanisms, ensuring continuous operation. For example, if visual cues disappear, audio cues persist. Users can naturally disengage from the application by looking away.
6. Low Physical Effort: The primary interaction requires no manual input mechanisms. Physical effort is minimized to wearing an AR headset (head-mounted mode), holding a smartphone (handheld mode), or holding objects in front of the smartphone's front-facing camera (stationary mode).
7. Size and Space for Approach: By adapting to various device sizes and accommodating user preferences and physical postures, including walking, standing, sitting, or lying down.

Prototype Features and Functionality:

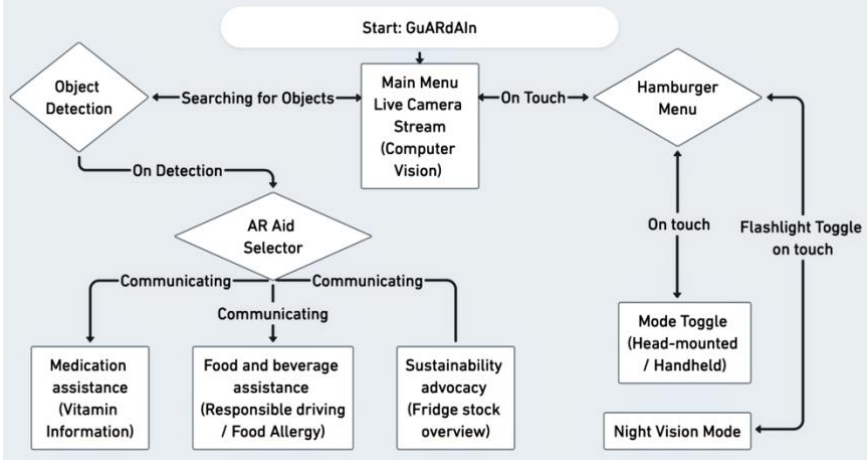


Figure 2 - The application starts with a main scene featuring a live camera stream that utilizes computer vision to identify and track objects. Upon detection, the AR aid selector provides tactile feedback and communicates multimodally through visual overlays (graphics/text) and auditory narration. It offers information on medical assistance, including vitamin details; food and beverage guidance, such as allergy warnings and responsible driving; and sustainability advocacy, like fridge stock overview. Users can access the hamburger menu to switch between head-mounted (stereoscopic) and handheld (smartphone) modes or activate "night vision" mode to enhance low-light visibility with the device's flashlight.

3. Research Design

The design validation employed a mixed-method approach to gather quantitative and qualitative data on user experience and attitudes towards the prototype.

Participants: Eight participants of various demographics were included: 25% (n=2) aged 18-24, 25% (n=2) aged 55-64, and 25% (n=2) aged 65+. Digital literacy levels were 37.5% (n=3) below average, 37.5% (n=3) average, and 25% (n=2) above average. Impairments included 50% (n=4) with minor and one severe visual impairment, 37.5% (n=3) with cognitive impairments (one with dementia and two with dyslexia), and one with motor impairment. AI familiarity was low, with 62.5% (n=5) having no familiarity and 37.5% (n=3) slightly familiar. The recruitment survey revealed skepticism about AI: 50% (n=4) felt "somewhat negative," 25% (n=2) neutral, and one "slightly positive." Concerns were mainly about privacy and over-reliance on technology.

Procedure and Materials: Upon obtaining participants' consent, they were introduced to the prototype, its functions, and the predefined test scenarios: 1) Medication Assistance, 2) Food and Beverage Assistance, and 3) Sustainability Advocacy. These scenarios simulated common daily activities where AI could provide guidance. Participants engaged with the prototype in their preferred mode, either head-mounted or handheld, with assistance from the researcher as needed. Each participant tried the prototype in both modes.

The total duration for the three test scenarios ranged from 4 to 7 minutes. After completing the tests, participants filled out a post-test questionnaire to provide feedback on the prototype's accessibility and usability. This was followed by a short semi-structured interview to gather their feelings and attitudes toward AI and its role in utility applications.

Data Collection and Analysis: Occurred in three stages, such as 1) Recruitment Survey: Conducted prior to the user testing to understand participants' background, experience, and preconceptions about AI and AR. 2) User Testing: Observations and performance data were collected during the interaction with the prototype. 3) Post-Experiment Survey and Interview: After the user testing, participants completed a survey and participated in an interview to provide feedback on their experience, perceived usefulness, and any concerns they had regarding the technology.

Quantitative data from the surveys were analyzed using statistical methods to identify trends and patterns in user perceptions and interactions. Qualitative data from the interviews were subjected to thematic analysis to extract common themes, particularly regarding the overall user experience and opinions on AI's applicability in everyday life.

4. Results

Prototype Evaluation and User Feedback: The prototype generally exceeded participants' expectations. All users (n=8), regardless of their skill levels, abilities, or impairments, were able to interact with, use, and execute tasks during the experiment, showcasing UD's impact on equitable use. Participants unanimously found the interface user-friendly, with 100% (n=8) rating it as "very clear and easy to understand." Even those with limited digital literacy executed the tasks without guidance, highlighting UD's impact on simple and intuitive use.

The predefined scenarios, including medication assistance, food and beverage assistance, and sustainability advocacy, were well-received. Half of the participants

(50%, n=4) rated the application's value in assisted decision-making as "excellent," 37.5% (n=3) rated it as "good," and one rated it as "fair." These ratings reflect the practical benefits of the system's real-time, context-aware information. Additionally, the system's AI-driven recommendations were praised for their accuracy and relevance, demonstrating its potential to provide valuable, personalized assistance in various everyday scenarios.

Participants tried both head-mounted and handheld modes. Head-mounted mode was preferred by 75% (n=6) of participants, who appreciated the immersive experience. However, 50% (n=4) reported discomfort with the headset, particularly during extended use. Issues included the headset being heavy and uncomfortable, squeezing glasses on the face, occasional unclear screens, and delayed pop-ups. Although not the majority's preference, handheld mode was favored by older participants for its familiarity and perceived ease of use, showcasing the importance of UD's impact on flexibility of use.

Overall, user feedback indicates that while the prototype is highly effective and intuitive, improvements in the head-mounted mode's comfort and screen clarity are necessary to further enhance the user experience.

AI Acceptance and Concerns: While initial skepticism and limited familiarity with AI were common among participants, post-experiment responses revealed a noticeable shift in attitudes. After using the prototype, 87.5% (n=7) reported that their trust in AI for important personal decisions had "somewhat increased," and one noted a "greatly increased" trust. This suggests that hands-on experience with the technology can positively influence trust levels.

The need for public education about AI became more apparent to participants after the experiment. Half (50%, n=4) indicated that their opinion on the necessity of public education about AI had "significantly increased," while the other half (50%, n=4) felt it was "somewhat increased." This underscores the importance of educational initiatives to improve understanding of AI technologies.

Despite the positive perception, concerns remained. Privacy and surveillance were notably present, as 87.5% (n=7) of participants raised concerns about constant camera vision and the implications of such applications in everyday life. Another major concern was over-reliance on technology, with 75% (n=6) wary of becoming too dependent on it for simple decision-making tasks.

Overall, the prototype demonstrated potential in enhancing decision-making through a UD-based AR interface. However, finding highlighted crucial areas for improvement, particularly in addressing privacy concerns, ensuring comfort in wearable technology, and balancing technological assistance with user independence.

5. Discussion and Conclusion

The prototype concept represents a significant advancement in integrating AR and AI through UD, creating a more intuitive, inclusive, and contextually aware interface for a diverse user base, supporting the claims of Coughlan and Miele (2017).

