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Towards inclusive sports and leisure buildings

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PREFACE

This thesis presents the outcome of the Industrial Ph.D. project conducted in partnership with the Royal Danish Academy and the Danish company Force4 Architects A/S, with financial support from Bevica Fund, and Innovation Fund Denmark (IFD).

This study would not have been possible without the established collaboration between the Royal Danish Academy, Force4 Architects and Bevica Fund, which share the common interest to strengthen knowledge on Universal Design and architectural inclusion with the goal of promoting a design practice that responds to people's differencies and uniqueness.

For the past four years, the Royal Danish Academy has paid special attention to inclusion with the goal of responding to the United Nations' "Leave No One Behind" agenda. This focus has directed the Academy's research into the impact that design process and practice have on people's everyday lives. To further this commitment, the Academy has developed the project "Universal Design and Accessibility for All: Architecture, Cities and Space" in partnership with Bevica Fund. This project aims to promote universal design as a value-based approach to creating equal opportunities in all areas of our environment and everyday life. Following this vision, the research Cluster of Spatial Inclusion at the Royal Danish Academy focuses on research and design projects that aim to improve the lives of all individuals, promoting independence, participation, and enjoyment through design. As part of this cluster, the study presented in this thesis intends to offer further knowledge about the dynamics of inclusion and exclusion in the built environment and the corresponding design implications.

Force4 architects base their practice on designing accessible and intuitive architecture that is meaningful for all people. This includes designing spaces that are easy to navigate and use, and that promote the values of diversity and equity. Their established yet growing focus on design for inclusion moved their interest and willingness to gain research-based knowledge and tools for more informed design decisions. With this goal, this study develops design strategies to support conscious consideration of the influences of the built environment on individuals' experiences, ultimately leading to the creation of spaces that are more responsive to human differences and therefore more inclusive.

PUBLICATIONS (full text in Appendix II)

- **Cassi, R.**, Kajita, M. and Popovic Larsen, O., 2020. Architecture and Disability: The Individual Experiences of People with Mobility, Visual and Hearing Impairments in Sport and Leisure Buildings. In The AMPS 2020 International Conference on Experimental Design: Rethinking Relations between People, Objects and Environments (pp. 119-131).

- **Cassi, R.,** Kajita, M. and Popovic Larsen, O., 2021. User-Environment Interaction: The Usability Model for Universal Design Assessment. In Universal Design 2021: From Special to Mainstream Solutions (pp. 55-70). IOS Press.

- Øien, T. B., **Cassi, R.**, 2023. Exploring the person-environment-occupation model. In Bevica UD Anthology. (In Press)

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I would like to express my heartfelt gratitude to the Royal Danish Academy, Force4 Architects and Bevica Foundation for giving me the opportunity to pursue this Ph.D. study which has been a challenging and extremely rewarding experience for me.

I am deeply grateful to my school supervisors Olga Popovic Larsen and Masashi Kajita for their invaluable guidance and support throughout my research journey. From start to finish you have been a solid reference point and I could not have asked for more competent and supportive mentors. I would like to especially thank Masa for his insightful comments which stimulated me to continuously improve both my research and myself as a researcher.

I would like to express my gratitude to Force4 architects and interns for welcoming me into their team like a family member and for providing an enriching and inspiring work environment. I am particularly grateful to Andreas Lauesen for always pushing me to think out of the box.

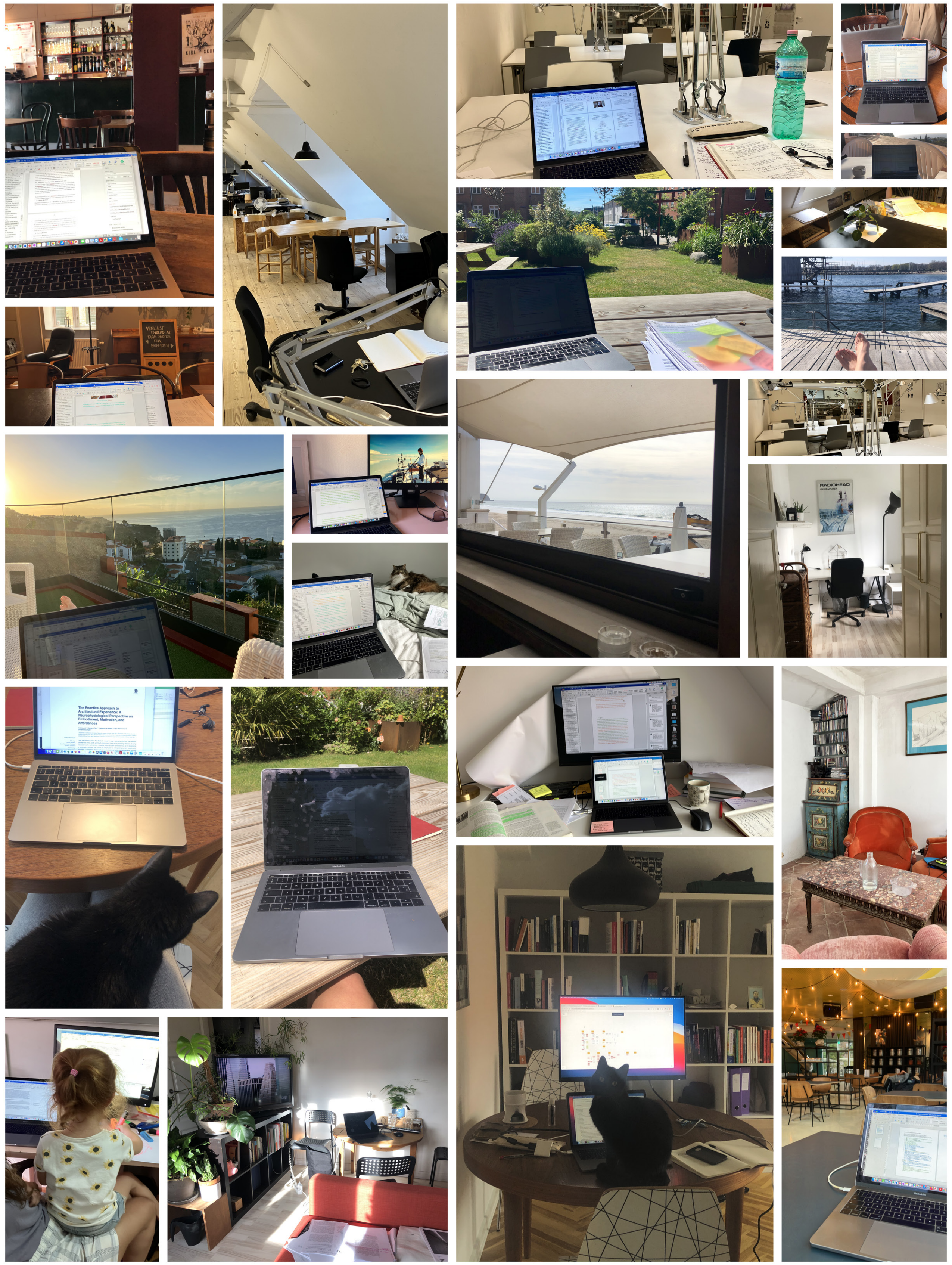
I would like to extend my sincere appreciation to Bevica and the research Hub for providing me with the opportunity to undertake this study and to participate in stimulating discussions on Universal Design. These conversations not only broadened my understanding of the topic, but also inspired me to think more critically about the ways in which inclusion should and could be achieved.

I am most grateful to Vandhalla and Musholm staff. Their hospitality has made it possible for me to access the facilities and resources necessary to conduct this research. I would especially like to thank all the persons I interviewed who took the time to share their personal experiences with me. Your participation has been crucial to this study.

I would like to sincerely thank my Ph.D. peers Ayoub, Octavio and Karen. We navigated together through the ups and downs of our academic journey, and I am deeply grateful for the friendships that have blossomed as a result of this shared experience.

I would also like to extend my heartfelt thanks to my fellow Ph.D. writers, Dave, Lizzie, and Reia. I feel extremely blessed to have met such committed and sensitive people, who made the hardful task of writing this thesis a truly enjoyable and unforgettable experience.

Completing a Ph.D. is no small feat, and I could not have done it without the serenity, the encouragement and belief offered by my family. I am increasingly aware of the great fortune of always having you by my side, no matter what. Your love have sustained me through the events of life, and I am grateful for all that you have done to shape me into the person I am today. You have instilled in me the importance of perseverance, but above all resilience in the face of defeats, disappointments, and setbacks. Finally, I want to express my gratitude to all my friends. I value and appreciate each and every one of you.



Over the last year, I have invested time and energy to synthesize my findings into a clear and coherent narrative. There were times when this task seemed overwhelming. In those moments, I found that changing my working environment helped me to regain perspective and focus. Whether it was the intimacy of my room, a busy coffee shop or an inspiring view of nature, each place offered me different levels of support and motivation, becoming an active participant in shaping my experience of writing this thesis.

ABSTRACT

The built environment can greatly influence human activities, thus becoming an important factor in users' everyday experiences, including those within sports and leisure buildings. For users with impairments in structure or body function, performing activities in the built environment can be a challenge as architectural design often does not take into account individual differences in perception and interaction with space. This leads these users to experience situations of disability and thus exclusion.

The Danish goal of greater inclusion of people in sports and leisure activities necessitates research to better qualify the role of architectural design on impaired users' spatial experience. By investigating the role of the built environment and its influence on the cognitive, physical and social activities of users with mobility, visual and hearing impairments, this study aims to develop knowledge on how architectural design can enable them to better perform, and thus participate, in sports and leisure activities.

While current research concerning the influence of the built environment mostly focuses on identifying and addressing the environmental aspects which hinder user performance, this study takes a different approach by investigating how the built environment can play an enabling role in supporting and stimulating users activities. This study employs a phenomenological approach to explore the experiential dynamics between users and the physical space and utilizes the theory of affordances to delve deeper into how the designed characteristics of the built environment enable users with mobility, visual, and hearing impairments to perform cognitively, physically and socially.

Drawing upon three existing analytical models which address and examine the dynamics between individuals and the built environment – the Person-Environment-Occupation, the Enabler and the Users-Environments – this study develops a new analytical model which focuses on the enabling mechanisms occurring in the person-environment dynamics. Throughout case study research, the developed model has been employed to investigate person-environment relation contextually in two selected sports and leisure buildings - Vandhalla, a sports centre in Odder, and Musholm, a multifunctional sports hall in Kørsor - which represent the state of the art in the application of Universal Design in the Danish context. The investigation of the enabling mechanisms was conducted with a dual perspective. The first identifies the enabling mechanisms offered by architects during design, the second identifies the enabling influence of the dimensional, organisational, visual, tactile and acoustic characteristics of the environment as experienced by users.

The analysis of the collected data from both architects and users' perspectives indicates that the design of the environment's materiality, dimension, organisation, lighting and acoustics can offer mobility and sensory impaired users better opportunities to orient and interact in physical and social contexts. As such, this study offers performance-based design strategies that can support architects in designing more usable and inclusive sports and leisure buildings - thus reaching toward both the Danish aim for greater inclusion, and Universal Design's objective to better include human differences in the design process.

DANSK RESUMÈ

Det byggede miljø har en stor indvirkning på menneskers aktivitet og er derfor en vigtig faktor i daglige oplevelser af blandt andet idrætsanlæg og fritidsfaciliteter. For brugere med funktionsnedsættelse kan det være en udfordring at udføre aktiviteter i det byggede miljø, da den arkitektoniske udformning ofte ikke tager hensyn til individuelle forskelle i opfattelsen af og interaktionen med arkitekturen. Dette fører til, at disse brugere oplever at blive ekskluderet på baggrund af deres funktionsnedsættelse.

Det danske mål om bredere inklusion af brugere i sports- og fritidsaktiviteter kræver forskning af disse interaktioner for bedre at kunne kvalificere den rolle, som arkitekturen spiller for funktionsnedsatte brugeres arkitektoniske oplevelser. Ved at undersøge det byggede miljøs rolle og indflydelse på de kognitive, fysiske og sociale aktiviteter hos brugere med bevægelses-, syns- og hørehandicap, sigter denne afhandling mod at producere viden om, hvordan arkitektonisk design kan sikre deltagelse af funktionsnedsatte brugere i sports- og fritidsaktiviteter.

Mens meget af den nuværende forskning fokuserer på at identificere og forstå de bygningsmæssige aspekter der hindrer brugernes anvendelse, forsøger dette studie at undersøge de faktorer i det byggede miljø, der understøtter og stimulere brugernes aktivitet. Studiet benytter en fænomenologisk tilgang til undersøgelse af oplevelsesmæssige dynamikker mellem brugerne og rummet. Med affordance som teoretisk ramme for undersøgelserne af arkitekturens potentiale til at muliggøre kognitive, fysiske og sociale aktiviteter for brugere med bevægelses-, syns- og hørehandicaps.

Med udgangspunkt i tre eksisterende analysemodeller, (Person-Environment-Occupation, The Enabler og The User-Environment), er en ny analysemodel udviklet som fokuserer på de muliggørende mekanismer der opstår i dynamikkerne mellem miljøet og brugeren. Gennem casestudier er analysemodellen anvendt i undersøgelser af kontekstuelle bruger-miljø relationer i to udvalgte sports- og fritidsanlæg - Vandhalla, et sportscenter i Odder, og Musholm, en multifunktionel sportshal i Korsør - som repræsenterer det nyeste inden for anvendelsen af universelt design i en dansk kontekst. Undersøgelsen af bygningernes muliggørende mekanismer blev gennemført med et dobbelt perspektiv. Det første identificerer de mekanismer, som arkitekter tilbyder under udformning af byggeri, mens det andet identificerer de muliggørende aspekter i arkitekturens rumlige, organisatoriske, visuelle, taktile og akustiske egenskaber, som brugerne oplever dem.

Analysen af de indsamlede data fra brugere og arkitekter indikerer, at udformningen af arkitekturens materialitet, dimensioner, organisering, belysning og akustik kan give bevægelses- og sansehæmmede brugere bedre muligheder for at orientere sig og interagere i fysiske og sociale sammenhænge. På denne baggrund opridses performative designstrategier, der kan støtte arkitekter i design af mere anvendelige og inkluderende sports- og fritidsbyggeri - og dermed nå både det danske mål om større inklusion samt målet om bredereinddragelse af menneskelige diversitet i designprocesser udtryk i Universal Design.

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1 INTRODUCTION

The built environment is an important factor in everyday life, as it can greatly influence human activities and people's experiences in spaces (Rasmussen, 1964). The characteristics of the built environment can either restrict or enable individual's activities (Lid, 2020) thus shaping their overall spatial experience. The purpose of the design of the built environment is to support human activities and to provide meaningful spaces for people to experience (Buttimer & Seamon, 1980) (Winters, 1999).

The built environment is experienced differently by each individual (Merleau-Ponty, 2013). Spatial experience is strongly linked to the perception of the built environment and the ways in which this occurs (Robinson, 2015). The encounter with the built environment is a bodily experience perceived differently by each individual according to their intellectual, physical, cultural and social characteristics (Lid, 2020). The purpose of Universal Design is to ensure that the built environment can support the activities and the experiences of all people, regardless of differences in their individual characteristics (Preiser & Smith, 2001).

The design of the built environment is often directly responsible in determining conditions of disability and in limiting participation of people with impairments (Lid, 2020). People with physical and sensory impairments are less likely to be active in different areas of society (Kissow & Singhammer, 2012), among which are sports and leisure activities (Damgaard, et al., 2013). This is due to the design of spaces which do not reasonably take into account possible bodily impairments, (Amilon, et al., 2020) leading to impaired users experiencing conditions of disability, and hence exclusion.

Universal Design approach define the condition of disability as an experienced gap or mismatch between an individual's abilities and the characteristics of their environment (Lid, 2013). Usability, on the other hand, is considered to be the alignment or compatibility between the individual and the environment (Steinfeld & Danford, 1999). The goal of Universal Design is to examine, comprehend and enhance the interactions between human and environment, so to understand how the person-environment gap can be reduced and thus how to create spaces that can be utilized and enjoyed by a broader range of people.

Research problem

To promote the inclusion and participation in sports and leisure activities of people with physical and sensory impairments, it is therefore important to draw attention to the design of the built environment and its influence on experiences of impaired users. However, the existing research mostly focuses on the identification and elimination of the possible disabling factors of the environment. The current understanding of human diversity, as well as the ambitions of Universal Design approach suggest the need to investigate the relationship between person and environment throughout other perspectives. The purpose of this research project is to explore how the design of the built environment, specifically in sport and leisure buildings, can empower the inclusion and activities of people with physical and sensory impairments.

Research hypothesis

The main hypothesis that moved this research posits that investigation of the person-environment relation of impaired users spatial experiences can be approached by exploring the potential of the built environment to compensate, support and enhance the abilities of the individual. This approach would thus develop knowledge on how the built environment can be designed so to serve as a source and driver of inclusion.

To examine this hypothesis, the study focuses on the performative character of the person-environment relation, which refers to the way in which the design of the built environment can facilitate and support the behavior and activities of those who experience it. By investigating the specific experiences of sports and leisure buildings for people with mobility, visual, and hearing impairments, the research aims to gain a deeper understanding of how the built environment can enable and support their inclusion and participation. This knowledge can then inform opportunities and ways in which the environment can be designed to align with the intentions for greater usability, and hence inclusion of people with impairments in sports and leisure activities.

1.1 Motivations for this research

In 2009, Denmark ratified the United Nations Convention on the Rights of Persons with Disabilities (CRPD), which intends to protect the rights and dignity of persons with disabilities and promotes their inclusion in any aspect of society (Withagen, et al., 2012). In the Convention, article 30 ensures the disabled person's right to be engaged in recreational, leisure and sports activities on an equal basis with others (UN General Assembly, 2007). By ratifying the CRPD, Denmark has committed itself to ensuring that the principle of equal opportunities is considered and applied. For this reason, the Danish Parliament, in 2010, appointed the Danish Institute for Human Rights to promote and monitor the implementation of the CRPD in different sectors through policies, programs, and plans.

In 2013, Denmark presented the Danish Disability Policy Action Plan "One Society for All" (The Danish Government, 2013), which complements the CRPD vision and sets a framework for enabling people with disabilities to participate fully in Danish society. The vision aims to ensure that everyone has equal opportunities through greater inclusion in all areas of society. The main goals are to increase respect for differences, and to recognise the importance of inclusion. Denmark is committed to supporting the individual's independence and active participation as a citizen. To this end, the proposed commitment is aimed at developing knowledge, initiatives, and improvements to ensure greater inclusion in all aspects of life, such as civil society and cultural life, education, employment, and accessibility, which also includes the accessibility of the built environment, which is considered one of the determining aspect of participation and thus an essential condition for greater inclusion.

In 2014, the Danish Parliament launched the Political Agreement on Sport. This agreement reinforced the importance of a special effort towards all citizens who do not participate in sports activities, as well as disabled or vulnerable groups. With the goal of reaching 75 per cent of the population participating in sporting activities, in 2016 the Danish Sports Policy established six focus areas: 1) sports for all, 2) sports as a resource for welfare efforts, 3) the integrity of sports, 4) sport in relation to learning, well-being, and education in and outside school, 5) nature and urban spaces as an arena for exercise and sports, and 6) branding, marketing, and international inspiration (Kultur Ministeriet, 2016). Through these focus areas, the main aim is to provide opportunities for everyone to participate, and hence foster greater inclusion in sports and leisure activities.

In different sectors, Denmark is making efforts for fulfilling the Sustainable Development Goals settled by the United Nations for 2030 (The Danish Government, 2021). The 17 goals steer the respect for, and the guarantee of, human rights with the intention of reducing any inequality or other conditions that could leave people and countries behind in individual and societal progress. One recommendation from the United Nation Committee is to incorporate the value of equity into strategic frameworks, decision making, and direct approaches in every disciplinary and interdisciplinary sector. Today, Danish commitment for the inclusion of people with impairments in sport and leisure activities is reinforced by the Leaving No One Behind agenda, settled by United Nation Member States for Sustainable Development (United Nations Sustainable Development Group, 2022).