User study results confirmed that combining UD with AR's context-aware features, such as camera vision and multimodal information communication, enhances accessibility and usability. This aligns with the findings of Szentirmai (2024) and Mambu et al. (2019), positioning AR as a facilitator of inclusion rather than a barrier for the visually impaired. The successful task completion of all participants, including those with limited digital literacy and minor to moderate visual and cognitive impairments,

underscores the potential of UD principles in making advanced technologies more inclusive and user-friendly, as noted by Björk (2009).

Participants reported exceeding expectations for the prototype, finding the interface intuitive and practical. users particularly appreciated the ability to perceive real-time information without extensive manual input. This aligns with the design objective of creating a seamless blend of digital and physical environments, enhancing the user experience and decision-making processes. These findings suggest that AR is an ideal interface for AI.

However, concerns emerged regarding the privacy implications of the "always watching" camera, the ergonomics and comfort of head-mounted modes, and the fear of over-reliance on AI. These issues, noted in previous AI (Du & Xie, 2021) and AR studies (Billinghurst et al., 2015). As AI and AR evolve and become integral parts of daily life, there is an urgent need to address ethical, ergonomic, and psychological aspects in future system designs. Developing best practices and implementation ideas will be crucial for the responsible advancement of these technologies.

The prototype design significantly diverges from current AI solutions that rely on text or voice inputs and require users to provide context and precise queries. It showcases the transformative potential of AI and AR integrated utility applications, where the user's physical environment serves as the interface, contrasting with traditional interfaces based on windows, icons, pointers, or text and voice inputs.

It is important to note that guARdAIn is not a technological marvel; it can run on low-tier Android smartphones equipped with cameras and adequate API support. This highlights that the primary bottleneck for similar concepts is the lack of content offerings and user-centered design rather than technological limitations.

Further research in this area is necessary. Future studies should address the limitations of this study by considering a larger sample size, inspecting users with specific needs and abilities, and extending task duration, especially in head-mounted mode, to address potential discomfort and motion sickness from prolonged use. Additionally, privacy concerns should be prioritized. Context-aware systems possess knowledge about the user, environment, and tasks, necessitating thorough evaluation and focused studies to establish best practices. As AI and AR evolve, they have the potential to become integral parts of daily life. Therefore, more research is needed within inclusive utility AI-AR applications to share best practices and implementation ideas.

In conclusion, while the prototype demonstrates a promising concept, it marks the beginning of ongoing exploration into how AI and AR applications can meet diverse societal needs. Future studies with larger participant groups and longer task durations are crucial for validating and expanding these initial findings, paving the way for more comprehensive and universally accessible AI and AR solutions.

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Enhancing Learning Through Universally Designed Augmented Reality: A Comparative Study of Augmented and Traditional Learning Materials

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Abstract. This paper examines the impact and effectiveness of educational Universally Designed (UD) Augmented Reality (AR) applications compared to traditional paper-based counterparts. The study evaluates accessibility, usability, user experience, and short-term learning outcomes in marine biology, human anatomy, and cultural history. Thirty-six participants with diverse skills and abilities, including visual impairments and dyslexia, participated in two experiments. The findings reveal that UD-designed AR applications significantly improve accessibility and usability for users with special needs and enhance learning performance for sighted users, particularly in spatial tasks. Users with dyslexia demonstrated effective information recall, while blind users could interact with and learn from the AR content without needing third-party assistive technologies, which is not possible with paper-based solutions. This study underscores the importance of incorporating UD principles in AR development to enhance accessibility and usability, ensuring that immersive technologies facilitate digital inclusion.

Keywords. Augmented Reality, Universal Design, Accessibility, Usability, Inclusive Learning. Learning outcomes

1. Introduction

Augmented Reality (AR) is an immersive multisensory technology that overlays digital information onto the user's physical environment (Billinghurst et al., 2015; Azuma, 1997). One of the primary advantages of AR in educational settings is the enhancement of spatial understanding and cognitive learning. Studies have shown that AR can significantly improve the comprehension of complex concepts by allowing learners to visualize and manipulate digital content (Godoy Jr., 2020; Akçayır & Akçayır, 2017).

Despite its potential, AR presents several challenges. Technological challenges such as computational power, mobility, and hardware costs have significantly decreased in recent years, especially with the advent of mobile augmented reality (MAR) (Szentirmai et al., 2024; Chiang et al., 2014). However, the immersive multisensory nature of the technology heavily relies on users' senses and perceptions, meaning user-centered

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challenges have remained consistent over the past decade. As the technology becomes more widely adopted, these challenges will impact more users. Chief among these are the issues of accessibility and usability, particularly for individuals with disabilities.

The current design of AR applications often overlooks the needs of a diverse user base, especially concerning users with sensory impairments, varying levels of digital literacy, or different learning disabilities (Szentirmai, 2024; Mambu et al. 2019; Freitas & Campos, 2008). Consequently, there is a common misconception that while AR has potential for enhanced learning, it also acts as a barrier for users with special needs (Szentirmai & Murano, 2023). This oversight restricts the technology's adaptation to the mainstream market and limits its capabilities as an inclusive educational tool. There are multiple national and international mandates for inclusive educational environments and applications (Lovdata, 2018; Kanter, 2006). Creating inclusive environments must address multiple factors such as accessibility, usability, and user diversity, which are the three pillars of UD.

Concerning Universal Design (UD), this is the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design (Björk, 2009; Story, 1998). Educational domains of UD, such as Universal Design for Learning (UDL), have also recognized AR's beneficial impact on learning (Stylianidou et al., 2020; Walker et al., 2017). However, UDL studies often suggest using AR to enhance the learning experience for sighted students while providing equal media alternatives for users with special needs. This approach is necessary if the AR applications are not accessible to students with special needs to achieve an inclusive classroom. While this approach can work with inaccessible AR applications, we argue that if AR is designed with UD in mind, it makes this approach redundant since the outcome can adapt to diverse user needs, providing the same application for everyone, instead of separating classrooms based on the students' skills, abilities, or lack thereof. AR features such as camera vision (which can see for the users), microphone (which can hear for the users), and multimodal information communication (audio, visual, tactile) have the potential to achieve accessibility (Szentirmai, 2024; Gupta et al., 2019; Mambu et al., 2019) and usability for a diverse user base without the need for adaptation or third-party Assistive Technologies (ATs) in the form of UD-ed AR applications (Coughlan & Miele, 2017).

The research described in the upcoming sections takes a novel approach by exploring how UD-ed educational AR applications can enhance learning for a diverse user base within the same application, focusing on accessibility, usability, and short-term learning outcomes. The study compares traditional paper-based materials with equivalent UD-ed AR learning materials across three educational domains: 1) marine biology, 2) human anatomy, and 3) cultural history, each selected for their distinct learning requirements involving factual, visual, and spatial knowledge. This exploration seeks to contribute to a broader understanding of how UD-ed AR features can be leveraged to create more inclusive and effective educational environments.

This paper is structured to first outline the learning and assessment materials and methodology. Subsequent sections delve into the findings and implications of UD-enhanced AR materials, with reflections on future research directions in this field. The paper aims to promote UD and reframe the perception of AR from a primarily visual-centric tool to a technology fostering truly inclusive educational environments without the need for ATs and segregation of students.

2. Research Design

This study employs a comparative design to assess the effectiveness of universally designed educational augmented reality (AR) applications to traditional paper-based learning materials. The research comprises two distinct between-users experiments aimed at evaluating both the learning outcomes and the accessibility of the AR applications across diverse user groups. For both experiments participants had varied ages (18-78), self-reported digital literacy levels (below average, average, above average, expert), and physical abilities, including visual impairments and learning disabilities such as dyslexia.

Twenty-two participants (n=11-Control Group, n=11-Experiment Group) were recruited for experiment 1. Efforts were made to balance the participants' characteristics described above to avoid biased results and have evenly balanced experimental conditions. The control group used traditional paper-based (textbook style) learning materials, while the experimental group used corresponding AR applications.

For experiment two, fourteen participants were recruited to investigate the impact of user diversity on learning performance with universally designed AR applications. Participants were categorized based on the characteristics described above and previous experience with immersive technologies.

Experiment Materials: The educational topics were selected to reflect factual, visual, and spatial learning. These applications were meticulously designed to meet universal design (UD) requirements, utilizing the UD-AR heuristics of Szentirmai & Murano (2023). The three applications were as follows: Application 1 focused on marine biology, where participants learned about the marine toad through an AR application that provided tangible 3D models and audiovisual information, delivering factual, visual, and spatial information (see Fig.1.A). Application 2 centered on human anatomy, allowing users to explore the human brain and its parts in 3D through tangible interaction, primarily providing visual and spatial information (see Fig.1.B). Application 3 delved into cultural history, offering information, historical context, and architectural details of Angkor Wat through visual and audio descriptions in the form of an inbuilt AR screen reader that can provide a visual guide for the reader or turn the printed text into an audiobook (see Fig.1.C).

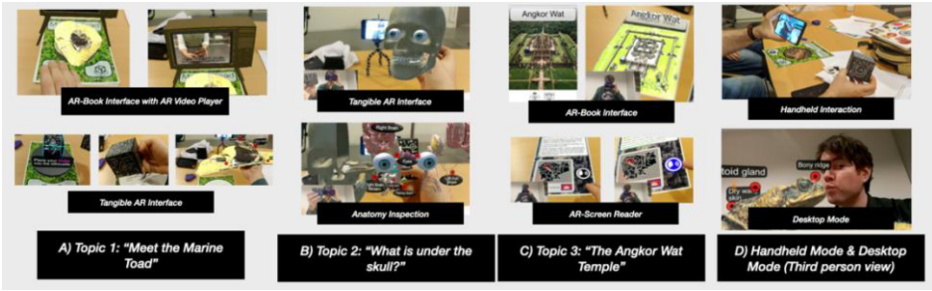


Figure 1.- Illustration of the three educational AR prototypes and their interaction modalities.

The application design, while resembling the typical architecture of AR books and tangible AR objects, adhered to the seven principles of universal design. For example, they delivered multimodal (audio, visual, tactile) perceptible information (Principle 3) to support equitable use (Principle 1). Additionally, all applications adapted to the user's

environmental surroundings, featuring a night-vision mode to enhance camera vision and AR-object tracking in unlit environments. This adaptation improved perceptible information delivery (Principle 3) under varying conditions—a feature often overlooked in devices that rely on computer vision and are accordingly light dependent.

Importantly, these enhancements did not require extra development resources, only careful attention to user needs and awareness of the technological limitations. All applications were evaluated by UD experts recruited from the university campus. Through expert evaluation and multiple cognitive walkthroughs, the evaluators validated the applications, classifying all three as universally designed.

Paper-Based Learning Materials: High-quality printed, paper-based learning materials were carefully designed to provide information equivalent to the AR counterparts in a traditional textbook format including comprehensive text and illustrative diagrams that corresponded to the content provided in the AR applications.

Assessment Materials: All participants completed a unified test reflecting the educational themes and information they learned. To test factual information recall, paper-based test materials were developed. For testing spatial knowledge in applications such as human anatomy, a digital test was created where users recorded their answers through interaction with a 3D model.

The Procedure: All participants completed a pre-test to ensure they were not familiar with the given educational topics. They were then assigned to their respective groups and participated in learning sessions lasting up to 30 minutes per topic. Regardless of the learning material, none of the sessions exceeded 15 minutes, typically varying between 4-7 minutes for paper-based materials and 5-10 minutes for AR users, who needed extra time to start and engage with the applications. After each session and when participants felt ready, they took an examination to assess their knowledge recall. The examination measured fact-based, visual, and spatial knowledge.

Participants in the AR group were given a demo session to familiarize themselves with the applications and different modalities (head-mounted and handheld). They could start their individual learning sessions at their own pace. Following the examination, participants completed a questionnaire to provide feedback on the user and learning experience of the AR applications.

Experiment 1 included all three AR applications, while Experiment 2 included only applications 1 and 3, excluding application 2. Application 2 focused purely on visual and spatial information, making it unsuitable for blind users, as it is specifically designed to train visual users.

Data Collection and Analysis: A mixed-method approach was used, with an emphasis on quantitative data collection. Exam scores from Experiment 1 were analyzed using one-way ANOVA to compare the performance of the control and experimental groups, allowing for the determination of statistically significant differences between the means of independent groups. To gain deeper insights into the different types of information recall, sub-scores for Topic 1 fact-based and visual knowledge, as well as for Topic 2 3D spatial and 2D blind map scores, were also analyzed. These two educational topics were selected because they provide an ideal platform for specific comparison of information recall. SPSS was used for statistical analysis.

For Experiment 2, quantitative data were analyzed by calculating the mean test scores and comparing the standard deviations to show variance between the groups. This method was chosen due to the presence of multiple groups and occasionally low sample sizes. This approach allowed for a clearer understanding of the differences in learning performance across various demographic and skill-based groups.

Qualitative data from post-test questionnaires and observations were coded and analyzed in NVivo for recurring themes. By combining both quantitative and qualitative data analysis methods, the study provided a detailed and nuanced understanding of how universally designed AR learning materials impacted a diverse user base.

3. Results

Experiment 1 - Total Test Scores: In this experiment, the AR (Augmented Reality) group demonstrated varying levels of performance across different educational topics when compared to the control group.

For Topic 1: Marine Toad, the AR group achieved significantly higher total test scores, with a mean score of 11.72 (SD=1.00), compared to the control group's mean score of 10.36 (SD=1.28) ($p = 0.012$).

In Topic 2: Under the Skull, the AR group showed a higher mean score of 8.27 (SD=1.27) compared to the control group's 7.45 (SD=1.03). However, this difference was not statistically significant ($p = 0.114$).

Similarly, in Topic 3: Angkor Wat Temple, the mean scores were closely matched, with the AR group scoring 4.63 (SD=0.67) and the control group 4.54 (SD=0.68), indicating no significant difference ($p = 0.757$).

Factual and Visual Information Recall (Topic 1): In the domain of factual and visual information recall for Topic 1 (Marine Toad), distinct differences were observed between the groups. The AR group significantly ($p < 0.001$) outperformed the control group in visual information recall, with mean scores of 5.81 (SD=0.75) and 4.45 (SD=0.68). However, for fact-based recall, both groups achieved identical mean scores of 5.90 (control SD=1.0; AR SD=0.7), indicating no significant difference ($p = 1$).

3D Spatial and 2D Blind Map Information Recall (Topic 2): Regarding Topic 2 (Under the Skull), the AR group showed a notable improvement in 3D spatial information recall, achieving a mean score of 4.09 (SD=0.70) compared to the control group's 3.36 (SD=0.50) ($p = 0.011$). In contrast, for 2D blind map recall, the AR group's mean score was 3.60 (SD=0.81), which did not significantly differ from the control group's mean score of 3.39 (SD=0.63) ($p = 0.772$).