Sport and leisure activities are vehicles for inclusion, aggregation and participation with a fundamental social role, fostering both the development of individual capacities and emancipation in society. The benefits of participation in such activities may have a positive impact on individual physical fitness (Carroll, et al., 2014) (Smith, et al., 2019), wellbeing (Hicks, et al., 2003) (Martin, 2013), and social relations (Kissow & Singhammer, 2012) (Stan, 2012) (Klenk, et al., 2019). In Denmark, as in the rest of Europe, participation in sport and leisure activities is growing steadily. However, the opportunity to participate in sports and leisure activities depends to a large extent on the built environment in which these activities take place.

Denmark's target is to achieve 75% of the Danish population participating in sport activities by 2025 (Fridberg, 2010). This challenge goes together with the necessity of coping with the growing proportion of elderly citizens, which in turn will determine a proportional increase in people experiencing physical and sensory impairments. The Danish commitment to engaging and including as many people as possible in sport and leisure activities, as well the ageing trends, move the need to develop knowledge on how the design of sports and leisure buildings can better influence the activities and experiences of bodily impaired users.

1.2 Aim

Taking up the challenge for a further inclusion, this research focuses its attention on architects' approaches to designing for human differences, with the intention of affirming their contribution to create usable environments for those whose physical and sensory abilities are temporarily or permanently impaired.

Research aim

The main goal of this Ph.D. thesis is to investigate how the designed characteristics of the built environment can improve the experiences of people with impairments in sports and leisure activities. The study aims to analyze the spatial experiences of users with mobility, visual and hearing impairments in order to understand the dynamics between the person and the environment and to identify how design can better enable users' activities. Additionally, the research aims to contribute to the integration of this knowledge into design practice, with the goal of improving the discourse of design for inclusion and aligning architectural practice with the need to provide built environments that are usable by a broader range of users. The objective of this study is hence twofold:

Research objectives

1) to develop knowledge on the enabling role of the built environment in improving the spatial experience of users with mobility, visual and hearing impairments;

2) to frame this knowledge to provide architects with strategies for the design of more usable and inclusive sports and leisure buildings.

The first aim concerns the identification of the enabling mechanisms of the person-environment interaction by observing, describing, and understanding the intrinsic dynamics occurring during spatial experiences. This exploratory investigation of users' spatial experiences is aimed at analysing architectural features in relation to users' individual experiences, and to provide information on how materiality, dimensions, organisation, lighting and acoustics have a relevant influence on impaired users' performances. By addressing the complexity of individuals' spatial experiences, this study questions the current approach to accessible design and space requirements to explore how architects can be informed on the influences of the built environment differently. Consequently, the second aim concerns the synthesis of the knowledge gathered to support architects in addressing the inclusion of people with mobility, visual, and hearing impairments through a more conscious use of the experiential qualities of the built environment.

1.3 Methodology

The research presented in this thesis aims to develop knowledge on the enabling role of the environment by observing and analysing the relationship and interaction between users with bodily impairments and the built environment of sports and leisure buildings. This study therefore focuses on the concept of the person-environment relation and uses phenomenological understanding to investigate spatial experience according to its most influential dimensions:

- the person (user)
- the environment
- the activity

The concept of affordances, defined as the opportunities of actions offered by the environment to an individual with certain skills (Gibson, 1977), focused this study on the performative character of the person-environment relation and oriented the investigation toward the enabling mechanisms offered by the built environment.

Building on existing models for analysing disabling mechanisms in person-environment relationships, this study developed a new analytical model (Fig. 1.3-1) with the aim of focusing on the enabling role of the built environment. The developed model orients data collection on the main dimensions of spatial experience: the person, the environment and the activity. In order to delimit and better frame the three dimensions, these have been further defined by a set of characteristics:

- Characteristics of the user
  - mobility impairments
  - visual impairments
  - hearing impairments
- Characteristics of the built environment
  - materiality
  - dimensions
  - organization
  - lighting
  - acoustics
- Characteristics of the activity
  - cognitive
  - physical
  - social

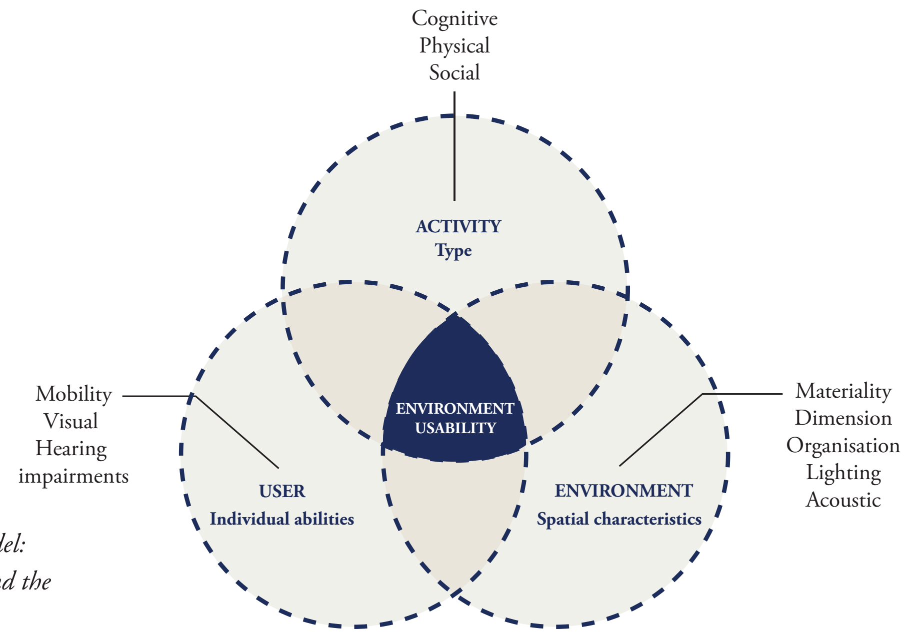


Figure. 1.3-1 Analytical model: the user, the environment, and the activity

Defined the opportunities of actions offered by the environment to an individual with certain skills (Gibson 1977), the concept of affordances have been implemented in the analytical model and employed to operationalize the investigation for identifying the enabling mechanisms that shape the usability of the built environment (Fig. 1.3-2).

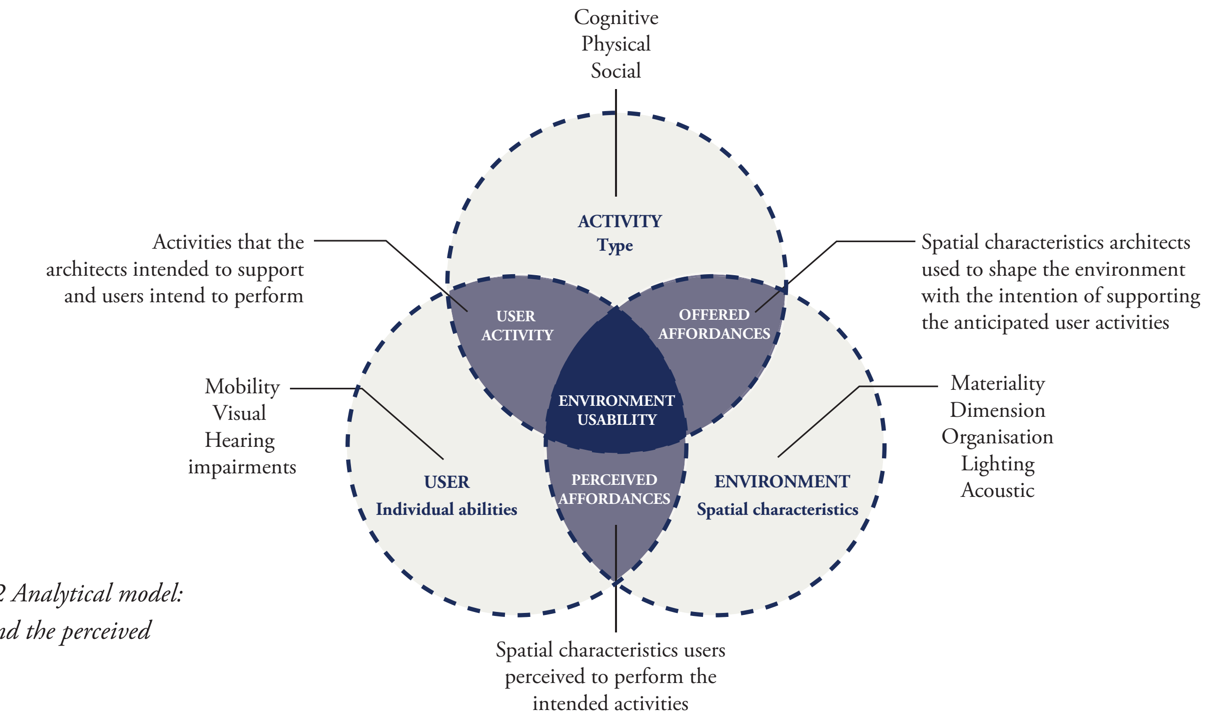


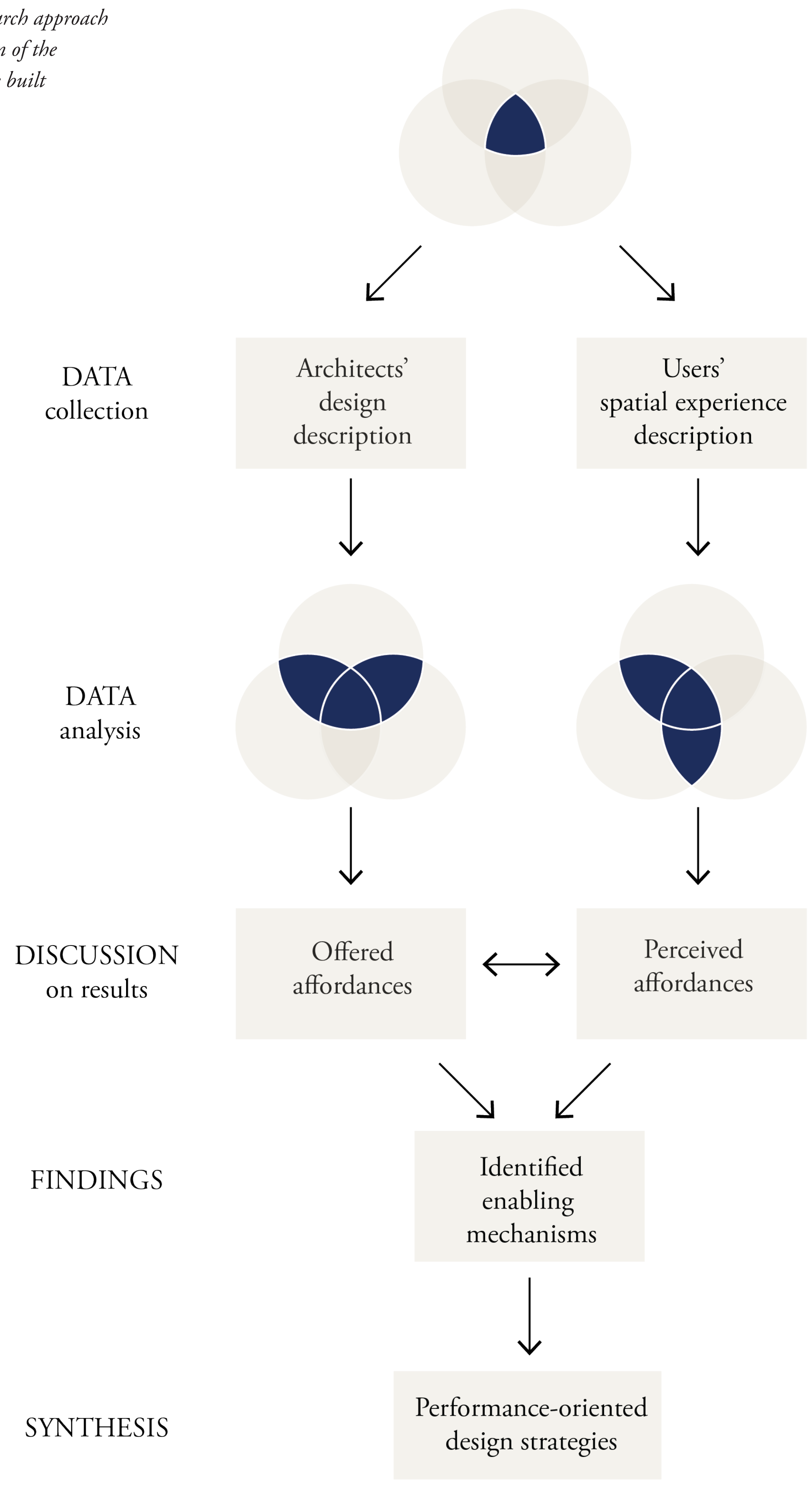
Figure. 1.3-2 Analytical model: the offered and the perceived affordances

This analytical model has been employed for the investigation of contextual spatial experiences through case study approach. Case study allowed to collect data on real circumstances and to analyse them qualitatively with reference to the person, the environment, and their contextual interaction during the performed activity. The exploration of person-environment-activity was conducted in two exemplary sports and leisure buildings:Vandhalla – a sports center in Odder, and Musholm - a multi-purpose sports hall in Kørsor. In this study, Vandhalla and Mushom represent the state of the art in the application of Universal Design in the Danish context and hence have been used to establish how the designed characteristics of the built environment contribute to improving the usability of the space.

First, these buildings were analysed in relation to the architects' intentions to support users' activities (offered affordances). The review of the building documentation combined with the interviews with the architects of the respective projects informed the understanding of how they engaged in design materiality, dimensions, organization, lighting, and acoustics for anticipating and supporting impaired users' activities. Subsequently, in the same buildings, the characteristics of the built environment have been investigated in relation to how they have been experienced by users during their activities (perceived affordances). In this case, the direct engagement of users in walkthroughs informed the understanding of how users perceived and relate with the designed features of the built environment for performing their intended activities.

The data on the design of the architects and the experiences of the users for the two selected cases was gathered using a mixed-method approach. These comprise documentation review, observations, semi-structured interviews with both the architects and the users and walkthroughs with the users. The data collected from architects and users, was processed using the developed analytical model. Data was first coded according to the three spheres of the model (user, environment, and activity), and then analysed to identify key enabling mechanisms in the investigated person-environment dynamics. Finally the identified mechanisms have been generalised and interpreted so to develop narratives on the enabling role of the environmental characteristics. By framing the investigated enabling mechanisms around the three categories of cognitive, physical and social performance, the developed knowledge has been finally synthesised in performance-oriented design strategies which can support architects in the design of more accessible, usable and inclusive sports and leisure buildings. The following diagram (Fig 1.3-2) displays the research approach of this study.

Figure. 1.3-3 Research approach for the investigation of the enabling role of the built environment



1.4 Thesis structure

This thesis, including this introduction, comprises nine chapters.

Chapter 2: Research context – the design response to disability

This chapter introduces the context and the focus of this research.

Disability is here presented as a condition determined by the incongruence between the characteristics of the individual and those of the environment. The aim of this chapter is to present how the design of the built environment responded to disability, and the approaches for improving the inclusion of people with impairments through architectural design. This chapter also introduces the concept of usability and describes how this concept is understood and employed in the Universal Design approach. This chapter concludes with the definition of the focus of this research, namely the person-environment relation, upon which to build knowledge for a better integration of Universal Design approach in architectural practice.

Chapter 3: Theoretical framework of the person-environment relation

This chapter presents the theory in support to the understanding and investigation of the role of the environment in influencing the spatial experience of people with physical and sensory impairments.

Phenomenology offered this study the theoretical base from which to address spatial experience and the variables involved. This chapter presents the phenomenological understanding of the individual's encounter with architecture, which steers this study to focusing on the perceptual characteristics of the built environment, and the physical and sensory impairments of individuals. This chapter also introduces the theory of affordances, employed as the link to tie the environment and the person together as a performative interacting, dynamic, and contextual system.

Chapter 4: Existing investigations of the person-environment relation

This chapter offers a review of the existing analytical models employed for the investigation of the person-environment relation.

To address the investigation of the role of the environment in the person-environment relation, this study conducted a review of the analytical models which aim at understanding and improving the performance of users with impairments in the built environment. This chapter presents the PEO (Person Environment Occupation), the Enabler, and the Users-Built Environments models to examine their considered variables and the investigated interdependencies. Following the discussion of the respective contributions to the knowledge of the influencing role of the environment on user performance, this chapter concludes by identifying the knowledge gap that this study seeks to address: the enabling role of the environment.

Chapter 5: Methods for the investigation of the enabling role of the environment

This chapter outlines the methodology and the new analytical model used for this study.

Drawing upon the phenomenological understanding of the person-environment relation, this study investigated impaired users' spatial experiences throughout case study research. To observe, describe, explain and evaluate contextual phenomena in which the environment enables user performance, the investigation was conducted in two selected sports and leisure buildings designed with the aim to support and stimulate the activities of users with physical and sensory impairments. Vandhalla and Musholm are hence presented to motivate their selection as case studies. This chapter concludes by presenting the new analytical model, developed within this study, and employed for the systematic collection and analysis of data related to the enabling role of the environment in users' spatial experiences.

Chapter 6: Case study results

This chapter presents the empirical study, which adopts a qualitative investigative approach to identify the enabling mechanisms designed by architects, and those experienced by users.

Through the use of the two selected case studies, the dynamics between the environment and the person are investigated here from two perspectives, that of the architects and that of the users. Initially, through a review of the design material and interviews with the architects, the solutions they developed with the intention of enabling the cognitive, physical, and social performance of the users are identified. Subsequently, through the involvement of users with physical and sensory impairments in interviews and walkthroughs in the buildings, the dynamics of the users' contextual and individual experiences are investigated. Like the first, this second investigation aims to identify the enabling processes offered by the environment, but this time by directly observing the dynamics occurring between the user and the environment. This chapter presents these two investigations by framing the identified affordances according to the identified patterns in enabling cognitive, physical, or social users' performances.

Chapter 7: Discussion

This chapter discusses the findings that led to the development of the design strategies built upon the enabling role of the built environment.

This chapter takes up the analysis of the case studies and discusses the significance of the findings in regard to the hypotheses advanced for this research. The chapter hence deepens the analysis by discussing the knowledge on the enabling role of the environment, and how this knowledge can be framed for its integration into architectural practice. The analysis and comparison of the identified affordances, as they have been designed and as they have been experienced, informed this study on the potential enabling role of the environment. The identified contribution of the environment to the cognitive, physical, and social performances of users opened up the thematic analysis of the enabling potentials of the built environment which have been synthesised in the performance-oriented design strategies presented in Chapter 8.

Chapter 8: Performance-oriented design strategies for inclusive sports and leisure buildings

This chapter synthesizes and generalizes the knowledge gained from the empirical investigation and proposes design strategies geared towards enabling user performance.

The results provided important insights into how users perceive and use certain characteristics as environmental elements that support their cognitive, physical, and social activities within the space. Based upon the conducted investigation on users' spatial experiences, this chapter concludes this study by presenting the design implications architects can consider for designing sports and leisure buildings which can better respond to users with limited physical and sensory abilities.

Chapter 9: Conclusion

This chapter presents a concluding summary, including limitations, contributions to knowledge, and perspectives for future research.

2 RESEARCH CONTEXT - THE DESIGN RESPONSE TO DISABILITY

This chapter presents the context and the focus of this research. The context in which this study is developed is that of disability and the role that the environment plays in determining this condition. As society has come to understand that disability encompasses more than just individual's functional limitations, various approaches to design have emerged and evolved. These approaches shift the focus from simply addressing physical accessibility, to considering the broader aspects of use, participation, and inclusion for all, regardless any impairment. Within these approaches, Universal Design represents the possibility for architectural practice to align the design with the current societal needs. Denmark's commitment to CRPD and *Leaving No One Behind* agenda requires a review of how the values of social inclusion can be better incorporated into Danish architectural practice. However, in order to effectively implement the principles of Universal Design in architectural practice, it is crucial to gain a deeper understanding of how people with different abilities perceive and interact with the built environment. Specifically, this requires to deepen the knowledge about the unique needs and experiences of people with different abilities, in order to design spaces that are more accessible and usable. To develop this knowledge, this study focuses on the concept of the person-environment relation, where usability can be observed and where the dynamics influencing usability can be described and investigated.