These results suggest that AR enhances learning outcomes in specific types of information recall, particularly in visual and 3D spatial domains, while its impact on factual recall and 2D map understanding appears less pronounced.

Experiment 2 - Total Test Score: In this experiment, various factors such as learning abilities, digital literacy, impairment status, age, and prior experience with AR and VR were analyzed to determine their impact on total test scores of Topic 1 (Marine Toad), and Topic 3 (Angkor Wat Temple).

For diverse learning abilities, the total mean scores were 11.8 for slow learners (n=3), 15.4 for average learners (n=9), and 13.2 for fast learners (n=2), resulting in moderate spread (SD=1.815), enough to be noticeable, but not excessively large.

Regarding digital literacy, while experts (n=3) scored higher in fact-based knowledge recall, the overall test scores showed moderate spread (SD=2.96) among the summed mean scores. The total mean scores were 11.0 for below-average (n=3), 12.6 for average (n=3), 16.2 for above-average (n=5), and 17.3 for experts (n=3).

When examining impairment status, we observed a high level of variability (SD=6.08) among the groups. Participants with no impairments (n=7) had a mean score of 16.4, those with mild (myopia, hyperopia, dyslexia) impairments (n=5) scored 15.6,

and those with severe impairments (n=2, low vision, blindness) scored 5.5. All impairment groups were able to produce test results.

In terms of age, participants aged 25-44 performed the best, with considerable level of variability (SD=4.72) noted among the groups. The mean scores were 12.3 for ages 18-24 (n=3), 16.5 for ages 25-34 (n=4), 16.6 for ages 35-44 (n=5), 13.0 for ages 45-54 (n=1), and 5.0 for ages 55 and above (n=1).

Finally, considering prior experience with AR and VR, noticeable but not high variance (SD=2.0) in performance were found. Most participants with no prior experience (n=12) had a mean score of 14.1, while those with prior (n=2) experience scored 17.

These findings indicate that while certain factors such as impairment status and age can influence test scores, others like learning abilities, digital literacy, and prior experience with AR/VR do not show major effects on overall learning outcomes.

Qualitative Results: AR users found the technology highly engaging, with 85.7% agreeing that AR was more engaging than traditional methods. However, opinions on efficiency were mixed. Many suggested that traditional materials and digital tools like YouTube were equally effective for learning. While AR was praised for its engagement, some users experienced frustration and discomfort due to the ergonomics and weight of the headset. Most users preferred the head-mounted mode over the handheld or desktop modes, finding it convenient and appreciating the immersive experience. Although some AR users reported sweating and eye strain, none exhibited or reported symptoms of simulator sickness (Kennedy et al., 1993).

4. Discussion and Conclusion

One of the most significant findings from this research is the effectiveness of UD-ed AR in accommodating learners with various disabilities. AR is often seen as a barrier due to its multisensory demand and reliance on visual skills. However, with UD principles, AR can mitigate and eliminate mismatches between users' skills and abilities by enhancing and communicating information multimodally. This aligns with the theoretical statements of Coughlan & Miele (2017) and demonstrates that classroom segregation based on individual abilities can be rendered redundant if applications are universally designed (Stylianidou et al., 2020). Our findings underscore the potential of AR to transform educational experiences across various demographics and learning conditions, especially when inclusivity and accessibility are prioritized in the design process. All AR users were able to perform tasks and learn using the applications, regardless of their skills and abilities. Participants with severe visual impairments benefited from auditory and tactile outputs, while those with dyslexia found the multimodal presentation of information helpful, which would not be possible with paper-based materials without assistive technologies. The nonsignificant performance difference between user groups with diverse learning abilities aligns with findings from Freitas and Campos (2008). This supports the idea that UD can reduce mismatches between user skills and abilities, facilitating the achievement of user goals (Björk, 2009). User experience results indicate that AR experiences are more engaging and compelling, corroborating the findings of Juan et al. (2010), Chiang et al. (2014), and Iftene & Trandabat (2018). While learning outcomes for factual information recall were similar to traditional methods, AR significantly improved spatial and visual knowledge. This aligns with the studies by Hsiao et al. (2012) and Chen (2006). In our study, domains such as human anatomy and

marine biology showed remarkable improvements in learning outcomes, likely due to the 3D visualization capabilities of AR, which traditional methods cannot offer. These findings are especially important in scenarios where spatial information and assessment are crucial, such as in medical education (Ferrer-Torregrosa et al., 2015).

Implications for Educational Practice: The results from this study have important implications for educational practice. Integrating AR into educational settings can enhance learning, engagement, and digital inclusion without the need for often stigmatizing assistive technologies or classroom segregation. Despite the positive outcomes, several challenges remain. While the applications used in the experiments do not require costly or exotic hardware and can run on mid-range smartphones, the main bottleneck is the lack of awareness of user-centered design. Current development kits do not support accessibility with inbuilt features. Developing AR applications requires significant resources and expertise in software development, spatial computing, and universal design, which are not commonly available. However, the entry barrier could be significantly lowered with the recognition of UD and the development of general-purpose drag-and-drop AR educational tools for teachers.

Limitations and Future Research: One limitation of this study is that, while it included participants with a wide range of abilities, more extensive studies are necessary to explore the full spectrum of special needs. Further research is needed to test a broad spectrum of AR interaction styles and themes beyond AR-books and tangible AR interactions to refine and generate best design practices. Future research should focus on longitudinal studies to assess the long-term impact of AR on learning outcomes and knowledge retention. Additionally, exploring the scalability of AR applications in larger, more diverse educational settings would provide deeper insights into the practical challenges and opportunities of implementing AR on a broader scale.

In conclusion, this study highlights the transformative potential of universally designed AR in education. AR's ability to enhance learning outcomes, increase engagement, and provide accessible learning experiences to a diverse range of students is evident. As educational technologies continue to evolve, the focus should remain on creating inclusive, engaging, and effective learning tools that cater to the needs and abilities of all learners, regardless of their skills and abilities.

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VR Dialogues: Enhancing Communication Between Autistic Individuals and Their Special Education Teachers Through Virtual Activities

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Abstract. This paper explores the potential of a Virtual Reality (VR) intervention to facilitate communication about sensitive topics between adolescents with Autism Spectrum Disorder and their special education teachers. The VR intervention was developed in collaboration with Special education teachers, incorporating feedback from a design workshop to create a VR application featuring activities like basketball, air hockey, drawing, and avatar customization.

The VR application was evaluated through two sessions between one autistic adolescent and a special education teacher at a residential home for autistic adolescents. The results indicate that VR has the potential to be used as a space for sensitive conversation between autistic individuals and their special education teachers.

Keywords. Autism Spectrum Disorder, Virtual Reality, Communication,

1. Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterized by deficits in social interaction, communication, and repetitive behaviors [1]. These challenges result in difficulties with both verbal and non-verbal communication, such as initiating and participating in conversations, reading facial expressions, and maintaining eye contact, which in turn reduces the ability to develop and maintain meaningful relationships [2]. The inability to effectively communicate can lead to misunderstandings and frustration, both for individuals with ASD and those interacting with them. As a consequence of these deficits and lack of relationships, many children with ASD are at a higher risk of being bullied [3] or experiencing social isolation [4]. Difficulties in verbal and nonverbal communication, such as initiating and participating in conversations, understanding nuanced language, and interpreting facial expressions, can lead to a reluctance or inability to express feelings and experiences related to sensitive issues such as bullying, trauma, or personal fears. The inability to communicate these concerns effectively can have profound consequences [5]. In this paper, we present a Virtual Reality

(VR) intervention designed to investigate whether autistic adolescents feel comfortable having conversations about sensitive topics with their Special Education Teachers (SET) in a virtual environment.

Unlike real-world interactions that can be overwhelming due to sensory stimuli or social anxieties, VR environments can be tailored to minimize distractions and provide visual and auditory cues that are easier to interpret. Real people can be replaced with cartoon-like virtual avatars without all the gestural, facial, and social expressions of a real person. Additionally, repetitive activities can be implemented in the virtual environment, which has been shown to serve as a way to cope with the environment for autistic individuals [10].

Previous studies have illustrated the potential of virtual reality (VR) as a tool to teach social [6], and daily living skills [7] to children and adolescents with ASD. A study by Halabi et al. has shown that autistic children find VR intervention as a tool to practice conversation skills motivating and satisfying [8]. Another study by Rosenfield et al. describes a VR simulation designed to help autistic adolescents practice conversation in a virtual environment, with the results illustrating the potential to improve the users' social and conversational understandings [9]. These solutions, however, relied on scripted conversations and social situations, not enabling free-flowing conversations that can occur in real life.

In this paper, we present a VR intervention designed to investigate whether adolescents with ASD feel comfortable having conversations about sensitive topics with their teachers or SETs who are also immersed in the same virtual environment as them while embodying virtual avatars.

2. Methods

2.1. Design workshop

The VR intervention is developed in collaboration with Mervib, a home for autistic adolescents, and teachers at Stuen, a special education center for young autistic individuals. A design workshop was organized with three teachers from Stuen and two SETs from Mervib. In order to familiarize them with the potential of having a conversation in VR, a prototype was developed, allowing two participants to join a virtual room together within which they could talk and interact with a virtual ball and pencil.

After trying the VR application in pairs of two, a focus group interview was conducted. During the interview, the teachers and SETs agreed that their students had difficulties initiating conversations about difficult topics such as bullying, trauma, or inappropriate behaviors they had experienced either in real life or on social media. Both parties, however, indicated that autistic adolescents would open more up during activities such as playing table tennis or basketball or while going for a walk or cooking. They mentioned that these activities are repetitive and can be used as a way to avoid eye contact or to analyze facial expressions. Finally, the teachers requrested emotion cards to be implemented similar to those they use in real life.

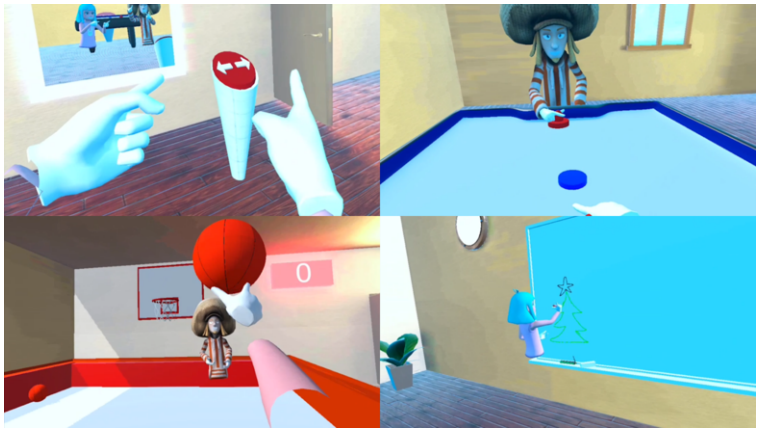


Figure 1. Top left: The mirror is used both as a social activity and to change avatar. Top right: The virtual air hockey. Bottom left: The virtual basketball game. Bottom right: Virtual drawing board

2.2. The VR application

Four activities were implemented in the virtual environment: basketball, air hockey, a whiteboard for drawing together, and a mirror. The basketball court (see figure 1) consisted of a hoop and three balls. A scoreboard was also placed in the scene to keep track of the number of balls successfully thrown into the hoop. The air hockey game (see figure 1) would, similarly to the basketball game, illustrate each player's score on their respective scoreboard and then reset the ball position in front of the losing player. The drawing board can be seen in figure 1. Different colored pens were placed below the drawing board. Finally, the mirror was placed in the virtual environment, big enough so that both players could look at their avatars together. The air hockey table and the basketball court were placed in separate rooms to keep each room simple, with few sensory inputs that could potentially distract the users. The rooms were separated using doors.

Additionally, when starting the application, each participant would start in an avatar selection room where they could choose between four different avatars by looking at a mirror and pressing a button to switch between avatars. Once ready, they could open a door that would take them to the air hockey room, where they could meet each other.

Finally, emotional cards were implemented as emojis as requested by the teachers. By pressing the button on the controller, an emoji menu would appear on the user's left hand. The user could choose an emoji to activate by pressing it using their right hand.

2.3. Evaluation

The VR application was evaluated at the residential home for autistic adolescents. One of the SETs, an educated special needs teacher, tried the application together with one of their residents during two sessions. The resident was an adolescent who identified herself as a female. None of the authors were present during the sessions. Before and after each session, a questionnaire regarding the participants' state of mind inspired by the Floereo joint attention module [11] was filled out by the resident together with the SET.

Following the VR session, the SET and resident filled out a questionnaire together. The questionnaire consisted of two sections: one with open-ended questions inspired



(a) Session 1. (b) Session 2.

Figure 2. Figure showing the differences in the individual with ASD's state of mind before and after testing the prototype. The blue boxes represent 'before' and the green boxes represent 'after'

by the diary study approach described in the book Interaction Design: Beyond Human-Computer Interaction by Rogers et al. [12] and four questions regarding system usability inspired by the SUS questionnaire [13].

Following the two VR sessions, a semi-structured online interview with the SET was conducted. The goal of the interview was to get feedback about the overall experience of using the prototype multiple times. The questions were open-ended with the purpose of further elaboration on specific data from the diary study. The interview was conducted on the last day of the diary study through the online meeting platform Zoom and lasted 25 minutes.

3. Results

During the assigned test week, the prototype was tested two times. The first session lasted 20 minutes, and the second one lasted 15 minutes.

3.1. State of mind questionnaire

The results from the first testing session showed a change in energy level and general mood before and after using the prototype (see figure 2). In the second testing session the participant did not show a change in energy level and general mood before and after using the prototype.

3.2. Usability questionnaire

Both the resident and the SET answered the question 'I found the system unnecessarily complex' and 'I needed to learn a lot of things before I could get going with the system' with 'strongly disagree' (Likert item 1) in testing sessions 1 and 2. In the first testing session, the resident answered 'agree' to the question 'I thought the system was easy to use', whereas the SET answered 'strongly agree'. They both answered 'strongly agree' to 'I think that I would like to use this system frequently'. In the second testing session, both participants answered 'strongly agree' to the question concerning whether the system was easy to use. However, to the question regarding whether they would use the system frequently, the resident answered 'strongly disagree', while the SET answered 'strongly agree'

3.3. Diary study inspired questions

After the first session, the best parts, according to the resident, were the emoji menu and air hockey. The worst part was how drawing on the drawing board worked since the pencil drew dots instead of lines. They also found it uncomfortable to adjust to the real world after leaving the VR environment. The resident also mentioned that they screamed every time the avatars got too close to each other. The resident described the overall experience with the VR environment as 'very nice', besides their opinions concerning the drawing board.