This chapter is organised into five sections:

Section 2.1 – Understanding disability and the role of the built environment – introduces the concept of disability and presents the evolution of the definitions and models provided by the World Health Organization commission: a) the *International Classification of Impairments Disabilities and Handicaps* (ICIDH), b) the *Disability Creation Process* (DCP) and c) the *International Classification of Functioning* (ICF). In so doing, this section focuses on how the environment has been understood and included in the disability framework as a relevant influencing factor to the condition of disability.

Section 2.2 – The response from the design field: accessibility, Universal Design and usability – introduces the concept of accessibility and its evolution through more comprehensive approaches such as Universal Design. This section also introduces the concept of usability and how this can contribute to orienting the design practice toward Universal Design approach.

Section 2.3 –Toward the integration of Universal Design approach into architectural practice - outlines how Universal Design is addressed within the framework of Danish architectural practice and presents the shortcomings of the existing tools which support architects for the design of accessible, usable, and inclusive environments

Section 2.4 – The usability of the built environment- explores the importance of the concept of usability in the integration of UD values in design practice. This section therefore delves the utilization of usability in evaluating the user experience within physical spaces and presents the various criteria employed in UD research to evaluate usability. This section concludes by presenting the identified three main aspects which the employed usability criteria cover: 1) cognitive aspect, 2) physical aspect and 3) social aspect.

Section 2.5 – Research focus: the person-environment relation in spatial experience – identifies the concept of the person-environment relation as the main focus of this research to understand how the design of the built environment can improve the spatial experiences of impaired people.

2.1 Understanding disability and the role of the built environment

Until 50 years ago, disability was considered an exclusive characteristic of the person. According to this interpretation, the presence of a physical or cognitive morbidity, such as a disease, pathology or chronic condition, was considered the only reason for the discrimination of people with disabilities in various areas of life (Boorse, 1975) (Boorse, 1977) (Eisenberg, et al., 1982). In the mid-1970s, in critique to this limited focus on medical aspects, disability activists and scholars proposed a different approach in which the concept of disability was separated from that of disease (Brisenden, 1986). Originating from the document *Fundamental Principles of Disability* (UPIAS, 1976), the so-called 'social approach' shifts the cause of disability from the impairment of the person to the disabling barriers present in society (Oliver, 1990). In this new approach, disability is no longer a problem associated with the person but with society, which is unable to adapt to people's limited abilities (Thompson, 2016). In the late 1970s, the evolution of the understanding of disability saw the combination of these two approaches in the 'biopsychosocial model' (Engel, 1977). This model does not deny the person's impairment as a determinant of disability, but still considers external factors such as society, infrastructure and the environment as concomitant factors (Barnes, 2011). This more recent understanding has evolved the concept of disability into a more complex and multifaceted one. To address the issue of disability, the World Health Organization (WHO) has followed this evolution over time by providing frameworks and definitions as a starting point for researchers and practitioners in different fields to better understand, and work on, the personal and external factors of disability.

The main documents developed by the WHO are *The International Classification of Impairments Disabilities and Handicaps* (ICIDH) and *The International Classification of Functioning* (ICF). While the former represents the earlier medical interpretation, the latter represents the biopsychosocial one. The aim of ICIDH was to provide definitions of the terms *disease*, *impairment, disability,* and *handicap* (WHO, 1980).

As shown in Fig. 2.1-1, ICIDH frames the terms *impairment, disability* and *handicap* as a sequence of interrelated conditions which initially derive from a pathological phenomenon like a *disease* or a disorder (Bickenbach, et al., 1999). The individual disease which affects the body structure manifests itself as an *impairment,* or rather, an observable limitation in the functioning of the body. The impairment results in a restriction of the ability (*disability*) to perform an

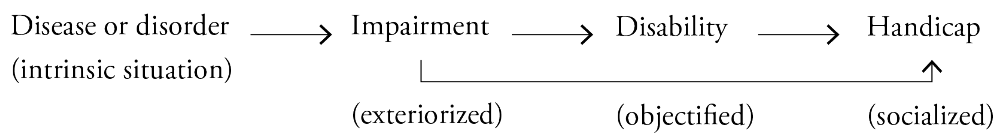


Figure 2.1-1 The World Health Organization's model of Impairments, Disabilities and Handicaps (WHO, 1980), edited by the author

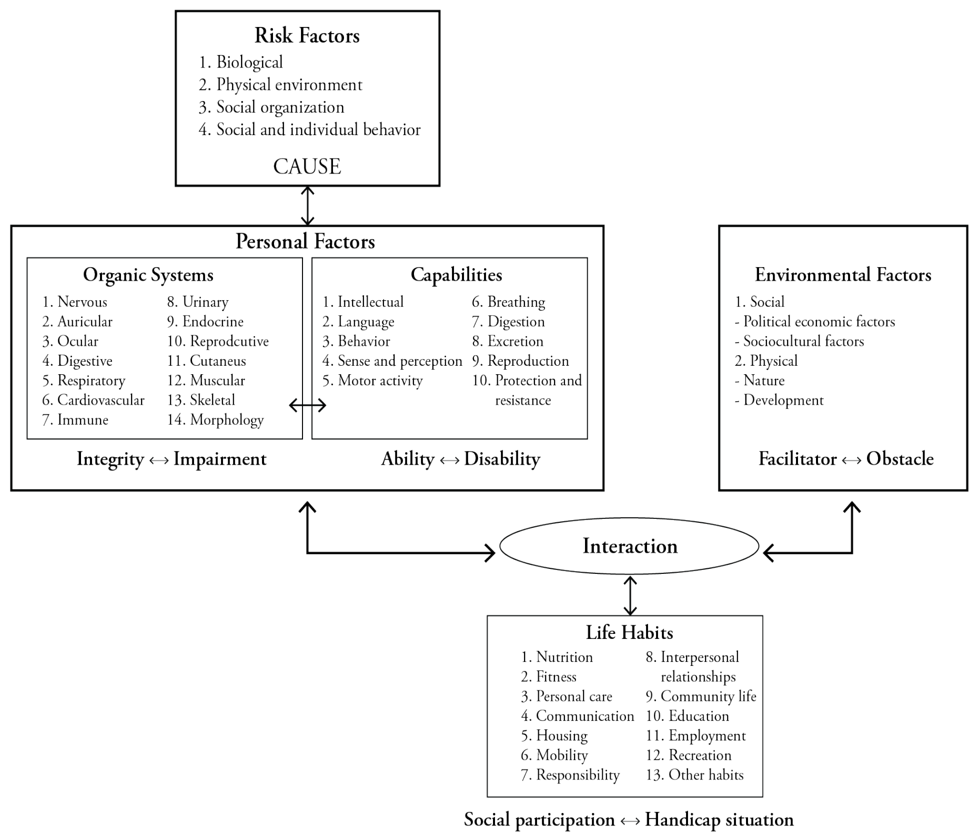


Figure 2.1-2 Disability Creation Process (DCP) model (Levasseur, et al., 2007), edited by the author

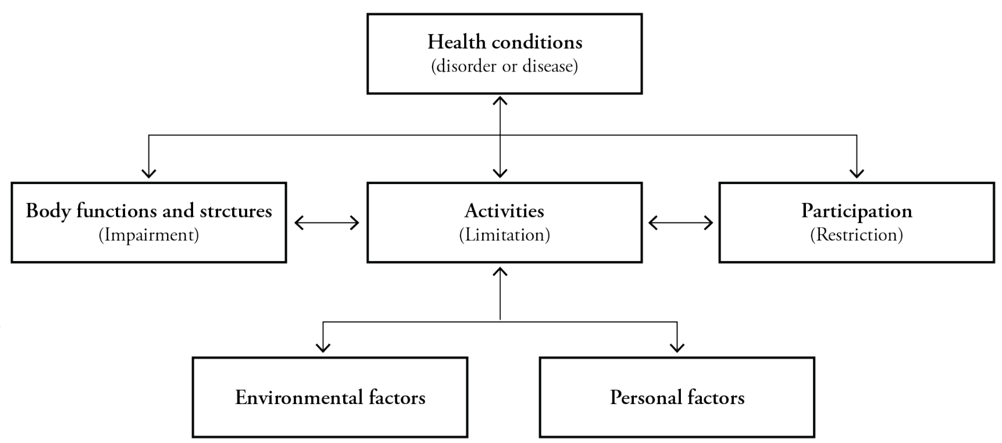


Figure 2.1-3 The World Health Organization's model of functioning and disability (Mitra & Shakespeare, 2019), edited by the author

activity, which in turn causes the disadvantage (*handicap*) that prevents the person from living and participating to the same extent as other persons.

In 1998, the first revision of the ICIDH by the Quebec Research Group led to the presentation of the *Disability Creation Process* (DCP) (Fougeyrollas, et al., 1998), which expands the definition beyond merely health factors and frames disability as a limitation in participation determined by the relationship between the person and the environment (Albrecht, et al., 2001).

The Disability Creation Process model (DCP) (Fig. 2.1-2) defines disability as a reduction in social participation (life habits), and frames this as the interactive result of personal factors (organic systems and capabilities) and environmental factors (physical and social). This model introduces the environmental component and considers social participation as the main indicator of the dynamic process of human functioning in relation to the environment. In addition, the DCP represents the complex relation between the person and the environment as a two-way interaction in which any change to one of these components may affect the other (Levasseur, et al., 2007). Finally, DCP, by departing from the medical model and introducing positive terminology for its components and reciprocal interactions, offers a more comprehensive vision that applies not only to those with impairments but to all human beings.

On the basis of the work developed by the Quebec collaborating center, WHO revised the ICIDH by recognising the social and environmental components as essential factors to integrate into the outdated medical framework. This led WHO to develop the *International Classification of Functioning* (ICF) (WHO, 2001). The ICF proposes a framework based on three dimensions – body function & structure, activity, and participation (Fig. 2.1-3). In this model, these dimensions are mutually interrelated and influenced by the health conditions of the individual, and by the factors which belong both to the individual (e.g., gender, age, lifestyle, etc.) and the environment (e.g., attitudes of the society, architectural characteristics, legal system, etc.). Evolving from the DCP, ICF expresses disability as an umbrella term which includes any or all aspects of body impairments, activity limitations and participation restrictions (Mitra & Shakespeare, 2019), which are determined and influenced by the mutual interrelations of personal and environmental factors. When the characteristics of the environment do not correspond to the intentions and capabilities of the individual, the person experiences limited participation, thus a condition of disability. Conversely, when the environment encounters the capabilities and limitations of the person, their activities are supported.

By considering environmental factors, the ICF extends the use of classification from the medical field to a wider range of professionals and researchers. These include professionals responsible for designing the physical environments in which individuals live and participate. Based on this framework, it is important that architects also consider and address disability no longer as an aspect that belongs exclusively to the person, but as a condition located in the interdependence between the person and the built environment - the person experiences an inability or difficulty to perform due to a person-environment incompatibility.

2.2 The response from the design field: accessibility, Universal Design and usability

The built environment has a critical influence in determining individuals' possibilities and the degree to which they might live independently and be part of society (Steinfeld & Danford, 1999). The problem of incompatibility between the person and the built environment began to be particularly evident in the post-war period (Evcil, 2012). During this period, many wounded soldiers returned home with physical impairments. Although medicine and new technologies started to allow them to regain a social life, the built environment was not accessible and precluded these people from participation. The visible discrepancy between people's needs and the built environment thus began to be a problem for the individuals, for society and for designers (Williamson, 2019).

Since the 1960s, when people with disabilities started to organise and fight for their rights to equal opportunities, disability issues and design for ***accessibility*** started to go hand in hand with an evolution of standards and code of practice, such as the *American National Standard* in the USA and the *Access for the Disabled to Buildings* in the UK, aimed at guaranteeing people with disabilities the rights of accessibility, independence and participation (Evcil, 2012) (Council for Codes of Practice, 1967). In the USA in the 1970s, independence and human rights demonstrations - and subsequent pressure on the US Congress – led to the approval of the Rehabilitation Act in 1973 and the American Disability Act, in 1990 (Sherr & Babovich, 1997). The victory and obtaining of federal laws by the disability rights movement strengthened and forced the design sector to take measures in this regard. The issue of accessibility thus began to evolve in this direction, through statuatory requirements for the removal of the physical barriers, and the provision of resources to help disabled people to participate (Mackelprang & Clute, 2009)(Evcil, 2012).

In architecture, the issue of accessibility has, historically, mostly referred to regulatory dimensional design requirements and focused on accommodating people with physical impairments in the physical environment (Salmen, 2001). This has led to the production of special design solutions which, by fulfilling the mandatory requirements, often turned out to be unattractively designed add-ons, and, despite the good intentions, also led to the stigmatisation and thus still the exclusion of people with disabilities (Preiser & Smith, 2001) (Frandsen , et al., 2012) (Ryhl, 2013) (Winance, 2014) (Kajita, 2016). This, in turn, corresponded to an approach to the issue of accessibility that divides the population into two different types: the normal population and the population that deviates from normal (Iwarsson & Ståhl, 2003).

The latter half of the 20th century and the beginning of the 21st century saw significant social and demographic changes which led to a further evolution of the concept of accessibility as the need to provide spaces that were not merely accessible, but also usable and inclusive, for an increasingly broad and diverse spectrum of users (Hamraie, 2017). The shift from the physical requirements of the built environment to individual experience and rights has been visible in different countries from the emergence of more inclusive and comprehensives design approaches. The intensifying fight for individual rights and the continuous flourishing of disability studies led to the development of design approaches, such as *Universal Design* (Mace, 1985) *Design for All* (Bendixen & Benktzon, 2015) and *Inclusive Design* (Clarkson & Coleman, 2015), which aim to address the need to ensure that all people, regardless of any physical, sensory and cognitive impairments, can access and use buildings, and so participate to the same extent as people without impairments.

Introduced in America in the 1980s by architect Ronald Mace and slowly embraced in the Scandinavian context, ***Universal Design*** (UD) stemmed with the objective to drive design practice through and towards the value of inclusion. UD emerged as a new approach to the design of products, environments and services that aims to achieve an inclusive society. Defined as the "design of products and the environments usable by all without the need for special accomodations" (Mace, 1985), UD sets the intention to consider all users comprehensively, without focusing on people with disabilities, thus avoiding *ad-hoc* solutions and stigmatisation (Aslaksen, et al., 1997).

The Seven Principles of Universal Design developed in 1997 - equitable use, flexibility in use, simple and intuitive use, perceptible information, tolerance for error, low physical effort and size and space for approach – also imply a shift of the design for accessibility towards a user-centered approach with the intention of accommodating *use* beyond *access*. For this reason, the concept of ***usability*** became an object of interest in the studies of UD, like in other user-centered disciplines, to better unfold how design can enable user functioning, performance and participation. Commonly used to evaluate user interaction with products and computer interfaces, usability reflects the extent to which an object or system can be used easily by a person (Bevana, et al., 1991). In the environmental design field, the concept of usability is used to determine the extent to which the properties of the physical environment correspond to a broad spectrum of physical and social requirements (Iwarsson & Ståhl, 2003) (Alexander, 2008).

Like accessibility, usability relates to the observation of the performance of a task (Steinfeld & Danford, 1999) by a person in the environment. However, while accessibility describes the possibility of the person to gain access to somewhere or to something, usability further describes the extent to which the environment enables and empowers the person in relation to the activity (Iwarsson & Ståhl, 2003). Furthermore, while accessibility is concerned primarily with the physical and quantitative domain of the environment, usability involves the individual aspects that relate to the subjective perception of the responsiveness of the environment, and the uniqueness of the situation experienced (Steinfeld & Danford, 1999) (Iwarsson & Ståhl, 2003). In the UD perspective, usability is considered the optimal outcome of the design process in which physical and social needs are satisfied through the possibility of user performance in different contextual life situations (Steinfeld & Danford, 1999) (Iwarsson & Fänge, 1999) (Iwarsson & Ståhl, 2003) (Andersson, 2014).

The purpose for the implementation of the concept of usability within the UD framework is twofold. First, the concept captures the variety of uses and interactions between users and design solutions considering cognitive and sensory aspects in addition to physical ones. UD approach in fact aims at placing more attention and emphasis on sensory and social aspects which relate to improved usability and which are currently still lacking in the accessibility framework (Ryhl, 2009) (Ryhl, et al., 2016). Second, it broadens the view of the individual dimension of the user by also considering the subjective character of the user in its cultural and social contextuality.

2.3 Toward the integration of Universal Design approach into architectural practice

Denmark, like other Western European countries, is reporting a continuous increase in life expectancy (Brønnum-Hansen, 2005) and is consequently outlining measures to address the related increase of people with physical and sensory disabilities. Also, Denmark's commitment to the CRPD and the current well-promoted national vision of an inclusive society, one which considers the importance of individuals and their full participation, have led architectural policies and practices to continue raising the bar towards greater inclusion. In this perspective, Universal Design has been acknowledged as the design approach that can offer Denmark a means to ensure equal access and participation for an increasingly diverse population (Grangaard, et al., 2016). While in the neighboring Norwegian context, the concept of Universal Design has been translated as *Universell Utforming* and progressively included as a reference approach in Building Regulations (BR), in Denmark, this has not yet taken hold, neither in legislation nor in practice (Grangaard, et al., 2016). However, a shift toward Universal Design is discernible and slow progress in this direction is evident in both architectural policies and guidance tools for practitioners.

In 1994, the Danish Ministries of Culture, Housing and Environment released the first architectural policy. In this document, the goal of achieving high functional, technological, and environmental quality of buildings was associated with the important social goal of considering the needs of the weakest user groups, especially disabled people (Danish Ministries, 1994). In 2007 and 2014, subsequent policies expanded this goal. *A Nation of Architecture* (Regeringen, 2007) and *Putting the people first* (Regeringen, 2014) introduce accessibility, well-being and inclusion as increasingly important aspects to consider in order to target the social sustainability of the architectural offering. To achieve this, Danish municipalities have been encouraged to formulate their own architectural policies (Grangaard, 2018), including Copenhagen, which released its latest policy - *Architecture for people* – in 2017, in which it states its intention to better accommodate 'human senses and needs' (Department, Technology and Environment, 2017). This policy envisions an inclusive city with room for people with different needs and attitudes, where a sense of community should be boosted through the creation of spaces that invite many different users to stay and meet, and where the individual can thrive through increased architectural quality (Department, Technology and Environment, 2017).

While architectural policies have increasingly raised the bar towards inclusive design, existing design legislation has merely added requirements for accessibility without reconsidering and updating the design approach towards inclusion. Before Denmark ratified the CRPD, the Danish Building Act of 1972 was the first legislation, together with the following Danish BR of 1977, to consider people with reduced mobility in relation to the design of buildings (Grangaard, 2018). The Building Act did not mention the term *accessibility,* but gave indications of how specific parts of the building should be designed and built (Grangaard & Gottlieb, 2019). It was not until 1995 that the new Danish BR included the word *accessibility* and introduced further design requirements, which were mostly related to the removal of physical barriers for ensuring that people with physical disabilities could have access to the built environment. Since accessibility requirements have been introduced in BRs, they have always been prescriptions to avoid building architectural barriers and thus ensure a minimum level of accessibility.

As in most Nordic countries, the Danish BR is complemented by non-statutory guidelines to aim for buildings of higher architectural quality, accessibility and usability. To this end, in Denmark, the BR refers to guidelines provided by the *Danish Building Research Institute* (SBi) now called *BUILD - Institut for Byggeri, By og Miljø*, which better explain the provision of the BR and offer further detailed guidance on the design, layout and fitting of buildings and physical surroundings (Sbi, 2020) (Ginnerup & Sigbrand, 2015). This guidance aims to offer a more comprehensive definition of the final user, by opening the target group to any user, with no, minor, or major impairments of a physical, sensory or cognitive nature. Furthermore, the SBi guidelines point to a new model of requirements, which depart from the current prescriptive ones and consider the more performative and contextual aspect of accessibility and usability (Grangaard, 2016). Although SBi guidelines aim to offer a more comprehensive and inclusive definition of the target user group and approach to design, they still refer to prescriptive indications and do not provide insight into the dynamic interactions between users and architectural features.