The SET also mentioned the part concerning the drawing board but described it as a bug. Additionally, the SET stated that he thought the VR environment had great possibilities for having conversations. When asked about which specific activities had the most potential for having a conversation, he answered basketball and standing in front of the mirror. Concerning the strengths and weaknesses of being in the VR environment with the resident, compared to being in the real world, the SET wrote that the fact that they did not have to address real-life human contact while using the prototype helped the adolescent relax more. Additionally, they felt the residents and themselves were more on the same wavelength, and the power dynamic was more equal.

The resident expressed that the experience was boring during the second VR session.

The SET found it more difficult to have conversations in the second session than in the first one. They suggested this might be because being in the VR environment was not a new experience anymore. However, the SET felt the residents communicated more positively than they do in real life. Another positive remark the SET mentioned was that the room does not seem too 'serious', which can make it easier for users to have difficult conversations in the environment.

3.4. Interview

The interview lasted approximately 25 minutes and focused primarily on the SET's perspective, with additional insights provided based on their familiarity with the resident.

According to the SET, the resident compared the prototype to established VR experiences, leading to a perception that the program did not meet expectations in the second session, where no new elements were introduced, and the participant got bored. This contrast affected the entertainment value, although the resident still enjoyed the VR environment, according to the SET. The SET suggested implementing a point system to potentially enhance engagement but expressed concern that losing points could negatively impact the resident's mood. They proposed setting goals, such as achieving 10 points, with rewards upon completion.

Both the resident and SET viewed emojis positively, facilitating emotional expression and communication within the VR environment. Further development of emojis was suggested to enhance visual communication of emotions. The SET found conversing with the resident in VR easier than in real life, noting improved communication dynamics and reduced challenges like maintaining eye contact. Contrary to their usual demeanor, the residents exhibited a happier, more communicative, and positive mood in the VR sessions, characterized by frequent laughter and gazes toward the SET avatar. The resident appeared comfortable interacting in the VR environment, which allowed for movement, play, and conversation without the usual dynamics of their real-world relationship with

the SET. During the second session, the SET experienced cybersickness, causing dizziness and a temporary need to remove the VR glasses during the first session. Despite this, they acknowledged the resident's desire to continue the session. The SET identified the potential for building trust and facilitating sensitive conversations between the residents and themselves within the VR environment, suggesting its use for regular conversation sessions.

3.5. Screen recording observations

Besides the feedback obtained from the interview, additional observations were found in the screen recordings from the sessions in the VR environment. The recording from the first session only lasted 45 seconds due to the SET removing the VR headset, automatically ending the recording. This recording will not be used in this evaluation. The recording from session two showed that the participants experienced several bugs and glitches during the session. The puck on the air hockey table moved outside the table at one point, but this was only visible to the SET. The resident still had the puck placed on the table. This resulted in them being unable to play for a short duration, but once the resident's controller collided with the puck visible from their point of view, the game worked again, and the puck appeared on the table for both players.

When the participants were playing air hockey, the resident initiated a sensitive conversation. The SET asked whether the resident had played air hockey before, and the resident answered with having played it while being committed to a psychiatric ward. The resident continued telling the SET about their experiences leading to being committed to a psychiatric ward during the game of air hockey. The SET asked a few questions regarding the episodes described by the resident. The conversation stopped once the bug with the air hockey pug happened. The communication between the SET and resident was continuous throughout the entire session. The participants discussed both the virtual environment and real-life topics, such as personal experiences and the resident having a doctor's appointment the following week. As mentioned earlier, the SET had to leave the VR environment due to cybersickness. When they asked the resident whether they wanted to leave the environment and start the diary evaluation, the resident did not want to. Instead, the resident continued moving around in the basketball room and went back to the activity room even though the SET had left. The resident did not suggest leaving the VR environment at any point during the session.

4. Discussion and Conclusion

Our study's findings suggest that VR can be a promising tool for enhancing communication and engagement among adolescents with ASD. A noteworthy instance occurred during the virtual air hockey session, where the resident disclosed sensitive personal experiences related to past psychiatric care. This spontaneous sharing of personal history underscores the potential of VR environments to facilitate discussions about otherwise challenging topics. The interactive and engaging nature of the activity seemed to lower inhibitions, allowing for a deeper level of communication between the resident and SET. This finding is particularly significant as it demonstrates how VR can serve as a catalyst for therapeutic conversations in a non-threatening setting. The SET noted that the

absence of direct real-world eye contact and the physical presence of real-world interactions mitigated social anxieties, enabling more natural and relaxed interactions. Specifically, the SET mentioned the residents having issues with keeping eye contact and people invading their personal space. Although the users' avatars are able to stand close to each other, this did not seem to be an issue for the resident. The SET mentioned being on the same wavelength when communicating in the environment. The SET thought this might have been caused by the power relations being more balanced when interacting in VR compared to the real world. For example, the SET did not need to tell the resident what they could and could not do, meaning they did not have to express authority towards them. This suggests the prototype had a positive impact on the communication. However, it must taken into consideration whether the impact on communication was caused by being in VR in general or by being in this specific VR environment.

Additionally, other commercial applications exist that can do what we have created and more. A similar VR application called VRChat which offers social VR experiences created by their community. It has the same functionalities and activities presented in the prototype, except for the emoji menu. VRChat is used by many to build relationships in a virtual environment, play various games, or just interact with each other. Based on the feedback concerning the resident at MerVib being comfortable with communicating in VR in general (regardless of the environment's activities), VR Chat could be as beneficial in easing communication for individuals with ASD. However, VRChat offers much more functionalities and environments with a lot of objects, which could risk being distracting to individuals with ASD, if the purpose is to ease communication through VR. Since the purpose of VRChat is mainly entertainment, keeping the individual with ASD engaged in the conversation could be difficult should they want to pay their attention to activities other than talking. By creating a singular experience, as in this project, there is a higher chance of keeping their attention in the virtual environment. This makes it easier for the SET to start using VR, since a premade room does not require them to make adjustments before entering the VR environment

However, our study also encountered challenges, such as technical glitches and cybersickness experienced by the SET, which temporarily interrupted the first session and finished the second session earlier than the resident. These issues highlight the importance of refining VR applications to ensure seamless user experiences, especially considering the sensitivity and focus required during therapeutic interactions. The resident did not enjoy the second session according to their feedback from the questionnaire, stating it was "boring". Even though the session was regarded as boring, the resident did not want to leave the virtual environment. This indicates enjoyment is not a deciding factor in wanting to stay in the environment. Although the SET felt it was not the activities that eased communication, the participant said they had an interest in basketball and had played air hockey before. This could create a bias towards the specific participant having a personal interest in the activities. Other individuals with ASD might not want to engage in the activities should they not find them interesting or entertaining. However, while playing air hockey, the SET asked whether the resident had played air hockey before, which resulted in them initiating a conversation regarding a personal, sensitive topic. It was the resident herself who brought up this personal conversation and answered the SET's question regarding it. The SET usually experiences the resident as being very negative in their communication regarding sensitive topics but felt this was not the case

while they talked about it during air hockey. This might not have happened, if the resident did not associate playing air hockey with this previous experience.

However, since this study only had one test participant, it is questionable whether or not it is possible to extrapolate the results to other autistic individuals. While the sessions resulted in deep conversations, more test participants would be needed to be able to generalize the efficacy of the prototype as a tool for easing communication about sensitive topics between autistic individuals and their SETs.

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AI in Software Development and Its Potential Influence on Accessibility Compliance

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Abstract. As artificial intelligence (AI) becomes increasingly integral to various sectors, its potential to enhance accessibility in digital services is of growing interest. This paper explores the influence of AI systems (AIS) on accessibility compliance, specifically within the context of Norway's national e-health service provider Norsk helsenett (NHN). Through a qualitative analysis, we assess how AISs are deployed in frontend programming, user interface design, and accessibility testing at NHN. Our study reveals that while AI has the potential to improve accessibility, it also presents challenges that require robust domain knowledge and effective human oversight. We explore the benefits and limitations using ChatGPT in accessibility testing, GitHub Copilot for generating accessible code, the implications of AI driven design tools, as well as the key differences between developing websites with existing component libraries and developing a simpler website from scratch. This paper aims to contribute to the ongoing discourse on AI and accessibility, offering insights and recommendations for future research and practical applications.

Keywords. Accessibility, artificial intelligence, software development, WCAG

1. Introduction

With the rapid digitalization of society, in Norway as well as the rest of the world, accessibility of digital services is increasingly important. The Norwegian Digitalization Agency estimates that when faced with digital public services as much as 20 % of the adult population of Norway is at risk of digital exclusion (1).

Members of an average agile team in software development (SD) do not always have sufficient knowledge on how to build accessible digital services or on how to embed it in their development process (2). Additionally, they are often forced to operate within a limited time schedule with other priorities having precedence (3).

With the Norwegian e-health service provider Norsk helsenett (NHN) as a point of departure we have carried out a qualitative review of how AI systems as a tool in SD may influence accessibility compliance of national e-health services and other web services.

Mainstream AISs are still in its relative youth and developing quickly. NHN has acquired several and employees are deploying them eagerly in a semi-organized manner.

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General company guidelines exist but are vague and unfamiliar to many. Accessibility is mentioned but only regarding alt-text on AI generated images.

By uncovering the unknowns of deploying AISs in SD in NHN through a qualitative review of several possible implements of AISs we have laid the foundation for mitigating risks and reaping the benefits regarding accessibility.

We identify three main areas where AIS in NHN may influence accessibility: frontend (FE) programming, user interface (UI) design, and accessibility testing, which are covered by frontend developers, designers and a very few accessibility experts. While knowledge about accessibility is varying among developers and designers, it is ultimately designers and developers who are responsible for the main workload in ensuring accessibility in the web services they build. Therefore, our focus will be on these two roles in the SD process.

Other roles of a traditional agile SD team may also include roles such as backend developers, project managers and functional testers. We deemed these roles out of scope for this paper as their produced output does not directly affect accessibility. Prioritizations made by, and the culture among, the team as a whole are significant to the accessibility of the finished product (3), but these aspects are unlikely to be impacted by the deployment of AISs. Members of agile teams do not necessarily have the same prerequisites or motivations to adopt and use novel technology (4). Therefore, a one-size-fits-all solution is unlikely to accommodate all team members equally.

2. Methodology

2.1. General Approach

Our research methodology came about organically as we learned more about the topic over time. We started by doing a simple literature search and research into the internal workings of NHN in parallel. It was soon obvious that the rapidly evolving world of AI made it impossible to stay within the realm of scientific research as there was much to be learned through other sources, such as blogs, traditional media, online forums, company announcements, webinars and so on. Most of these sources of information have not been referenced in this paper because we ended up not using them directly. It was nevertheless a valuable exercise to expose ourselves to a realistic up to date state of the technology, trends and culture of AI. It also led us to many of the referenced sources in this paper.

The purpose of our research and methodology was to learn and uncover as much information as possible about the topic at hand. We made a conscious decision to not make our search too narrow and to avoid a specific vision of the format of the end results. The information was gathered qualitatively as opposed to quantitatively because we assessed quantitative data gathering as insufficiently purposeful and was not needed to achieve the aim of this paper – to highlight and discuss potential blind spots and opportunities and lay the foundation for further research.

2.2. Literature Search and Information Gathering

The specific theme of this paper is not widely researched, and little direct peer reviewed evidence exists to support, dispute or answer the stated research questions. To gain an

understanding of how the adaptation of AI systems may affect accessibility compliance we investigated literature on how they affect other subject matters, such as code quality and privacy and security concerns. Literature was also targeted based on relevance to context of NHN as a large government owned service provider. Subsequently, we evaluated and discussed if and how the same principles, or other more general principles, may realistically apply to accessibility compliance in NHN specifically.

The literature search was complimented by internal research into NHN itself. This research consisted of activities such as reading internal documentation, following certain Slack and Teams channels, and speaking to a few key persons in NHN. The internal research provided sufficient information to gain an overview of which AISs that are in use or available for use in NHN, to which degree they are deployed, and how they are and may be deployed. This information was used in further investigations of literature and relevant reflections on the topic in context. It also sparked the idea to conduct a superficial experiment, as explained in the next sub-section. The results of our information gathering are presented in section 3, 4 and 5.

2.3. Having ChatGPT Conduct Accessibility Assessments

To experience first-hand how certain applications of AISs may be deployed in accessibility testing we performed a superficial experiment to see whether different ChatGPT models combined with different strategies can be used efficiently for WCAG compliance testing.

The models used were NHNs enterprise ChatGPT 4 and ChatGPT 4o. At the time of writing this paper ChatGPT 4o was the best and most recently released model while ChatGPT 4 was the best ChatGPT model available to employees at NHN. The non-enterprise ChatGPT 4o has internet access and can interpret images, both of which we took advantage of.

First, we prompted ChatGPT 4o to do an accessibility assessment of a web page and provided a screenshot of said web page. Secondly, we gave ChatGPT 4o the same prompt and provided the URL to the same web page. As this model can access the elements on the web page, we hypothesized that it should be able to correctly assess the accessibility based on WCAG 2.1 requirements. Both times we followed up errors in the initial responses with one or more prompts to further investigate their limitations and their ability to correct themselves. In both cases the follow up question involved color contrast checking.

3. AI Systems in NHN and Their Deployers

As of June 2024, the most used AISs in NHN are GitHub Copilot and ChatGPT which are deployed mostly by developers and less so by designers and accessibility experts, both by percentage and total numbers, although concrete numbers could not be settled. Some developers are also experimenting with other LLMs that can be run locally. From speaking to a few employees with general knowledge of the deployment rates of AISs, we found no reason to believe that the influence of such AISs has been significant so far.

Employees may not deploy AISs that may pose a risk to privacy and security, for example by collecting inputs to further train the model. Instead of using the latest version

of ChatGPT employees are limited to an older enterprise version that does not have reading access to the open internet and is trained on data from before November 2023. This affects how ChatGPT may be deployed and thereby influence accessibility in NHN, and thereby the associated risks and potential gains, as presented in subchapter 8.1.

By asking the designers in NHN via one of their weekly joint meetings and Slack channel, we could not find that any of them have been using AISs in a way that may influence accessibility.

4. AISs in Design Work

While not deployed in NHN we have started to see usability testing and research with synthetic users. Synthetic users are AI-generated and are meant to replace real human users in certain cases and may be used in conversations with i.e. ChatGPT. While this practice may be cheap and scalable it is also controversial. They may not fully capture the nuances and unpredictability of real human behavior which can lead to overlooking certain accessibility barriers that only real users might encounter. One study also demonstrated issues with ChatGPT outperforming humans in a controlled experiment (5).