To offer recommendations for the development of accessible and usable spaces for users with disabilities and, at the same time, reconcile the expectations between parties in construction, the SBi guidelines propose a system based on three levels of quality (i.e. A, B and C) linked to single performances (Stang, 2008) and indicative to both the functional and the technical quality. Quality level A is the highest and C is the lowest, corresponding to the requirements of the BR and generally good building practice. The purpose of the quality levels is to facilitate the achievement of higher quality design solutions than those specified in the BR and to apply the three quality levels according to the different construction areas and customer requirements. SBi guidelines include the concept of usability and individual satisfaction, by defining a high degree of usability and satisfaction of all users as necessary for achieving quality level A.

Despite these additional guides, the consideration of sensory disabilities in the Danish legislative framework for architecture is still very limited (Ryhl, 2010). This was also demonstrated in interviews conducted with architects from AART, CUBO, and Force4 as part of the study. The architects stated that when working on projects where accommodating into account the needs of individuals with sensory impairments was important, they used resources other than BR and SBi. Relevant information for this type of user was in fact collected through the websites of organisations specific to a certain type of sensory impairment. *TiBS - Tilgængelighed for blinde og svagsynede* (Accessibility for blind and partially sighted people) explains the general difficulties encountered by people with visual impairments and present the corresponding parameters and architectural solutions to be implemented to improve the usability of spaces (Dansk Blindesamfund, u.d.). In the case of hearing impairments *Høreforeningen Tilgængelighed* (The Hearing Society Accessibility) gives indications of accessibility with regard to assistive hearing devices and audio-acoustic systems in public spaces (Høreforeningen, u.d.). Concerning the specific case of sports and leisure buildings, the *Videnscenter om handicap* (Knowledge Center on Disability) has developed an additional online guide with examples of good accessible design as sources of inspiration for architects and builders (Handicapidrættens Videnscenter, Lokale og Anlægsfonden, 2013).

Internationally, other guides to designing for people with impairments are available online. The *IDEA Center of Buffalo* offers an on-line comprehensive guide to innovative solutions for the accessibility and usability of public and commercial buildings (IDEA center, 2022). These solutions are organised according to the different areas of the building and are described with clear spatial indications and example images. Developed through evidence-based knowledge, this tool can be used not only to browse solutions, but also to evaluate one's own project from a UD perspective. Another interesting guidance document for designers was developed by architect Hansel Bauman in 2015 at Gallaudet University during the *DeafSpace* project (Gallaudet University, 2015). The result of this project is a catalogue that addresses the five main themes representative of the deaf experience in the built environment: space and proximity, sensory reach, mobility and proximity, light and colour, acoustics and EMI (Electromagnetic Interference). Recommendations on each theme are given in regard to the built environment for better designing inclusive spaces for deaf people.

It is aknowledged that current Danish legislative requirements on accessibility significantly increased over the last years (Ryhl, 2014). Building codes can be seen as a useful tool for architects through which inequalities in the built environment can undoubtedly be reduced (Frandsen, et al., 2012) and the provisions of th BR contribute to impact on the design of more inclusive architecture (Grangaard, 2016). However, these provisions still primarily focus on physical disability and do not consider either the variability of differences or the social contexts of individuals (Kajita, 2016). On one hand, the specific and prescriptive nature of BR requirements does not give architects knowledge about human diversity and what it implies in relation to the built environment and interaction with its materiality (Kirkeby, 2015) (Froyen, 2014) (Grangaard, et al., 2016) (Van der Linden, et al., 2016). On the other hand, the knowledge on the experiences of users with impairments provided by representative organizations or specialized research centers can be helpful. However, this is often specific to certain impairments and does not necessarily provide a comprehensive understanding of how the environment can support different performances.

Although architects work with experiential aspects such as dimensions, materials, shapes and textures on a daily basis, the available design tools and frameworks do not include knowledge of how these characteristics can be used in design to provide more usable buildings, especially for users with impairments. This might limit the design of more innovative architectural solutions which could be capable of better including the physical, sensory, cognitive, cultural, and social diversity of users and their experiences (Ryhl, 2009) (Ryhl, et al., 2016) (Kajita, 2016).

Universal design (UD) aims to align architectural practice with societal developments by embracing human diversity in experience and use of the environment through design. Over time, UD has clearly defined its values and intentions and has become the fundamental approach to designing buildings and spaces that are accessible and usable to all. UD approach shows the potential to consider human differences in a broader way, and the opportunity to design high quality and inclusive environments. The main challenge in doing so, however, lies in recognising the immense complexity and variety of individual experience and relationships with space (Bianchin & Heylighen, 2017) and therefore in the need of an extensive knowledge for tackiling and understanding this complexity. Current challenge of UD is thus to address disability conditions by better framing and understanding the human plurality (Lid, 2013) of spatial experience so to develop UD from an idealistic ambition to a practical design approach focusing on addressing real person-environment interactions (Lid, 2014).

On-going discussion for a more inclusive design is the possibility to shift from prescriptive accessibility requirements to performance-based ones (Grangaard, 2016), which better cover the usability of the built environment and the different modalities of interaction. A different type of approach, which expands from the current prescriptive requirement and shifts towards more performance-based requirements can broaden the spectrum of possibilities for solutions. This will favor an application of the topics of accessibility and usability with an approach that better includes the understanding of the users' experiences and feelings while interacting with the physical environment. This has also been hypothesized as a possible way to leave much more freedom for architects to develop inclusive design solutions as well as more innovative ideas that can be applied differently according to different projects and contexts. An approach to inclusivity with performative requirements and flexible criteria can offer designers the possibility to adapt and creatively respond to an increasingly diverse and complex society. To effectively address inclusivity in design through performance-based requirements however it is important to make a continuous effort to understand how diversity in abilities can affect people's experiences of the built environment. By gaining a deeper understanding of how diversity affects spatial experiences, architects can be better informed and equipped to

Figure 2.4-1 Three levels analytical approach for the development of Universal Design (Lid, 2014)

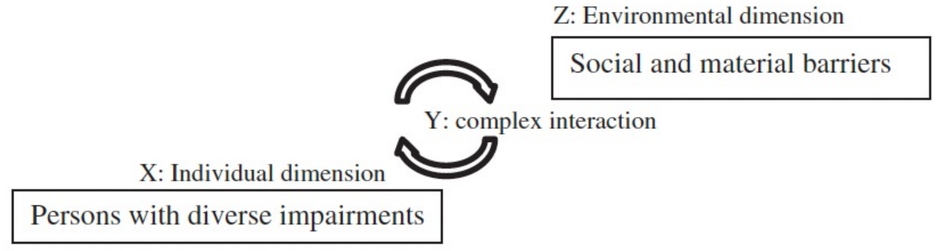
design more usable and accessible environments that enhance inclusion and empower the role of architecture in people's everyday lives.

To bridge the values of UD with its operationalization and implementation in design practice, Professor I.M. Lid, a globally recognized researcher in the field, suggests an approach based on three levels: macro, meso, and micro (Fig. 2.4-1). The macro level expresses the intentions of Universal Design and incorporates human rights and values in the form of policies and strategies. The meso level actualises value-based strategies in the form of regulations and guidelines aiming at Universal Design solutions. Finally, the micro level involves the individual and the first-person perspective of the quality of the lived environment (Lid, 2013).

While the macro and meso levels refer to term Universal Design, the micro level, representing the individual's direct experience of the environment, refers to the experiential concepts of *accessibility* and *usability*. According to Lid, the micro level is where the direct spatial experience of the individual and their interaction with the environment can be examined and where the enabling and disabling mechanisms of the person-environment relation can be observed and approached (Lid, 2013). This level is the level where the person relates directly with the environment with the aim of fulfilling their individual needs.

Within this relation, the complex interaction of the personal and environmental characteristics determines the quality of the spatial experience (Fig. 2.4-2). While the unmatch of the mutual characteristics origins experienced conditions of disability, the match represents the grade of *usability* offered by the environment and experienced by the person. It represents the level at which the knowledge and concepts necessary to understand different human conditions are placed and on which UD practice can be based (Lid, 2014).

Figure 2.4-2 Relational understanding of Disability (Thomas, 2007)



2.4 The usability of the built environment

The environment takes on meaning when it can support the daily activities that should take place within it. User performance and experience of space is strictly related to the design of the physical environment (Lang, 1988). The presence of an entrance area with seats and tables, their arrangement in the entrance space, the existence of transition zones, the distribution of rooms, etc., find their meaning when they are functional to users' possibilities of perception, use and experience. The correspondence between design and user performance represents the usability of the built environment. Initially developed within ergonomics studies, the concept of usability established itself according to a user-centred approach that recognises the relevance of differences, not only in relation to the physical aspects of use, but also to the cognitive and social ones.

The concept of usability is subjective and contextual, meaning that it is influenced by individual perspectives and the specific context in which it is being evaluated. What may be considered usable by one person may not be considered usable by another person, depending on their abilities, preferences, and needs. Similarly, the usability of a particular space or structure may change depending on the specific context in which it is being used. Additionally, usability is also subject to cultural and social differences, different people and groups may have different expectations and understanding of what is usable and what is not. With this perspective, usability as understood according to the Universal Design approach, moves away from the search for solutions that can be used by everyone, and considers the complexity of designing spaces that can accommodate different individuals.

The subjective and contextual character of the concept of usability, while helping to better evaluate the built environment on the basis of the individual, makes it challenging to define and frame it in parameters for its observation and evaluation. Attempts to anchor usability evaluation on defined criteria were initially made by referring to the three key usability factors included in the international standard definition of usability (ISO, 2018): effectiveness, efficiency, and satisfaction (International Standards Organization, 1998). These criteria were mostly used for the evaluation of the usability of products; however, despite addressing personal satisfaction, they were found to be insufficient in the consideration of different abilities and contexts (Granath & Alexander, 2006). To help designers to address a wider range of user needs and contexts, different sets of principles, goals and criteria have been developed to support both the design and the evaluation of product, building usability and inclusion.

In 1997, the Center for Universal Design developed a set of universal design guidelines presented through the seven Principles of Universal Design (Story, 2011).

Principle 1: Equitable Use

Principle 2: Flexibility in Use

Principle 3: Simple and Intuitive Use

Principle 4: Perceptible Information

Principle 5: Tolerance for Error

Principle 6: Low Physical Effort

Principle 7: Size and Space for Approach and Use

The well-known 7 principles of UD are based on the concept of *use*; despite considering *equitable use* as a principle of social justice, the focus of the other principles is limited to human functional performance (Steinfeld & Maisel, 2012). From this limitation, Steinfeld and Maisel outline the relative shortcomings of these principles, including a limited consideration of the social aspects of spatial experiences (Steinfeld & Maisel, 2012).

Steinfeld and Maisel, developed the 7 UD principles into 8 UD goals, which include aspects of human performance, wellness, and social participation (Fig 2.4-1). The first four goals (starting from the bottom in the figure: Body Fit, Comfort, Awareness and Understanding) address physical and cognitive human performance. The last 3 goals (Cultural Appropriatness, Social Integration and Personalization) address the social and cultural dimensions, while Health and Wellness represents a goal which bridges the human performance and social aspects (Steinfeld & Maisel, 2012).

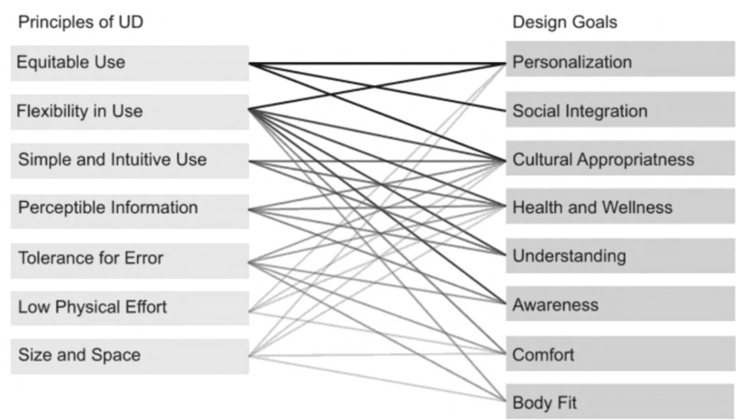


Figure 2.4-3 Development of the 8 Design Goals from the 7 Universal Design Principles (Steinfeld & Maisel, 2012)

Mosca and Capolongo further developed Steinfeld and Maisel's goals and the accessibility goals prescribed by the International Organization for Standardization (ISO/IEC, 2021) through a Universal Design-based framework to assess usability and inclusion (Mosca & Capolongo, 2020). In this framework, they grouped and expanded Steinfed and Maisel's goals in three categories of quality: 1) Physical & Spatial, 2) Sensorial & Cognitive, and 3) Social (Fig. 2.4-2). This set of categories and criteria supports the *performance-based evaluation* (Mosca & Capolongo, 2020) for assessing the compliance of the built environment with user occupation by considering both human performance (physical and cognitive) and social inclusion. The use of this framework aims to evaluate building performance of existing built environments as a rating system, and so to define priorities and modalities of intervention for improved usability and inclusion (Mosca & Capolongo, 2020).

Categories	Criteria	Indicators
1. Physical-spatial quality	1.2 Usability	Equal use of the environment
		Equal use of furniture
	1.3 Functionality	Flexibility/Personalization
		Low physical effort
		Flows/Distribution
	1.4 Safety/Security	Minimize risk situations
		Maximize security perception
2. Sensorial-cognitivequality	2.1 Wayfinding	Visual information (signs, colors, map, landmark)
		Perceptible information (tactile, sound)
	2.2 Understanding	Information easy to understand (symbols, language, color contrast)
		Communication (awareness, ICT)
	2.3 Environmental factors	Illumination (natural/artificial)
		Acoustics
		Thermal comfort
		Indoor air quality
3. Social quality	3.1 Well-being	Health promotion and Physical activity
		Hygienic conditions
		Aesthetic quality (color, materials)
	3.2 Social Inclusion	Cultural appropriateness
		Social relation (integration and privacy)
		Inclusive design process

Figure 2.4-4 Universal Design-Based Framework to Assess Usability and Inclusion of Buildings (Mosca & Capolongo, 2020)

In both of these criteria frameworks, usability is regarded as the optimal design response to a wide range of individual and contextual diversity. Both frameworks aim to offer references for investigating the compatibility of design with the individual, while taking into account the contextuality and complexity of the object under investigation. Although different, the suggested evaluation

indicators cover three main aspects of the individual spatial experience. These three aspects concern: 1) cognitive, 2) physical, and 3) social. The cognitive aspect pertains to how the individual perceives and understands the space. The physical aspect relates to how the individual approaches and interacts with the space physically and functionally. Finally, the social aspect concerns the interaction and engagement of users with the space and with each other by addressing how the experience of the space meets individual and contextual expectations.

Usability is a central issue in assessing the extent to which the design of the built environment meets the cognitive, physical and social needs of individuals. However, it must be informed by knowledge of how to better meet these aspects:

1) how the built environment can better support the individual in perceiving and understanding space (cognitive aspect)

2) how the built environment can better support the individual in approaching and interacting with space (physical aspect)

3) how the built environment can better meet individual and contextual expectations (social aspect).

2.5 Research focus: the person-environment relation in spatial experience

Main focus of this research is on the dynamics of the *person-environment relation* to delve deeper into the usability of sports and leisure buildings for individuals with bodily impairments. The study will thus look at the differences in mutual characteristics between users with impairments and the built environment, and how these differences influence the dynamics of interaction. By observing and analysing how the characteristics of the built environment enables cognitive, physical and social activities of users with physical and sensory impairments, this study intends to uncover how the environment can be designed to better improve usability.

This study, as proposed by Lid (2014), emphasizes the importance of addressing the experiential level in order to bridge UD values with their operationalization and development in design practice. The person-environment relation represents for UD development and thus for this research the main point of departure from which to produce knowledge on the individual experience of the built environment and to develop design strategies more oriented towards usability. In this perspective, it is in fact considered essential to understand how people with impairments interact with and perceive the spaces around them, as this knowledge can be used to inform the practice with the final aim to improve the usability of sports and leisure buildings and enhance the overall spatial experience.

3 THEORETICAL FRAMEWORK OF THE PERSON-ENVIRONMENT RELATION

This chapter presents and explores the main object of investigation in this study - the *person-environment relation*. This study addresses the person-environment relation in order to better understand the phenomenon of spatial experience and the implications of the design of the built environment within this relation. By employing the phenomenological understanding of spatial experience and the theory of affordances this study unfolds the person-environment relation and examines the role of the built environment and its implications for impaired user performance and participation. Together, phenomenology and the theory of affordances provide the investigation of spatial experience with a comprehensive understanding of how individuals perceive and interact with their environment. On one hand, phenomenology focuses the investigation on the subjective experience of the user, how the user perceives the environment and how it impacts their actions. On the other hand, the theory of affordances allows this study to examine the person-environment relation by looking at the performative character of this relation and hence to investigate the potential of the built environment in enabling users' activities in the space.

This chapter is organised into two main sections:

Section 3.1 – Phenomenology: understanding the person-environment relation – introduces phenomenology as the theoretical framework for the understanding and the investigation of person-environment relation. Based on the phenomenological interpretation this section also introduces and presents the main dimensions that characterise and determine the person-environment relation: a) the person: the perceiving and acting body, and b) the environment and its perceptual characteristics.

Section 3.2 – Affordances: opportunities for person-environment relation – introduces the concept of *affordances* defined as the possibility of action offered by the physical environment to a person endowed with certain abilities. By this definition, the theory of affordances is employed in this study to address the person-environment relation by looking at the performative interdependencies that exist between individuals' abilities and the physical and sensory characteristics of the environment.

3.1 Phenomenology: understanding the experience of space

Arising at the beginning of the 20th century, phenomenology is the branch of philosophy that focuses on the deep understanding and description of the world as it is experienced by humans in the course of life (von Eckartsberg, 1998). Phenomenology indeed explores the specific instances of human experiences, which can describe the essential nature of the phenomena (Seamon, 2000). Founded by the German philosopher Edmund Husserl (1859-1938) at the beginning of the 20th century, phenomenology emerged from a desire to depart from the rationalism of classical German philosophy and reconsider knowledge of the world through the investigation of the being of human nature (Macann, 2005). It is on this basis that phenomenology intends to set up a new philosophy based on the description of the nature of the world from its lived, embodied experience (Seamon, 2000); this constitutes the main object of phenomenological investigation.

In contrast to the previous idealist interpretations of the external world represented by Kant and Descartes, phenomenology merges the person and the world into an indivisible investigative whole which is the lived experience (VonderBrink, 2007). Over time, the main exponents of phenomenology, from Husserl to Martin Heidegger (1889-1976) and Maurice Merleau-Ponty (1908-1961), helped to explain the nature and significance of lived human experience by framing the discussion around the intertwining between the person, who experiences the world, and the world, which is experienced by the person. Phenomenology explores and describes any object, event, or situation from the individual experience of the person who perceives it and uses this description to delineate the essence of the person's encounter with the world (Seamon, 2000). In phenomenological studies, the world is thus no longer considered as an external entity in its own right, but as an object of experience that is perceived and thus mediated by the person (Merleau-Ponty, 2013). In the more specific context of the physical environment, which is the interest of this thesis, phenomenology focuses its investigation and exploration on the relation between the architectural space and the person, by providing a qualitative description of the architectonic experience as it is perceived and lived by users on an individual level (Basayazici-Kulac & Ito-Alpturer, 2013). Based on this approach, the main process by which the physical environment can be known is the direct experience of situations, and meanings - determined by qualities and features of both the environment and the person (Otero-Pailos, 2012). In this process, the person develops knowledge of their own existence (Merleau-Ponty, 2013) and the environment in which they are immersed as they perceive it through all the senses (Pallasmaa, 2012) and acts within it.

In the context and focus of this study, phenomenology is considered as the most appropriate theoretical means for analysing person-environment relation; the experience of people with physical and sensory impairments can offer a contextual description of how the environment is perceived and how this affects the overall experience of the space. Specifically, this approach can provide insight into how physical and sensory limitations mediate the perception of the built environment and how the characteristics of the built environment influence this spatial encounter and the performance of people with different abilities. Based on the investigation of the experience of human nature, which includes diversities of form, ability and perception, phenomenology can, according to Husserl, offer the opportunity to move away from abstract and unrealistic thinking of person-environment relations and move towards a more realistic, albeit complex understanding of the human experience of space. Furthermore, the phenomenological relevance of human perception implies the corresponding importance of the environment in stimulating sensoriality for enriching the character of spatial experience (Pallasmaa, 1996) (Basayazici-Kulac & Ito-Alpturer, 2013).

Like the ICF relational model of disability, phenomenology focuses on the person-environment relation. In this relationship, in which disability manifests in the person encountering the environment, phenomenology offers the opportunity to investigate the dynamics involved in this encounter. By using a phenomenological approach, this study intends to observe, describe, and analyse the mechanisms which occur between users with mobility and sensory impairments and the built environment. Based on this phenomenological understanding of the person-environment relation, the following subsections present and explore the value of the two main dimensions involved in spatial experience:

a) the person: the perceiving and acting body

b) the environment and its perceptual characteristics

3.1.1 The person: the perceiving and acting body

One of the main issues concerning phenomenological thinking is that of the body. As Merleau-Ponty argues, experience and knowledge of the world and of the self develops from the perceptual dimension in which the body is the main bearer (Merleau-Ponty, 2013). Stimuli from the environment come to the body not as “a sum of visual, tactile, and audible givens” but as a “unique structure of the thing, which speaks to all the senses at once” (Merleau-Ponty, 1968) (Pallasmaa, 1996). Bodily perception forms and informs the direct engagement with the world (Robinson, 2015) and determines the processing of these stimuli (Merleau-Ponty, 2013). Merleau-Ponty explains this encounter as the primary experience of the fact that we are in the world and the means by which the world can be understood. Every contact between body and world marks “a new birth of consciousness” (Merleau-Ponty, 2013) in which one is not merely a spectator of perceptual phenomena, but instead part of a unique “relationship between the subject, its body and its world”.

Contextual social and individual aspects shape the perception of external stimuli in reflexive or self-referential intentionality of action (Gallagher & Marcel, 1999). The individual perceptual experience, the conceptual understanding of this experience, together with the emotional attitude of the person, constitute the intentional system that bridge the stimulus with the action (Gallagher, 2007). The body, both as a perceiving physiological object and as a vector of intentions and actions, assumes a central role in shaping the ways in which the person behaves in the world (Bermúdez, 2011) (Gallagher, 1995). This active role of the body underpins the theory of *embodiment,* of which Merleau-Ponty is the main ambassador. The close relationship between perception, thought, and action, was initially theorised by Uexküll, Heidegger and Gibson (Dotov, et al., 2012), who see perception and proprioception of the body as the first mechanism that generates action. Perceiving and acting are part of the same process, whereby bodily sensory-motor experiences of the built environment influence the ways in which a person makes decisions and acts within it (Lakoff, et al., 1999).

Human perception, cognition and relation to the world cannot be abstract and indistinct for all, but instead rooted in and shaped by each person’s unique body and sensory processes and contextuality (Wilson, 2002). The body is the means and context through which individuals relate to the world and thus also to the physical environment (Grosz, 1992). In this relation, the understanding of the physical environment depends on the body’s form and capacity for perception, just as the body’s perception and production of meaning depend on the physical environment (Grosz, 1992). This joint mutual influence requires design reflections that consider the differences in individual capacities in relating to the physical environment. The embodied experience of a person with physical and sensory impairments should thus be accounted for as a different context and condition through which the relation with the environment takes place. Within this different context, the individual with different sensory-motor skills makes a self-experience of the environment which differs from the experience of an able-bodied person (Toro, et al., 2020). In this sense, a phenomenological approach invites and supports the investigation of person-environment relation that considers the diversity of bodies and abilities.

3.1.2 The environment and its perceptual characteristics

Perception of sensory characteristics constitutes the boundary line between the environment and the person (Ragavendira, 2017). Underlying phenomenology is the idea that the individual perception and experience of anything belonging to the outside world can become an engine of knowledge, intention, behavior and action. Following this line of reasoning, perceptual characteristics and their modalities of encounter become indispensable in the exploration of the person-environment relation. Building on phenomenological theories, architects such as Christian Norberg-Schulz, Steven Holl, Daniel Libeskind, Peter Zumthor and Juhani Pallasmaa have contributed, both in architectural research and practice, to understanding and advancing the contemporary phenomenological approach to architecture by focusing on its perceptual, sensory and emotional aspects and their encounter (Seamon, 2018).

The physical environment is constituted as an ensemble of colors, forms, materials, textures, odors, and sounds intertwined with each other in a multisensory dimension (Rasmussen, 1964). The encounter of human bodily senses with these features makes possible their perception and thus the experience of spaces, places and situations (Pallasmaa, 2012). The way perceptual characteristics are composed and presented in the environment affects their modalities of perception and thus their interpretation by the individuals who experience the space (Pop, 2013). Concurrently, as described in the previous section, users, according to their own set of abilities, knowledge and attitude, perceive the space differently (Wilson, 2002). Architects' influence and skill thus lies in anticipating users' experiences (Pallasmaa, 1996), stimulating their perception, and communicating the intended atmospheres, sensations, ideas, and memories (Pallasmaa, 2012).

Physical and sensory characteristics of the environment, once they are perceived, can constitute information that triggers possible actions (Bergson, 1991) and guides user behavior (Chemero, 2011)(Withagen, et al., 2012). The environment, through its characteristics, reveals "solicitations to act" (Dreyfus & Kelly, 2007) (Withagen, et al., 2012). Drawing on the work of Gestalt psychologists, Dreyfus and Kelly use the term *solicitation* to describe the user's attraction to perform a certain action drawn by the environment (Dreyfus & Kelly, 2007). When the active engagement of the user and the environment in which the action takes place are in *synchrony* (Merleau-Ponty, 2013) (Merleau-Ponty, 1968) the environment is experienced as a *place* (Seamon, 2018) defined as "any environmental locus that draws human experiences, actions, and meanings together spatially and temporally" (Casey, 1993).

3.2 Affordances: the performative character of the person-environment relation

The embodied person is not only understood as the main bearer of perceptions, but also as a 'source' or 'power' for action (Gallese & Sinigaglia, 2010). When people experience a space, they perceive opportunities for interacting with it in order to behave and act (Gibson, 1979). As part of the development of ecological psychology, the psychologist James Jerome Gibson coined and defined the term *affordances* as the opportunities of actions offered by the environment to an individual with certain skills (Gibson, 1977). By this definition, affordances represent the conceptual link that ties the environment and the person together as a performative interacting and dynamic system (Masoudi, et al., 2019). Originating from ecological and perceptual psychology, and eventually becoming more integrated in the domains of design and architecture, the concept of affordances frames and explores the tied connection between environments and occupants with respect to design form and function (Maier, et al., 2009). Affordances reflect the character and the structure that the action implies. Basic actions, nested inside each other, like grabbing and flipping the light switch, constitute the action of turning on the light. Likewise, the properties of the light switch, by offering the user the possibility to grab and flip, mirror these actions in offered affordances that enable a user with certain skills to turn on the light.

Early theories of ecological psychology referred to affordances exclusively as properties belonging to the object (e.g. graspability of the switch). More recent understanding of affordances, however, expand the term's focus to the correspondence between the properties of the object and the skills of the individual (Chemero, 2003) (Chemero, 2011) (Rietveld & Kiverstein, 2014). According to this understanding, environmental properties offer opportunities of actions, in the form of stimuli and information. These are perceived and processed by the person, as the agent of the offered action, and exist by virtue of the relation between the environmental and personal characteristics (Withagen, et al., 2012). Physical and sensory properties of the environment can constitute opportunities for action only if compatible with the person's sensoriality and plasticity (Maravita & Atsushu, 2004), where the latter is considered as the totality of the bodies' sensory and motor possibilities. In this relationship, as also argued by phenomenological theories, the possibility of action is thus determined on the base of the individual agent (e.g. agent's ability to see, grasp and flip the switch, as well as the personal intention to turn on the light).

The physical and sensory characteristics of the environment can favour user interaction in the space, not only in the physical realm but also in the cognitive and social ones. In regard to cognition, the issue of users' spatial awareness and knowledge was first introduced by Lynch through the concept of *spatial legibility* (Lynch, 1964). Spatial legibility has been deepened and linked to aspects such as spatial layout (O'Neill, 1991) (Baskaya, et al., 2004), and presence of spatial characteristics (Herzog & Leverich, 2003), which together contribute to support the user in creating cognitive maps and thus wayfinding. Spatial legibility, however, does not depend only on the presence and organisation of spatial characteristics, but also on the characteristics of the user who perceives and understands space through individual psycho-cognitive processes (Koseoglu & Onder, 2011) which affect the acquisition of knowledge and thus spatial awareness.

A further extension of the concept of affordances concerns the study of social interactions. Affordances can in fact be meaningful in relation to the social effects of the afforded actions (Searle & Willis, 1995) (Pols, 2012). Although Gibson does not define the notion of social affordances, he offers the example of the post-box which "allows letters to be sent to a human being writing in a community with a postal system" (Gibson, 1979). In this example, affordance is identified in a particular socio-cultural context, in which the action enables the subject to socially participate in the community. In the specific case of the built environment, spatial characteristics can offer and invite behaviours, among which are bodily engagement and social encounters. A simple and clear example of the contribution of design to social interaction is the one of seating layouts and solutions in public spaces. As demonstrated by different studies (Afonso, 2017) (Paydar & Kamani Fard, 2021), increased visibility offered by the spatial attributes of seating can improve the engagement and interaction between people.

The theory of affordances suggests that people perceive the potential actions or uses of an object or environment based on their individual abilities and current goals (Pols, 2012). People thus tend to focus on certain affordances that are relevant to their current intentions and needs, while disregarding others. If affordances are opportunities of actions offered to an individual with certain skills (Gibson, 1977) the question arises as to how affordances relate to people with mobility, visual, and hearing impairments. While the condition of disability is defined as a limitation in activities and participation determined by the relation between personal and environmental characteristics, affordances, on the other hand, are defined as the action possibilities determined by virtue of the same person-environment relation (Withagen, et al., 2012). In light of these definitions, the concept of affordances can provide the opportunity to better understand the relations between the individual's capacities to act and the environment's characteristics which enable individual's activities (Jelić, 2021).

From these premises, it becomes clear how affordances can be a tool for investigating and identifying the enabling mechanisms within the person-environment relation. The concept of affordances has been increasingly used for addressing a more fundamental analysis of both disability and usability studies in different fields, including architecture (Hartson, 2003) (Koutamanis, 2006) (Baumers & Heylighen, 2010) (Clapham, 2011) (Atmodiwirjo, 2014) (Masoudi, et al., 2019). In order to design environments that are more responsive to individual's capabilities and intentions, an affordances-based design points toward considering and emphasising the performative relation between users and their environment (Maier, et al., 2009). Likewise, in the context of this study, the concept of affordances is used to unfold the dynamics of the person-environment relation and to operationalize the investigation of how the environment can better support the activities of users with different characteristics and abilities.

Within the focus of this research, phenomenology can be used to investigate how individuals perceive, think about, and interact with the built environment (Wilson, 2002). This approach can provide insight into the unique ways in which individuals encounter and make sense of the environment, including how the designed characteristics shape their experiences. On the other hand, the theory of affordances posits that the environment offers possibilities for action to individuals based on their personal abilities and needs (Gibson, 1977) (Pols, 2012). This theory can be used to investigate the enabling role of the environment in supporting users' experiences by examining how the characteristics of the environment shape the opportunities for activity and performance. This theory can be used to understand how the aspects of the environment can enable physical, social, and cognitive activities and how users can perceive and use the environment to achieve their goals.

Theoretical framework

This theoretical framework informs this research on:

- the understanding of how the characteristics of the built environment are encountered by users with physical and sensory impairments
- the analysis of how the characteristics of the built environment offer users possibilities for better performing

Users'performance is strictly related to the interaction of the individual with the physical and sensory characteristics of the built environment, which, by *affording* users cognitive, physical and social activities, determine the extent of usability. The possibility of framing knowledge about users' spatial experiences according to the cognitive, physical and social aspects of the person-environment relationship is used in this study as a reference point for both the investigation of users' spatial experiences and the development of performance requirements for design.

4 EXISTING INVESTIGATIONS OF THE PERSON-ENVIRONMENT RELATION

This chapter provides an overview of the existing research that addresses the person-environment relation for aiming at understanding and improving the performance of users with impairments. The literature review led to the identification of analytical models employed to support the analysis of the interdependencies occurring between the person and the environment during spatial experience. These analytical models already provide extensive knowledge about how the built environment influences users' experiences. However, these models have been developed with the purpose of identifying environmental barriers for the eventual evaluation and improvement of the environment's accessibility and usability. The performative character of the person-environment relation suggests that an alternative approach to the investigation of impaired users spatial experiences could focus on the enabling potential of the environment to identify and understand the mechanisms by which certain architectural features could contribute in supporting and stimulating user activity.

This chapter is organised into four main sections:

Section 4.1 – The review of person-environment analytical models - introduces the three analytical models identified as most relevant for investigating the person-environment relation: a) the Person-Environment-Occupation model, b) the Enabler model, and c) the User-Built Environment model. This section offers an overview of the methodologies and objectives that these models address respectively in disability and design research.

Section 4.2 – Discussion: the investigated interdependencies of the Person-Environment relation – discusses the knowledge provided by these models by framing it in three contributions to person-environment research: a) Person-environment patterns, b) Person-environment fit, and c) The role of the environment.

Section 4.3 – Knowledge gap: the enabling potential of the environment – identifies the knowledge gap in the investigation of the person-environment relation, which the existing analytical models do not address. This section lays the foundation for the new analytical model developed in this research project to support the investigation of the enabling role of the environment in the spatial experiences of impaired users.

Section 4.4 – Research questions – based on the identified knowledge gap and the theoretical framework on which the concept of person-environment relation is built upon, this section introduces the objectives and the related research questions that this study aims to address.

4.1 The review of person-environment analytical models

The in-depth knowledge of the person-environment relation is crucial to understanding how spaces that enable users with physical and sensory impairments to perform and experience everyday activities might be designed. The need to incorporate the conceptual understanding of disability into its investigation, however, requires reliable tools that can help to link the dimension of the person with that of the built environment. Analytical models which include personal factors, environmental factors, and reciprocal interactions can provide the opportunity to better understand disabling and enabling mechanisms in the context of spatial experiences (Altman, 2001) (Imrie & Luck, 2014). In this sense, these models can support the empirical investigation of the person-environment relation to better understand the influences of the built environment on users' spatial experiences. The intertwined nature of the person-environment relation and of the concept of disability requires that the analytical models employed for the investigation of users' spatial experiences do not focus exclusively on the person or the environment, but on their interaction (Lid, 2013). Moreover, the inherent complexity of the person-environment relationship requires that analytical models do not oversimplify this complexity, but instead are able to consider the contextuality of interactions in relation to both the environment and the person (Lid, 2013).

Most of the existing analytical models employed for investigating the complex dynamics between the person and the environment are built upon the apparently simple "Life Space" equation B=f(P;E) (Lewin, 1951). This equation is centered around the idea that the behavior is determined by the person's life environment. It in fact considers the person (P) and the environment (E) as two variables whose correspondence results in behaviour (B), hence in activity and participation (Preiser, 2016). Focusing differently on the person, the environment or behaviour, the analytical models developed upon this equation seek to consider the intrinsic complexity of each of the three elements, as well as their interaction, through what is called a transactional perspective (Altman & Rogoff, 1987) (Moore, 1976) (Stokols, 1981) (Wandersman, et al., 1979). Aiming at assessing person's behaviour, existing models have been used by observing and analysing it in relation to both laboratory settings and real-life contexts (Steinfeld & Danford, 1999). While the first allows for better control of the environmental variables, the latter permits the consideration of situational aspects which belong to real word experiences (Steinfeld & Danford, 1999). In these models, the direct engagement of the person is the pivotal factor for considering the subjective experience, and assessing the performance as a result, in the balance between personal abilities and environmental demand. The assessment of the performance is usually based on criteria of task completion or rating scales. Although the use of rating scales can capture the personal level of difficulty in performing the task, it must also be recognised that this level may vary contextually for the same user (Steinfeld & Danford, 1999).

The literature review of the existing models led to the identification of three analytical models which have been considered relevant for this study. All three models take into account both the characteristics of the person and the environment in order to assess individuals' performances through their observation in real contexts. Specifically, they all aim to identify the environmental characteristics that influence the performance and the way these characteristics mediate with the functional abilities of the person. The review of these model helped this study to understand how they conceptualized the person-environment relation to operationalize its analysis and assessment. Characteristics of these models were subsequently considered for the development of the analytical model employed in this research.

The following sub-sections present the three analytical models identified for assessment:

a) the Person-Environment-Occupation model,

b) the Enabler model,

c) the Users-Built Environments model.

4.1.1 The Person-Environment-Occupation Model

The Person-Environment-Occupation (PEO) is a model developed in the field of occupational therapy in 1996 (Law, et al., 1996), while WHO was shifting from the medical (ICIDH) to the bio-psycho-social (ICF) frameworks of disability. Since its development, the PEO model has been used in occupational therapy practice as a guide for evaluating, assessing and adjusting the responsiveness of the environment to an individual's characteristics and activities. This model was introduced to facilitate occupational therapists in conceptualising complex processes between people, their occupations, and the environment (Strong, et al., 1999). Specifically, the PEO model helps therapists to identify issues in the performance of impaired people in the built environment, to examine the influencing factors, and eventually to consider interventions for improvement (Strong, et al., 1999).

The PEO model is built upon three main dimensions: 1) the person, 2) the environment, and 3) the occupation (Fig. 4.1-1). The person is defined as a dynamic being, characterized by qualities and skills, which influence the way the person acts and interacts with the environment. This dimension also includes individual socio-cultural factors, personality, health conditions and related functional impairments. The environment, or rather the context in which the person behaves, is also considered dynamic and characterized by situational aspects that affect the performance of the person. The environmental dimension includes the physical setting where the person acts, as well as the socio-cultural context. Finally, the occupation, which is any activity performed by the person for fulfilling their needs. For each dimension, the PEO model considers the corresponding contextual factors and examines their mutual congruence.

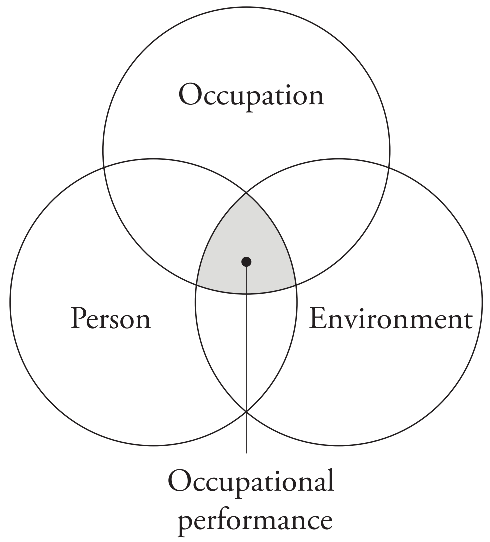


Figure 4.1-1 Occupational performance based on person, environment, and occupation fit (Law, et al., 1996), edited by the author

By framing occupational performance as a relational outcome, the PEO model represents it as the overlap of the three dimensions (i.e. the person, the environment and the occupation). In this conceptual representation, the greater the level of congruence (overlap of the three dimensions), the greater the extent to which the person is able to perform independently. Conversely, a limited performance capability is represented by a reduced overlap of the three dimensions.