We did not otherwise come across any AISs that can be considered low hanging fruit in terms of ease of deployment for designers in NHN and influence on accessibility. However, on the 26th of June 2024 Figma announced the introduction of integrated AI features in Figma – a design tool that has taken the place as the industry standard and is the design tool of choice in NHN. With the new AI features designers will be able to generate editable UIs, text, images, clickable prototypes and so on directly in Figma, many of which may very well influence accessibility. We were not able to try out these features ourselves as they are still being gradually rolled out in beta.

In a joint meeting with the designers in NHN where the recent announcement of Figma AI was discussed, there was expressed feelings of both apprehension and excitement, with the largest criticism relating to the UI generating feature not currently working with Figma component libraries.

5. AI Generated Code

NHN's AI guidelines, supported by several sources, highlight a few key areas that the deployer needs to keep in mind: Training should be offered to the deployer before using AI in their work – especially if the deployer is unexperienced in their profession (6) (7), knowing what data the AIS has been trained on (7), the importance of quality control of the AIS's output, understanding that an AIS makes mistakes which may also be presented in a manner easily mistaken as facts (8), and the significance of how a prompt is worded.

None of the listed key areas are specific to accessibility but most are still relevant in varying degrees. For example, if a FE developer prompts GitHub Copilot to generate code that complies with WCAG 2.1 requirements, they still need to be able to control the validity of the output and fix potential errors and accessibility bugs.

Another significant factor is knowing what you want the AIS to do for you (9). If the same FE developer does not include mentions of WCAG 2.1 in their prompt, perhaps

because they forget or lack the knowledge to do so, the output will much less likely be WCAG compliant.

6. Deploying AISs for WCAG Compliance Testing

ChatGPT may be utilized for code assessments and debugging by simply passing the code as a prompt to ChatGPT along with an appropriate request (10). The same technique should be applicable to accessibility bugs and improvements but may be limited to overly simple websites and thus not be very useful in contexts such as NHN. This aspect is discussed briefly in a web article written by The Authority for Universal Design of ICT in Norway where they point out limitations to AISs when faced with large and complex websites. Mentioned challenges include dynamic content on a web page, advanced technological features, many subpages and a complex navigation structure (11).

These findings were not disputed by the results of our simple experiment where we prompted two different ChatGPT models to assess the accessibility on a web site as neither model was successful. NHN's enterprise ChatGPT 4 did not have access to the open internet, and therefore, the source code of the web page. Thus, it was unable to provide an actual assessment and instead chose to give advice on how a proper assessment should be conducted. Although quite general its advice was not factually wrong. It also informed us that the color codes may not be accurate when interpreted from a screenshot. When prompted to try anyway it based the contrast score on incorrect color codes. It was able to assess contrast correctly when provided the color codes manually. However, this workflow is easily beaten by simple browser plugins and automated accessibility test tools regardless of the accuracy of the model.

ChatGPT 4o, which did have access to the open internet, was able to assess the accessibility based on WCAG 2.1 requirements. However, the assessment did contain errors, one of which being incorrectly identified colors. One such example was the color of the background. The color of the page title was identified correctly, resulting in a false negative contrast check.

7. Discussion and future work

7.1. AISs as a First Responder Accessibility Advisor

Looking at the ways tools such as GitHub Copilot may be deployed, we see a possible application that may ease NHN's few accessibility experts. NHN has very few dedicated accessibility testers, and NHN does not provide standardized accessibility training for either developers or designers. This means their accessibility knowledge is varying, and they often need help and advice when faced with accessibility issues. By asking GitHub Copilot or ChatGPT first, they may discover the answers to be satisfactory, thus saving the accessibility tester's time. Moving forward we will recommend looking into how this can be leveraged successfully, for example by encouraging employees to deploy an AIS before asking a human and by gathering quantitative and qualitative data on differences in perceived efficiency and in WCAG compliance.

7.2. Comparing Accessibility Compliance of Web Pages where AISs Have and Have not Been Deployed

GitHub Copilot has been adopted by most of helsenorge.no's FE developers over the last several months. It is near impossible to separate what code in production has been produced with the help of AI or not. Therefore, we need to assume the hole web site could be affected. By examining WCAG compliance scores from 2022, 2023 and 2024 for specific sub-pages we could get a rough impression of the level of AISs' impact on accessibility in the case of any obvious and major differences in WCAG compliance found in the newest versions of the web pages.

7.3. Building Websites with an Existing Web Component Library

With web component libraries, such as NHN's Frankenstein design system, a lot of the accessibility factors come out of the box. Given that the components are built to WCAG 2.1 standard there is much less room for both FE developers and designers to make accessibility mistakes. Designers don't need to consider color contrast within single components such as buttons, and the developers don't need to remember using semantic HTML and appropriate ARIA-tags when implementing them. Similarly, there is less room for AISs to make these same mistakes – and to assist deployers in avoiding said mistakes.

Most web services from NHN are built using existing component libraries and design systems, with Frankenstein design system being the most notable one. Therefore, the value of generating UIs from scratch, as promised by Figma in a coming feature, is probably marginal at best. And effort to explore Figma AI regarding accessibility will be made in further work, with added importance as these tools potentially being the first AISs to be deployed by designers in NHN with significant influence on accessibility.

Of course, using design systems and component libraries will certainly not guarantee full WCAG compliance as many WCAG requirements are context dependent and requires individual components to be combined in meaningful ways. Therefore, we deem this as a relatively high risk and potential high reward area regarding accessibility and will recommend this to be investigated in future work and research.

7.4. Other Reflections of Findings and Aspects not Covered in This Paper

The AI systems are as good as the data they are trained on. Assessing the quality of the training data in terms of accessibility compliance as outside the scope of this paper. Thus, we suggest looking into this in future research to understand to which degree the different AISs can be trusted to produce accessible code.

Usability testing with users of varying disabilities is difficult to achieve in satisfactory quantity and the resources for doing so in NHN are scarce. Despite existing controversies (12), we propose looking into this area in further research, not ignoring the risks associated with replacing real humans with synthetic alternatives where user involvement is required.

We only executed each of our superficial experiment once, which may be a risk of validity to the results. However, as neither version of ChatGPT was able to identify color codes correctly on the first (and only) try, there is a strong reason to believe that such

methods are not reliable enough to be useful for this particular use case with the state of the technology as of today. There are other contrast checking tools on the market that are quick and easy to use, can assess other WCAG requirements simultaneously, and will calculate color contrast correctly every time.

Our experiments showed us that AISs such as ChatGPT may not be reliable enough for certain accessibility checks. At the same time, they are useful when the need for accuracy is not crucial. Our experiments may also be overly simplistic compared to more realistic use cases of higher complexity. Therefore, we find it worthy of further investigation, perhaps with the intent to write concrete and detailed guidelines for accessibility testing with AISs in NHN, or to understand how to leverage AISs for learning about accessibility testing.

8. Conclusion

In this paper we sought to uncover blind spots regarding AI's influence on accessibility. We found that while AISs may assist the deployer in producing accessible designs or code, as well as act as an agent in learning about accessibility, AI is no replacement for domain knowledge or expertise. While this is no revolutionary breakthrough in the grand scale, the increased awareness of the fact may mitigate the risk of accessibility investments being downsized because of such misconceptions.

With an in-depth analysis of accessibility assessments of helsenorge.no from previous years and comparing it to the state of accessibility compliance in the time to come, we should be able to quantify accessibility influences of AISs as their deployment continues to increase, their models improve and new tools arriving on the market.

During the end of writing this paper new AISs directed at designers were announced, and its eventual enrollment may present new unknowns to be uncovered. We have also uncovered the need for further investigation into how NHN may mitigate risks of and leverage the deployment of various AISs regarding accessibility influences in SD.

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