To operationalise this conceptual model in practice, the PEO model offers the possibility of deepening the transactional relations (Strong, et al., 1999) represented by the mutual overlap of the three dimensions: person-occupation, occupation-environment, and person-environment (Fig. 4.1-2).

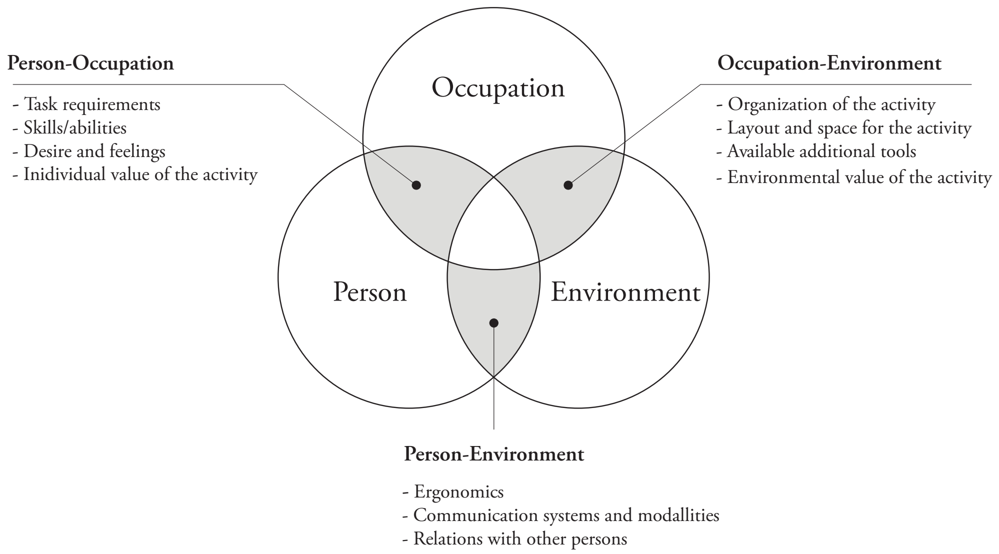


Figure 4.1-2 Transactional relations of the PEO model (Strong, et al., 1999), edited by the author

Through directly involving the person, potential causes of inconsistency are identified by the therapist, and possible modifications within any of the three dimensions are proposed. For example, in order to improve a person's autonomy in preparing meals, the model provides a framework for the analysis presented in table 4.1-1 below:

Table 4.1-1 Analysis of the transactional relations for improving the autonomy in meal preparation (Strong, et al., 1999)

Person-occupation	Occupation-environment	Person-environment
- Skills/abilities for meal preparation - Desire for autonomy - Enjoyment of cooking - Nutritional needs	- Layout & space in kitchen for meal preparation - Tools/ingredients available - Community resources for shopping for meal preparation	- Safety issues - Family support - Reliability of other resources - Eligibility criteria for community resources

This more detailed sub-framework provides further details for the assessment of the performance, beside collecting useful information for defining and planning strategies for intervening in one or more of the three dimensions to improve their congruence and thus the performance.

4.1.2 The Enabler Model

The Enabler model is interdisciplinary, combining elements of design and occupational therapy practices; it was originally developed in 1979 (Steinfeld, et al., 1979) to analyse the impact of the environment on people with functional impairments. In 1999, the same model has been translated and further developed to be employed in Sweden to assess the accessibility of housing quantitatively and objectively (Steinfeld & Danford, 1999) (Iwarsson, 1999). Similar to the PEO model, and in line with the ICF framework of disability, the Enabler model focuses on identifying the environmental barriers that contribute to cause individual limitations in daily activities. The Enabler model is conceived of as a tool to identify, list, and score the most relevant housing accessibility issues by juxtaposing physical architectural barriers against the functional limitations of the individual (Iwarsson, 1999).

Through this model, the different abilities of the individual are considered according to a list of 15 items, of which 13 are concerned with physical limitations, 4 with perceptual limitations, and the remaining 2 consider assistive mobility devices (Steinfeld & Danford, 1999). Environmental barriers are listed as 144 different characteristics which relate to the physical setting. The listed environmental items also refer to Swedish norms for accessible housing (Handikappinstitutet, 1989) and are divided into four subparts: outdoor conditions, entrances, indoor conditions, and communication (Steinfeld & Danford, 1999).

The Enabler model helps to identify accessibility problems and to evaluate their degree of influence on user performance by following three main steps: 1) the assessment of the functional limitations of the individual (Fig. 4.1-3), 2) the assessment of physical environmental barriers (Fig. 4.1-4), and 3) the calculation of the accessibility score through the combination of the individual functional limitations and the physical environmental barriers (Fig. 4.1-5).

The model offers the possibility to mark the functional limitations that characterise the individual's abilities and the potential environmental barriers observed in the examined environment. The accessibility score is calculated by using the suggested points at the intersection of the items which have been marked. The accessibility points, which are already provided in the model based on practical experience and accessibility experts' opinions, are used in this investigative approach for calculating the extent to which the environmental barriers affect the individual's functionality in space (Iwarsson, 1999).

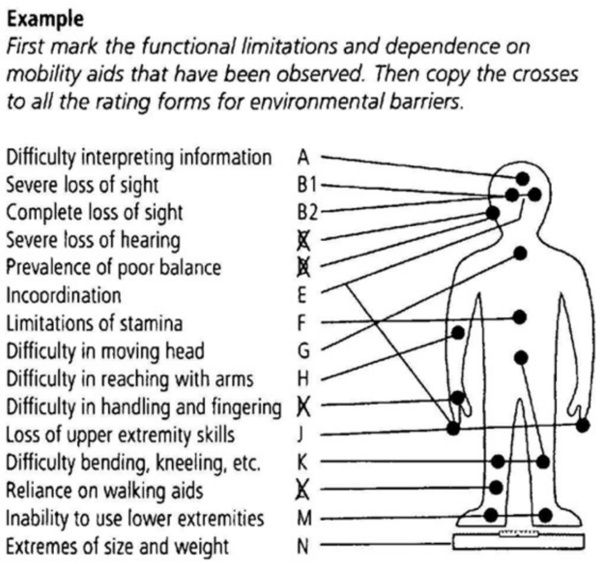
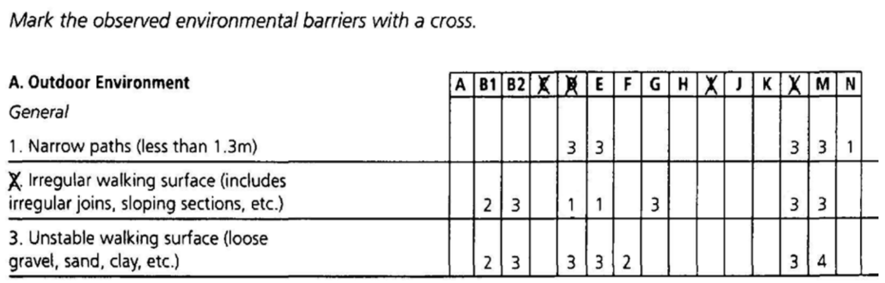


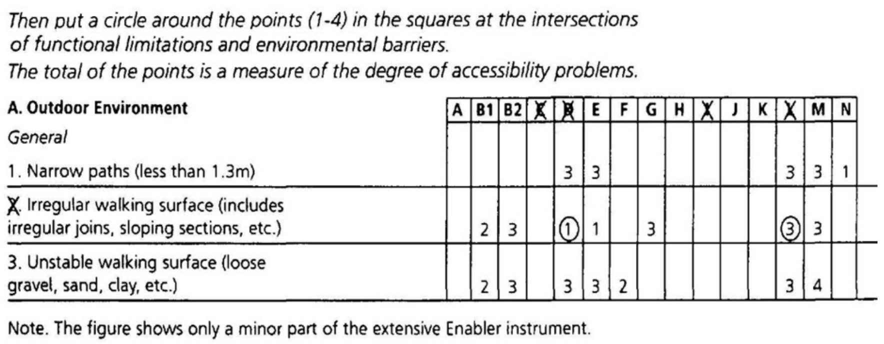
Figure 4.1-3 The Housing Enabler assessment tool – step 1 (Steinfeld & Danford, 1999)



Mark the observed environmental barriers with a cross.

A. Outdoor Environment	A	B1	B2	X	X	E	F	G	H	X	J	K	X	M	N
General															
1. Narrow paths (less than 1.3m)					3	3							3	3	1
X. Irregular walking surface (includes irregular joins, sloping sections, etc.)		2	3		1	1		3					3	3	
3. Unstable walking surface (loose gravel, sand, clay, etc.)		2	3		3	3	2						3	4	

Figure 4.1-4 The Housing Enabler assessment tool – step 2 (Steinfeld & Danford, 1999)



Then put a circle around the points (1-4) in the squares at the intersections of functional limitations and environmental barriers.
The total of the points is a measure of the degree of accessibility problems.

A. Outdoor Environment	A	B1	B2	X	X	E	F	G	H	X	J	K	X	M	N
General															
1. Narrow paths (less than 1.3m)					3	3							3	3	1
X. Irregular walking surface (includes irregular joins, sloping sections, etc.)		2	3		1	1		3					3	3	
3. Unstable walking surface (loose gravel, sand, clay, etc.)		2	3		3	3	2						3	4	

Note. The figure shows only a minor part of the extensive Enabler instrument.

Figure 4.1-5 The Housing Enabler assessment tool – step 3 (Steinfeld & Danford, 1999)

Although this model was developed for assessing the accessibility of dwellings, consideration of different environmental characteristics and the corresponding accessibility scores can allow this model to be applied for the evaluation of different contexts (Iwarsson, 1999). Used as a practical tool in empirical accessibility studies, the model provides a detailed rating of the accessibility conditions, by pointing out the most relevant barriers, which eventually require actions for changes and adaptations.

4.1.3 The Users-Built Environments Model

With the aim to develop Universal Design strategies, the Users-Built Environments model was developed to map and describe interrelations between the diverse characteristics of users and the built environment in different situations (Froyen, et al., 2009a). This suggested model links permanent, temporary, and situational limitations of the user with environmental features during the performance of observed activities. As with the PEO and Enabler models, the Users-Built Environments model is framed around two main components: 1) the user and 2) the environment. In this model, the user is defined based on lists of possible impairments and activities, while the component of the environment is characterized through aspects and elements belonging to the physical setting (Fig. 4.1-6).

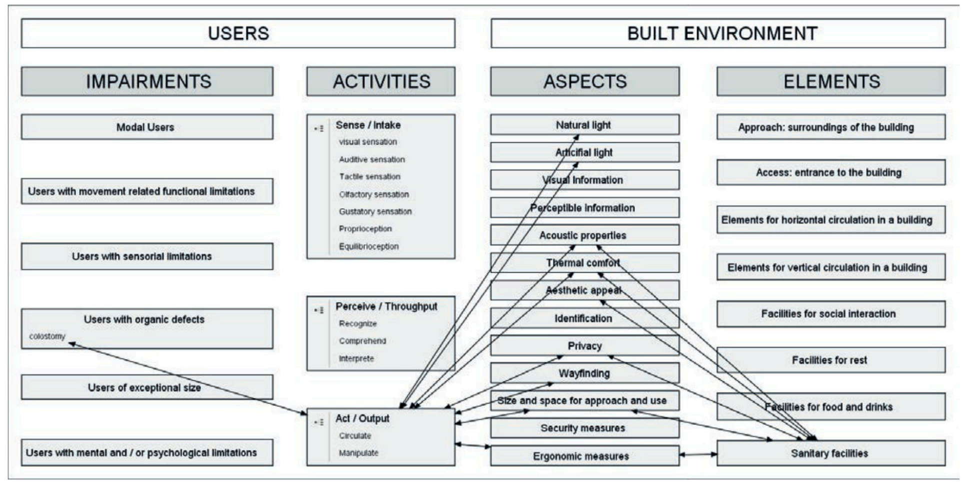


Figure 4.1-6 Users-Built Environment Model (Froyen, et al., 2009a)

Observed interactions between the two components and their listed items are linked and mapped by the researcher to show key circumstances, called patterns, which constitute the framework for describing user-environment conflicts (Froyen, et al., 2009b). Each identified pattern is described by using the same structure:

- Title of the UD pattern (e.g., Toilet facilities in public buildings)
- Introductory paragraph with the problem description (e.g., toilet provision in urban design)
- Description of the user-built environment conflict (i.e., list of problems which may occur from the use of the public bathroom by a user with functional limitations)
- Research resources which address the problematic situation (i.e., knowledge

about needs of users with a stoma)

- Architectural resolution with suggestions about how to solve the identified conflicts (e.g., changes to the disposition of the grab bars, hooks, mirror, etc.)

The model is detailed, and the lists of components are used as building blocks for describing and pointing out the conflicts which are experienced by the person as disability situations (Froyen, et al., 2009a). The extensive use of this model aims to generate and continuously update UD patterns by providing designers with a comprehensive collection of possible conflict situations and their architectural solutions.

4.2 Discussion: the investigated interdependencies of the person-environment relation

The presented models were developed with the aim of addressing the person-environment relation by considering their transactional interaction. Furthermore, these models investigate the person-environment relation at the experiential level, by observing, describing, and analysing spaces' accessibility and usability within contextual situations in relation to personal experience. Thus, in these models, the person is considered and recognised as the main resource for assessing interaction with the characteristics of the built environment. These three analytical models are characterised by approaches and frameworks of investigation that, although different, all lead to the production of research-based knowledge on the person-environment relation and the interdependencies between the individual and environmental characteristics. Drawing upon the "Life Space" equation B=f(P;E) (Lewin, 1951), the knowledge provided by these analytical models can be organized through three identified contributions:

a) *Person-environment patterns* which refer to the relation between the personal and environmental characteristics (P,E) and aims at identifying links between the reciprocal characteristics occurring during the performance (B)

b) *Person-environment fit* which refers to the outcome (i.e. performance) of the person-environment relation (B) and aims at assessing the extent of congruence between personal (P) and environmental (E) characteristics;

c) *The role of the environment* which refers to the environment's potential role in mediating the outcome of the person-environment relation and aims at identifying the characteristics of the environment (E) that have the greatest influence on the person's performance (B).

4.2.1 Person-environment patterns

Person-environment relation refers to the interaction and relationship between an individual (person) and their surroundings (environment). This relationship is based on the idea that the characteristics of the person (such as their abilities, and behaviors) and the characteristics of the environment (such as physical and context conditions) are mutually influential. This aligns with the phenomenological perspective, which emphasizes the subjective experience of the individual and the importance of understanding how individuals perceive and interact with their environment. The analysis of the person-environment patterns involves studying how personal and environmental characteristics are interconnected and how they influence each other (Fig. 4.2-1).

All three models presented look at the person-environment relation by delving into the encounters between the reciprocal characteristics with the aim of finding those that constitute an obstacle to activity. PEO model employs the transactional mutual relations (Strong, et al., 1999) to better investigate how the characteristics belonging to each of the three dimensions (i.e. the person, the environment and the occupation) relate to each other. The analysis of their correspondences determines the suggestion of changes in one or more of the characteristics involved in order to achieve a better match. For example, the suggestion of the use of an aid for the person's abilities, a different layout, as well different modalities of performing the activity, can constitute changes to improve the match of the reciprocal characteristics and thus the final performance. The Enabler model, instead, identifies links between the personal and environmental characteristics by marking the possible problems in their reciprocal correspondence (Steinfeld & Danford, 1999). Similarly, but through a different graphic representation, the Users-Built Environments model links the users' abilities and activities with the environment's aspects and elements in order to highlight possible conflicts (Froyen, et al., 2009b). The links representing the possible conflicts are then collected and addressed through the so-called UD patterns to inform for better design solutions.

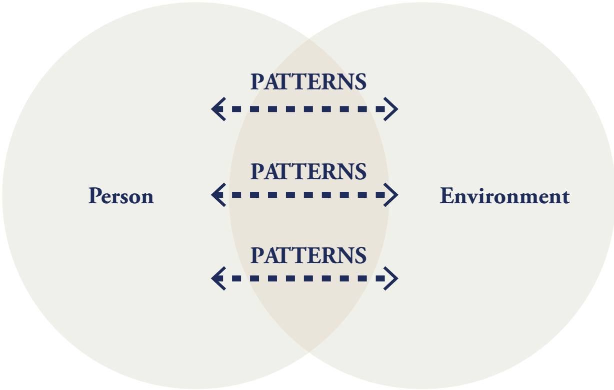


Figure 4.2-1 Relations between person and environment mutual characteristics

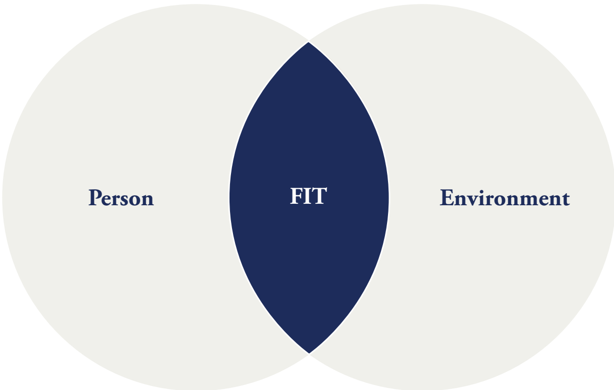


Figure 4.2-2 Person-environment FIT as the possibility to perform an activity

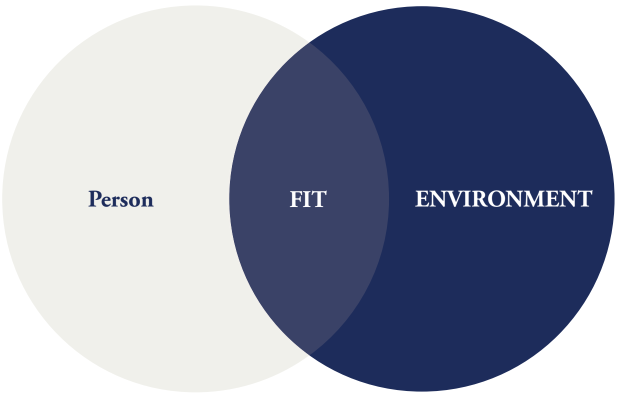


Figure 4.2-3 The role of the environment in the person-environment FIT

4.2.2 Person-environment fit

Spatial experiences are dynamic phenomena that imply a person carrying out an action in the space, such as standing, moving, walking, grabbing, and so forth. Person-environment relation concerns the extent to which the possibility of performing these activities is hindered or enabled by the mismatch or match between the characteristics of the environment and the functional characteristics of the person (Steinfeld & Danford, 1999) (Slaug, et al., 2015). As expressed by the ICF framework, the condition of disability arises from a limitation in performing activities due to a mismatch between the person's characteristics and those of the environment. All of the three models presented focus on investigating the person-environment relation through the analysis of the person-environment *fit* (Fig. 4.2-2) manifested through the performative character of this relation and achieved thanks to a successful design of the built environment (Alexander, 1970).

While the PEO and Enabler model also provide information about the extent of the person-environment fit, the Users-Built Environments model is only concerned with the production of a list of possible situations of mis-fit together with the indication for their resolution. Especially for the PEO and Enabler models, the personal environmental *fit* is considered achieved when a *balance* (Nahemow & Lawton, 1973) between personal impairments and environmental characteristics (Steinfeld & Danford, 1999) is observed during the performance. The usability of the environment is determined by the extent of this balance; it is measured in reference to the personal satisfaction of the performed activity (Steinfeld & Danford, 1999) together with the judgement of professionals (i.e. the therapist and the architect). The extent of the person-environment *fit* is proportional to the degree of user autonomy in performing the activity. Particularly in occupational therapy, where the focus is on the singular person, the aim is to increase this extent for improving individual independency and participation. The Enabler model, on the other hand, focuses on the environment and aims to evaluate accessibility by scoring the disabling person-environment intersections and thus provides a numerical calculation of the extent of person-environment mis-fit, along with possible interventions.

4.2.3 The mediating role of the environment

The reviewed analytical models aim to assess the individual's capacity for independent living by examining individual and environmental variables contextually and according to their mutual influences. A common characteristic of the considered models is that they have all been developed for looking at the relationship between the functional limitations of the person and the demands of the environment in order to identify how activity limitations and restricted participation arise from the encounter with potential architectural barriers (Fig. 4.2-3).

According to the Docility Hypothesis (Nahemow & Lawton, 1973), the person's ability to perform is found in the balance between personal limitations and environmental demand. This balance is reached through modifications and adjustments of the physical setting in order to decrease the environmental demand. Through this kind of approach, the reviewed models evaluate and address the person-environment relation by identifying and removing the negative influences of architectural features on individuals' activities. All these models in fact analyse and investigate the person-environment relationship by observing, predicting and explaining situations of disability experienced due to high environmental demands. This provides important information on the characteristics of the environment that determine *disabling* mechanisms and constitute barriers to the individual's performance; however, the *enabling* mechanisms are not investigated and addressed as such.

4.3 Knowledge gap: the enabling potential of the built environment

In the equation B=f(P;E) (Lewin, 1951), behaviour (i.e. the performance accomplishment) is determined as transactional by the balance between the person and the environmental variables, and thus also influenced by changes of any of these. According to the Docility Hypothesis (Lawton, 1982) (Lawton & Nahemow, 1973), the environment brings into play a "press" within this relation (Nahemow & Lawton, 1973) that could be either supportive or challenging (Steinfeld & Danford, 1999). Existing research on the person-environment relation addressed the balance of the person-environment relation either by focusing on empowering the individual's capacity (Golant, 2011) (Lawton, 1989) (Oswald & Rowles, 2006) or on lowering the environment's barriers and demands (Iwarsson, 1999) (Steinfeld & Danford, 1999). When it comes to people with impairments, architecture is often experienced and addressed as a barrier. However, the intrinsic potential of architecture to empower user activity suggests that understanding the dynamics between the person and the environment can also be seen from the perspective of the potential enabling role of the environment.

Within a Universal Design perspective, new research should be developed so to also investigate the supportive role of the environment to individual performance and participation in space. Through this new perspective, the B=f(P,E) equation could be approached differently, examining how the environment variable can balance this equation by exerting a supporting and enabling role. Furthermore, investigating the potential of the environment to enable the experiences of users with physical and sensory disabilities may be an opportunity to better include multisensory environmental aspects that enrich the user experience. In this sense, the theory of architectural affordances and their relationship to cognitive, physical and social aspects of user experience can provide insights into how sensory and functional characteristics of architecture can offer users the possibility to better experience space both physically and sensorially.

This knowledge would enable architects to approach designing for people with impairments no longer by only avoiding designing barriers, but by also using the intrinsic potential empowering role of architecture design. This would also make it possible to address the design of accessible and usable spaces in a more integrated way during the design process and not merely through the fulfilment of recommendations aimed primarily at reducing environmental demand. Furthermore, insight into the potential support of architectural features could provide architects with the opportunity to make use of them creatively, aiming for a higher quality of space and experience, not only for impaired users, but for all people.

4.4 Research questions

The design of the built environment is directly responsible in limiting participation of people with impairments (Lid, 2020), who, not having the possibility to easily perform, participate less in sports and leisure activities than people without. CRPD calls for the adaptation of new appropriate approaches, relative legislation, and measures for implementing the recognized human rights and for abolishing any situation of discrimination (UN, 2007). Alongside this, inclusive design approaches, such as Universal Design, are calling for the adaptation of design practice for better understanding and addressing the spatial experience of people with impairments in the built environment (Lid, 2013).

Therefore, the main research question this study aims to address is:

Main research question

How can we develop UD strategies for the design of sports and leisure buildings that can better enable the activities of users with physical and sensory impairments and thus support their participation and inclusion in society?

Based on the phenomenological understanding of person-environment relation, and the theory of affordances presented in Chapter 3, an in-depth investigation of spatial experiences of people with mobility, visual, and hearing impairments can reveal the crucial role the environment has in facilitating and stimulating activities in sports and leisure buildings. Through the investigation of impaired users' spatial experiences, the aim of this research is to develop knowledge on the enabling role of the environment in supporting their activities and, thus, their participation and inclusion. This brings to the first objective of this research which is to investigate impaired users spatial experiences of sports and leisure buildings for identyfing the role of the environment in improving usability.

Hence the first sub-question concerning the means of investigation:

Research sub-question 1

1) *How can we investigate spatial experiences of people with mobility, visual and hearing impairments in order to identify how the dimensional, visual, tactile and acoustic characteristics of the built environment influence, support, and stimulate people's activities in the space?*

Spatial experiences are a complex phenomenon, the investigation of which requires the use of an analytical model that can support the analysis of the interaction between personal and environmental characteristics. The first sub-research question aims to guide this study on how to develop a new analytical model for investigating users' spatial experiences. Existing analytical models, although reliable tools for evaluating such interaction, do not consider the positive role that architecture has in supporting and facilitating the activities of people with physical and sensory impairments. In this perspective, based on the variables considered from the existing models, this research develops a new model that can further integrate the current knowledge on the person-environment relationship. Therefore, the first sub-research question leads to reflecting on the variables to include in the new analytical model for investigating the usability of the built environment.

The implementation of the Universal Design approach in architectural practice reaffirms the need to better understand the role of the environment within the interactions that occur with people with different bodily abilities. The existing body of such knowledge is still focused on the disabling influence of the environment and for this reason informs design practice with minimum requirements to avoid the design of barriers. The different knowledge about the enabling role of architecture could instead suggests architects with new ways of addressing accessibility and usability through design. Architects, by knowing the enabling potentials of the environmental vaiables, can creatively design these meanwhile exploiting their potential and offering more accessible, usable and inclusive spaces. Second objective of this study is therefore to frame the knowledge on the impaired users spatial experiences for providing architects with design strategies for more accessible, usable and inclusive sport and leisure buildings.

Hence the second sub-question addressing the knowledge developed through the investigation:

Research sub-question 2

2) *How can materiality, dimensions, organisation, lighting and acoustics improve the usability of the built environment and thus the inclusion of users with mobility, visual and hearing impairments in sport and leisure activities?*

The second sub-research question aims to structure and synthesise the knowledge developed through the investigation of users' spatial experiences about which features are particularly significant for their performances in space, and how these identified features have potential in contributing to the improvement of users' cognitive, physical and social activities. This research-based knowledge can both substantiate the current design strategies for inclusive design, and provide new information for the development of solutions that better enable and empower different abilities and activities.

5 METHODS FOR THE INVESTIGATION OF THE ENABLING ROLE OF THE ENVIRONMENT

This chapter presents the methodology employed for the investigation of the role of the environment in enabling user performance. Based upon a phenomenological understanding of the person-environment relation, this study investigated impaired users' spatial experiences contextually in two selected sports and leisure buildings. This investigation aimed at deepening person-environment relations by considering the enabling role of the environment supported by the theory of affordances. In the previous chapter, a review of current analytical models for the investigation of interdependencies between the person and the environment was conducted. This review informed the development of a new analytical model, built around the concept of usability and made operable through the theory of affordances. This newly-developed model supported the collection and the analysis of data with the objective of revealing the experienced affordances, and, in so doing, the potential enabling role of the environment.

This chapter is organised into four main sections:

Section 5.1 – Case Study research for the phenomenological investigation of users' spatial experiences in real contexts – describes how the phenomenological approach presented in Chapter 3 is employed in this case study research to address the complexity of impaired users' perception and their experience of offered affordances in contextual settings.

Section 5.2 – Two exemplary cases of sport and leisure buildings– presents the criteria and reasons which motivated the selection of the two case studies. This section introduces the two buildings, Vandhalla and Musholm, and their characteristics in relation to Universal Design approach.

Section 5.3 – The new analytical model to investigate the enabling role of the built environment – presents the new analytical model developed for the study of users relation with the characteristics of the built environment. The analytical model, based and framed around the concept of usability, integrates the concept of affordances to guide the investigation of the enabling mechanisms. The model is a tool to collect and structure the enabling influences of architectural features experienced by users with mobility, visual and hearing impairments, and to support a reliable analysis of person-environment mutual interrelationships.

Section 5.4 – Methods for data collection and analysis – presents and describes the methods used to collect data from the case studies and to analyse the person-environment relation using the developed analytical model.

5.1 Case Study research: investigation of users' spatial experiences in real contexts

The initial concern of this research was how to conduct the investigation of impaired users' experience of the built environment. Depending on personal abilities and contextual situations, people act and react differently in the environment. In relation to the users' abilities to perceive and utilise the elements offered in the space, as well as in relation to desired activities (Bechtel & Churchman, 2003), specific elements are noticed and experienced (von Uexküll, 1992); this determines the realisation of the person-environment interaction. In order to describe and capture the essence of these contextual person-environment interactions, this research employs a phenomenological approach. The main aim of phenomenology is to explore the specific instances of an experience, through which one might describe the essential nature of the phenomena (Seamon, 2000). This study employs a phenomenological approach to define the elements in play within the temporal, physical and social uniqueness of the investigated experiences, and, in so doing, reveal the enabling essence of the contextualised person-environment interaction (Gallagher & Marcel, 1999).

Drawing upon phenomenological theories, this study considers individual lived experience as the main means through which knowledge of the experienced phenomena, and their influencing aspects, can be obtained (VonderBrink, 2007). For the phenomenological investigation of experiences of single or multiple events in context (Yin, 2009), this study was conducted through case study research. Case study research is defined in the Merriam-Webster on-line dictionary as "an intensive analysis of an individual unit (as a person or community) stressing developmental factors in relation to environment" (Merriam-Webster, 2009). This definition guided and determined the choice of case study as the appropriate methodology to employ in this research (Flyvberg, 2011). First, the choice of the person as the *individual unit* of study was necessary in order to consider the unique individual perception and experience of space. Second, the *intensive analysis* was critical to comprise a rich and varied collection of real-life circumstances for a comprehensive understanding of *what* users experience and *how* they experience it. Third, the *developmental factors*, understood to be interrelated events that constitute the case (Flyvberg, 2011), allow for the consideration of design development and the integrated intentions of architects to support the activities of users with physical and sensory impairments. Finally, the *relation to environment,* which represents the phenomenological approach of this research, allows for the investigation of users' encounters with the built environment, revealing how architecture can play an enabling role within person-environment relations.

Case study is a methodology that is often used to describe, explain and evaluate contextual phenomena and to answer research questions posed in the form of *how* (Yin, 2009), as in the case of this study (i.e. *How can materiality, dimensions, organisation, lighting and acoustic improve the usability of the built environment and thus the inclusion of users with mobility, visual and hearing impairments in sport and leisure activities?).* Case studies therefore offer the possibility of answering this question through the collection and interpretation of descriptive information about user experience of architectural features that reveals the object under investigation, in the case of this study, the enabling mechanisms in person-environment relation. Case study encompasses a systematic collection of data and the subsequent interpretation of the results, conducted through the active role of the researcher (Merton, 1948).

However systematic and structured the collection and interpretation of data on users' spatial experiences may be, they relate to contextual phenomena and are reduced to the subjectivity of the researcher's observation and interpretation of the phenomenon under study (Feldman, 2019). According to Yin, to overcome the issue of subjectivity, the construction of a logical path is necessary (Yin, 2009). This path includes the choice of the case(s) according to certain criteria, and the clear definition of the object of study, which must guide the collection and analysis of data (Feldman, 2019). For this study, two cases were considered and selected as representative examples of Danish sports and leisure buildings designed with a Universal Design approach. The definition of the object of this study determined the selection of these case studies as a means through which to investigate the enabling role of the built environment.

The subsequent analysis and interpretation of the results from the investigation of users experiences is thus guided by the identification of patterns in which the characteristics of the built environment played an enabling role. For doing so, the use of an analytical model that can act as a bridge between theory and empirical data collection can support the understanding and the interpretation of these patterns (Yin, 2009). Through the interpretation, and the subsequent generalisation, (Flyvberg, 2006) of contextual enabling mechanisms, case study methodology can finally offers the possibility to develop knowledge which can contribute to outlining new ways of designing enabling environments.

5.2 Two exemplary cases of sport and leisure buildings

In this study, the built environment is considered to be the pivotal factor in contributing to the improvement of people's experiences and the stimulation of their activities. The body of existing research in this area focuses on the disabling mechanisms in the person-environment relation; in contrast, this study intends to identify enabling mechanisms of the environmental characteristics. As part of this research, field investigations of person-environment relation were conducted in two case studies. The main criteria for the selection of these case studies was the presence of design solutions aimed at supporting users with physical and sensory impairments, and where the intention of the architects was to offer something more than a physically accessible building.

The decision was to start with buildings that represent the state of the art in the application of Universal Design in the Danish context, and to consider the case study as an opportunity to gain insights into how architecture can support users' participation, to validate the design choices, and to explore how they can be further improved. The aim of this investigation is in fact to establish how users experience these solutions and how the designed characteristics of the built environment contribute to the usability of the space. Furthermore, in addition to testing and verifying the contribution of these solutions, this study aims to explore and identify further person-environment enabling mechanisms and thus provide knowledge on the potential of the built environment to support the spatial experiences of users with physical and sensory impairments. For this purpose, two exemplary cases from Denmark, which aimed to integrate innovative and inclusive solutions, were selected.

Vandhalla – a sports center in Odder (Fig. 5.2-1), and Musholm – a multi-purpose sport hall in Kørsor (Fig. 5.2-2), were selected for this study. The buildings have been considered remarkable for their approach to thinking about, and addressing, the value of equity through architectural projects. The two projects have been featured in articles in local newspapers and specialized magazines on both architecture and disability such as Handbog and Handicap nyt (Fig 5.2-3). In addition, both projects have also been object of study in research articles because of the way the issue of accessibility has been treated as a quality aspect of design. These studies, listed in the APPENDIX C and D have been considered in this study as main references for the understanding of the design process of these two buildings and the way accessibility and inclusion have been embraced and considered for offering users opportunities to participate.

In the following sub-sections Vandhalla and Musholm buildings are introduced by presenting the goals of these projects and the reasons behind their uniqueness - starting from the big commitment that the clients and the architects showed in understanding users' needs and in translating the value of inclusion into physical design solutions.

Figure 5.2-1 Vandhalla Egmont rehabilitation centre

Figure 5.2-2 Musholm holiday and sport center

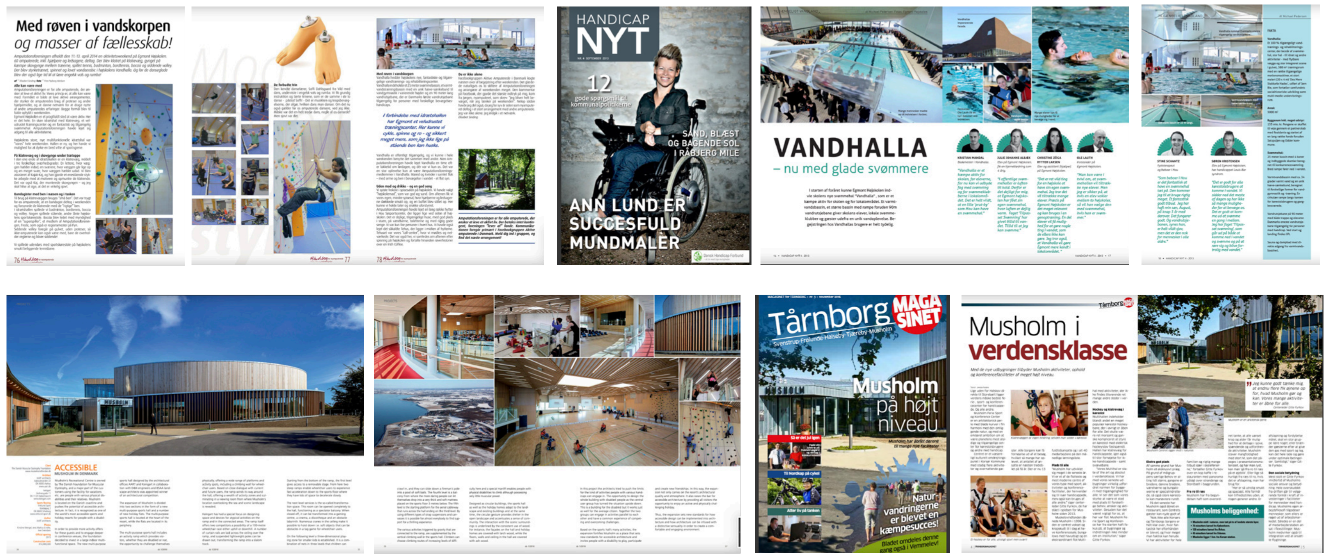


Figure 5.2-3 Press articles on Vandhalla and Musholm buildings

5.2.1 Vandhalla – a landmark of accessibility

Vandhalla is a sports center designed in 2009 and opened in 2013 as an extension of Egmont High School; it includes an indoor swimming pool and a multipurpose gym. Egmont, founded by Oluf Lauth in 1956, is located in Hou and is a high school for people with physical disabilities. Over the years, the school has been expanded and renovated with the aim of accommodating an increasing number of students and offering them an increasingly accessible environment. Egmont High School's ambition is to improve students' lives and offer them opportunities to participate in educational and physical activities, as well as strengthening their independence and building new social relationships.

In 2009, with the involvement of Realdania, a competition was set up with the aim of expanding Egmont's offer with an accessible swimming pool and rehabilitation centre. The main requirement of this competition was to design a building that represented the state of the art of accessibility through innovative solutions capable of considering the needs of users with physical impairments, but also of challenging users' capacities and independence. For this competition, five project teams were selected, including the winning team consisting of CUBO Architects (CUBO) and Force4 Architects (Force4) with landscape architects GBL - Group for Urban and Landscape Planning Aps, and the engineering firm Hundsbæk & Henriksen A / S.

The new extension consists of a 25 meter long swimming pool, a hot water hydrotherapy round pool, a multipurpose hall, and an audio-visual space. These spaces are built around a functional hub with toilets and dressing room (Fig. 5.2-4). Both swimming pools are accessible by stairs and by a ramp so that wheelchair users can also easily access the water (Fig. 5.2-5). In the pool area, there is a 90 meter long water chute which can be reached by stairs or elevator. For the main activities, the building offers a big multipurpose hall which is connected to a smaller exercise room with accessible machines for team training or individual exercise and rehabilitation. The central functional hub, which is reachable from all the other areas, includes a unisex dressing room in addition to those dedicated to women and men.

Force4's working method, based on in-depth research on users' needs and differences in perception and use of the space, helped to propose the initial ideas in the first phase of the competition - like the swimming-pool ramp and a continuous distribution flow. This knowledge, which was previously developed by Force4 for the unrealized Fremtidens handicapbolig (Future disability housing) project, has been shared with CUBO and has been developed by the design team along the two phases of the competition (Grangaard & Ryhl, 2016).

Grangaard and Rhyl (Grangaard & Ryhl, 2016) (Grangaard & Ryhl, 2017), in their in-depth post-occupation study which was focused on the design process of Vandhalla, trace and analyse the two phases of the design competition and the evolution of the architects' approach in understanding the concept of equity and pursuing inclusivity through architectural design. While in the first phase, equity was approached by providing one solution for all, in the second phase it developed into the design of more alternatives to accommodate the wide diversity of users. Furthermore, in the first phase, the design solutions were mainly aimed at supporting users with physical impairments, but the architects' increased awareness of human diversity allowed them to broaden the target group of users in the second phase, where solutions that take into account sensory impairments were integrated to enhance the understanding and personal experience of the space.

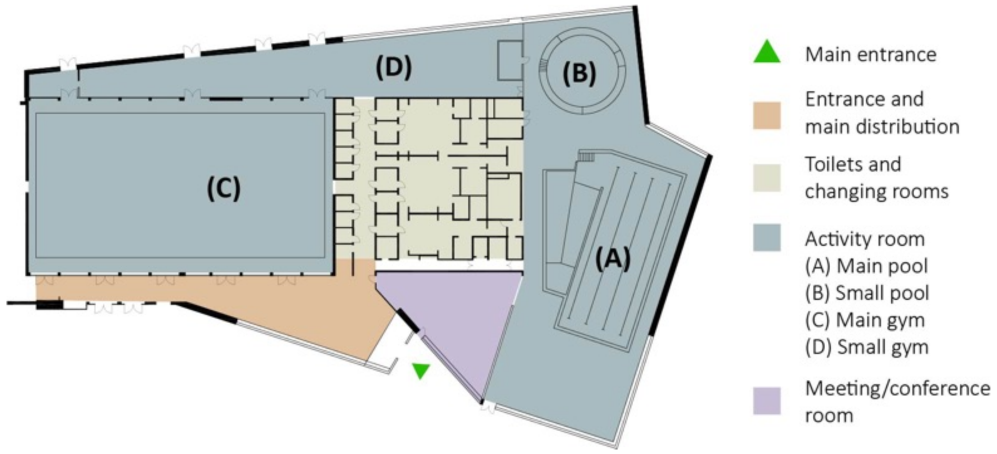


Figure 5.2-4 Vandhalla Building program

Figure 5.2-5 Vandhalla Swimming-pool ramp

According to the evaluation presented by Grangaard and Rhyl, Egmont's ambition to offer a fully accessible environment where students can train and grow has been embraced by the architects, who have shown a high sensitivity in the approach to the project and in the development of the implemented solutions. These aspects determined the special character of this project, as well as the reason why it was selected for this study.

5.2.2 Musholm – a place for including and challenging users' abilities

Musholm project arises from the desire of the Danish Muscular Dystrophy Foundation to have a holiday, sports and recreational facility that can be used and enjoyed by people with any mild or severe physical impairment along with their relatives. The multipurpose facility designed by AART and Keingart in collaboration with C&N engineers and BSAA landscape architects was built in 2015, as an extension of the existing holiday facility established in 1998, to offer guests a space to hold conferences or sporting competitions. The ambitions for this extension, as in the Vandhalla case, were to set a new standard for accessible architecture where people are invited to play, participate and share meaningful experiences with both their peers and family. Even though people with physical impairments were seen as the core user group, the clients' and architect's intention was to make room for differences and challenge the traditional approach to accessible architecture by creating high-quality spaces for any citizen, regardless of different capabilities.

The extension is based on a central multi-purpose hall for sports, concerts and conference activities. In addition to the building dedicated to collective and sports activities, the extension saw the construction of an additional building with 24 guest rooms. A particular feature of this extension is the 110-metre-long activity ramp (Fig. 5.2-6) which surrounds the multi-purpose hall by leading guests to the panoramic viewpoint on the Great Belt's coastline. Along this ramp, a sequence of plateaus offers the opportunity to engage in challenging physical activities, like the 30 meter cable-lift and the 6 meter high climbing wall. In addition to the main hall, the extension includes a meeting space, which can be divided into two independent meeting rooms and an area where dressing rooms and toilets of different size are located (Fig. 5.2-7).

The design process involved Bexcom, a consulting and project company established in 2004 by Karin Bendixen. Bexcom supported the design team by facilitating meetings with end users during the design process and providing architects with specific knowledge about users' needs. Through focus groups

Figure 5.2-6 Musholm Activity ramp

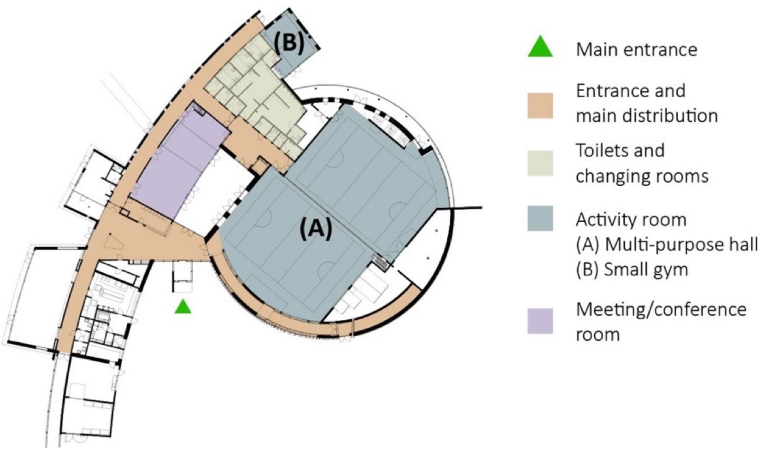


Figure 5.2-7 Musholm Building program

involving users with different impairments, interests and desires, the architects had the opportunity to present their ideas throughout the design phase and be able to discuss problems, opportunities and alternatives with interested users. Musholm received many recognitions as the world's most socially inclusive building. In 2017, Musholm won the Culture Ministry´s Sports Prize for putting Denmark on the world map in terms of giving everyone, regardless of ability, the opportunity to practise sports. The project was also awarded as "Best indoor sports and leisure facility" and it received the Grand Award at the 2016 IAUD (International Association of Universal Design) in Japan.

The awards received demonstrate the quality of this building's approach to inclusiveness and support the choice of this building as the second case study for this research. Indeed, it is internationally regarded as a remarkable example of how the topic of accessibility can be rethought to become a starting point for designing spaces which are not only physically accessible, but also sensorially stimulating and pleasant for everyone to inhabit.

5.3 The new analytical model for the investigation of the enabling role of the built environment

Investigating people's spatial experiences in real environments and contexts involves a high degree of complexity. Even with a small number of people, the diversity of individual characteristics and their ways of perceiving and relating with space are countless and changeable, both over time and contexts. In the case of complex dynamic relationships, such as those between the environment and individuals, analytical models can give a dual contribution. First, they can link theory and empirical research to structured processes of investigation and interpretation of observable phenomena in real contexts (Yin, 2009). Second, in the specific case of disability studies, they allow for the framing of individual and environmental factors by developing and qualifying knowledge of disabling and, in the case of this study, enabling mechanisms arising from person-environment relation (Imrie & Luck, 2014). For these reasons, following the review of the existing analytical models conducted in Chapter 4, this study developed a new analytical model to approach and operationalise the investigation of person-environment relations by anchoring the study to the key concepts of usability and affordances, which represent and exemplify the enabling character of the investigated relation. On one hand, usability represents the congruence and mutual responsiveness between individual and environmental characteristics, where participation and inclusion can manifest and therefore can be investigated. On the other hand, the theory of affordances allows for the investigation of the role of the environment in offering better possibilities for participation and thus inclusion.

The definition of the new analytical model stemmed from the concept of the person-environment relation presented in Chapter 3. Like in the PEO model (Law, et al., 1996), the Enabler model (Steinfeld & Danford, 1999) and the Users-Built Environments model (Froyen, et al., 2009a) presented in Chapter 4, the newly-developed model considers individual and environmental factors and analyses them in their relationship to assess the fulfilment of individual needs in the environment. Unlike existing models, the new model is developed based on the theory of affordances presented in Chapter 3.2, which is used in this analysis to reveal the opportunities that the environment offers users to perform their intended activities in space.

The following sub-sections present the analytical model developed and employed in this study. The first presents and defines the variables included in the model, while the second explains how the model is operationalised through the concept of affordances to link the considered variables and reveal the contribution of the environment to users' performances.

5.3.1 The definition of the analytical model and the variables involved

The analytical model consists of three main components:

- the *user*;
- the *environment*;
- the *activity*.

The model represents the dynamic interaction between these three dimensions. The person brings their physical, cognitive, emotional, and social characteristics to the experience, which in turn shape their perception and interpretation of the environment. The environment offers opportunities for actions and interactions which are shaped and influenced by its physical characteristics. Finally, the activity which shapes and provide the sense and meaning of the spatial experience (Fig. 5.3-1). The relationship between these dimensions is bidirectional, meaning that the person, the environment, and the activity mutually influence each other. Physical and sensory characteristics of the person may therefore influence their ability to act in the environment, while the environmental characteristics may shape the person's perceptions, intentions and feelings.

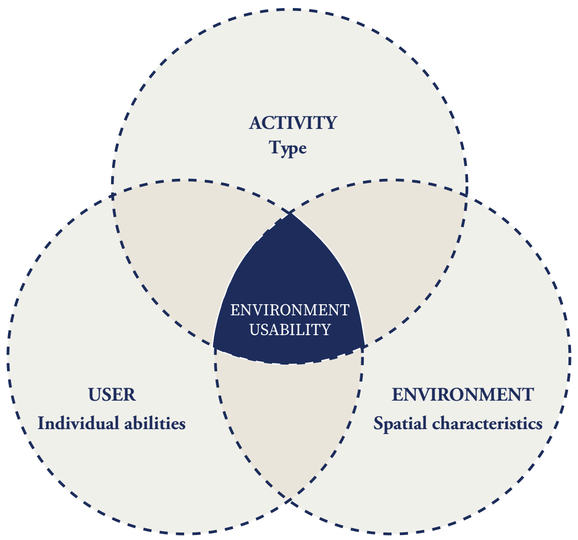


Figure. 5.3-1 Analytical model: the user, the environment, and the activity

Through this understanding, the person, the environment and the activity are represented by three interrelated spheres, the overlap of which represents the *environment usability* (Fig. 5.3-1). The three main variables of the model and their congruence represented by the environment usability are further specified in the following:

- **The user**

The sphere of the user refers to the single person, characterized by physical and sensory functionalities and abilities. This component allows this model to consider the subjective perspective of the spatial experience, as it is lived and reflected upon in all of its first-person detail (Pollio, et al., 1997). In addition to involving the user's body in perceiving and interacting with the environment, this dimension also involves the individual's intentionality (Seamon, 1982) to act and relate with the environment on the basis of individual interests, values, past experiences, and psychological aspects. For the investigation of this study, the sphere of the user specifically refers to three type of users: 1) user with mobility impairments, 2) user with visual impairments and, 3) users with hearing impairments. Mobility, visual, and hearing impairments have been identified as the main bodily impairments that greatly influence the dynamic of sensory perception and physical interaction between the person and environments. These three types of impairments affect the individual's skills and abilities to navigate and experience the physical and sensory characteristics of space. Therefore, the study takes into account the individual characteristics of these users, their subjective modalities and assessment of the space. with the intention to engage the users through participatory methods, cognitive impairments were not considered for this study as it was deemed necessary to have reliable and valid data from the users themselves, who possess the first-hand experience of the physical and sensory characteristics of the space.

- **The environment**

The sphere of the environment refers to the spatial context in which the user performs the activity. It encompasses the physical and sensory characteristics of the environment that the user can perceive and interact with. These characteristics include the materiality, dimensions, organization, lighting, and acoustics, which have been identified as the main design variables that influence the perception and experience of space by users with physical and sensory impairments. These characteristics were initially hypothesized and subsequently verified through the data collected on the users' experiences.

By employing a phenomenological understanding of spatial experience, these characteristics are investigated through the subjective experience of the environment from the user's point of view. This perspective emphasizes the importance of considering the specific context in which the person experiences the space, including the presence of other people and other contextual phenomena. This approach is particularly useful for investigating the impact of the environment on the user's activity or intention to act. With a phenomenological perspective, the component of the environment refers to the *segment of reality* (Smith, 1997) in which the user experiences the space. This perspective allows for the consideration of the uniqueness and specificity of the context in which the investigated spatial experiences take place, which can influence the user's activity or intention to act.

- **The activity**

The sphere of the activity refers to the cognitive, physical, and social activities carried out by the user in the environment during the spatial experience. Cognitive activities concern the activities of the user for the understanding of space, its elements, its functionalities, and the contextual aspects related to the environment they are experiencing. Physical activities are those which involve movement and the direct interaction of the user's body with the physical setting of the environment. Finally, social activities involve user interaction with other people and with the social context of the environment. These three types of activities have been identified based on the review of criteria for Universal Design and Usability evaluation presented in Chapter 3.3 and chosen as the main performative aspects in relation to users spatial experiences.

- **The environment usability**

The intersection between the spheres constitutes the fit between the three components. This intersection represents usability, which refers to the positive person-environment relation in which the individual's performance in the environment manifests itself. In this framework, usability is considered and evaluated in relation to the three dimensions. The supporting potential of the environment is evaluated in relation to the personal experience and satisfaction of the individual performing the activity in the environment (Iwarsson & Ståhl, 2003). This potential is associated with the physical design of the environment and the conditions that enabled the user's performance (Harun, et al., 2011). Furthermore, the usability of the environment is related to the outcome of the performance in relation to the user's expectations of interacting with the environment to perform the intended activity (Harun, et al., 2011). Therefore, in this analytical model, the intersection represents both user satisfaction and the conformity of the environment with respect to the performative character of the spatial experience.

5.3.2 The operationalization of the analytical model through affordances

The object of investigation in this study is the enabling role of the environment within the person-environment relation. To link data collection and analysis to the object of investigation (Feldman, 2019), the analytical model was further developed through the transactional interactions of the three main components so to include the concept of affordances and employ it to operazionalise the model for the identification of the enabling person-environment mechanisms which determine the built environment usability.

The three transactional interactions are defined in the model as:

- *user activity* (user-activity relation);
- *offered affordances* (environment-activity relation);
- *perceived affordances* (user-environment relation) (Fig. 5.3-2).

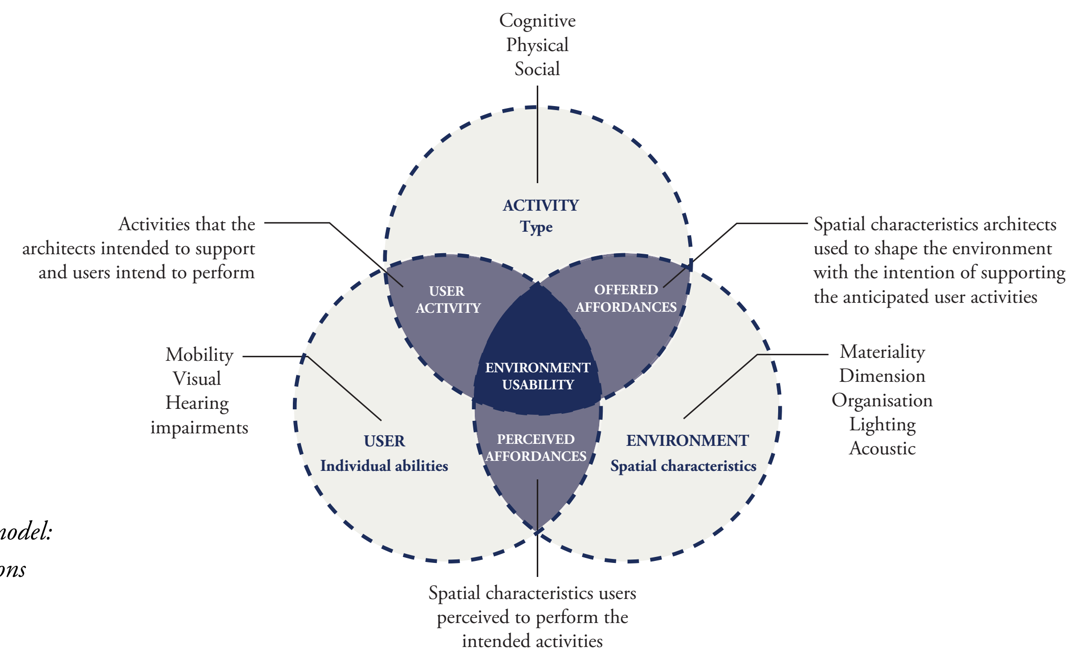


Figure 5.3-2 Analytical model: the transactional interactions

The developed analytical model, like the PEO model (Law, et al., 1996), considers the transactional interactions between the user, the environment and the activity (i.e. user-activity, environment-activity, and user-environment). While the PEO model uses these interactions to provide occupational therapists with more details for assessing and planning interventions (Strong et al., 1999), in this model, the transactional interactions have been introduced to better assess individuals' actual perception and use of the offered space in support of the performed activities. This will permit the use of this model to: 1) analyse the affordances offered by the architects through the design, 2) analyse how these are actually perceived and experienced by the users for their validation, 3) explore further characteristics of the environment which can be identified as affordances for an increased usability.

- **User activity**

Affordances empower and trigger actions and behaviours (Nisha, 2018), however, they are implicitly related to the perceiver (Tillas, et al., 2017) thus to their personal characteristics, expectations, desires, and needs to carry out certain activities in the environment. The user-activity intersection allows this model to collect and analyse data in relation to: 1) the activities that the architects intended to support based on the target users they considered, 2) the activities that the users involved in study carried out in relation to their characteristics and intentions.

- **Offered affordances**

Environmental properties offer opportunities for actions (i.e affordances), in the form of stimuli, information, and intrinsic spatial characteristics (Withagen, et al., 2012) that can be used by the user to perform an activity. Offered affordances are here considered as the characteristics of the environment in terms of visual, tactile or acoustic stimuli, that represent potential to enable users to understand and use the space to perform their activities. The environment-activity intersection allows this model to collect and analyse data in relation to *which* spatial characteristics architects used to shape the environment with the intention of supporting user activities.

- **Perceived affordances**

People perceive and focus on certain affordances to the exclusion of others based on their individual capabilities and process them according to their intentions, needs and the context in which they are experiencing (Pols, 2012). Perceived affordances are the characteristics of the environment which are encountered and processed by users as particular useful resources for supporting their cognitive, physical, or social activities. Through the user-environment intersection, this model allows for the collection and analysis of data on: 1) *how* users perceived and experienced the design solutions developed by architects to perform their activities, 2) *how* users perceived and experienced other spatial characteristics of the environment to perform their activities. The following table (Table 5.3-1) summarises the components of the analytical model, their definition and their connection to the empirical data collection and following analyses.

Table 5.3-1 Definition of the components of the analytical model and their reciprocal transactional interactions

DEFINITION OF THE USABILITY ANALYTICAL MODEL	
COMPONENT	**DEFINITION**
User	Subjective perspective of the spatial experience of users with mobility, visual and hearing impairments
Environment	Dimensional, visual, tactile and acoustic characteristics that shape the spatial setting in which the user's performance takes place
Activity	Cognitive, physical, and social activities carried out by the user in the environment
OPERAZIONALISATION OF THE USABILITY ANALYTICAL MODEL	
COMPONENT	**DATA COLLECTION and ANALYSES on**
User activity	1. ARCHITECTS' INTENTION
	Activities that the architects intended to support based on the target users they considered
	2. USERS' EXPERIENCE
	Activities that the users involved in the study performed or referred to in relation to their individual characteristics and intentions.
Offered affordances	1. ARCHITECTS' INTENTION
	Which spatial characteristics architects used to shape the environment with the intention of supporting user activities
Perceived affordances	VALIDATION of ARCHITECTS' INTENTION
	How users perceived and experienced the design solutions developed by architects to perform their activities
	EXPLORATION of USERS' EXPERIENCE
	Which spatial characteristics users perceived and experienced to perform their activities

By using this analytical framework, investigation of spatial experiences aimed to better unfold how the person, the environment, the activity, and their embedded characteristics relate to each other - to reveal the intrinsic offered affordances in space and thus provide more specific details about the positive mediating role of the environment.

5.4 Methods for data collection and analysis

The proposed field study comprises a systematic and in-depth investigation of the spatial experience of users with mobility, visual and hearing impairments. It consists of a mixed-method approach to reveal how spatial materiality, dimensions, organisation, lighting and acoustics contribute to enable the physical, cognitive, and social activities of disabled users in sport and leisure buildings. The study focused both on the environment as it was designed, and on how it was perceived and experienced by the users. The investigation first looked at the offered affordances, and how the architects shaped the space by considering the needs of the users to offer them support for their activities. After this, the second step of the research is to investigate how users perceived and experienced the spatial characteristics of the environment in relation to their ability to perform their activities. This includes both the affordances that were intentionally designed by architects and those that, even if not designed intentionally, have been perceived and experienced by users as supportive in their activities. Specifically, the analysis of the built environment, as designed, has been used to map the design solutions developed by design teams to support users' cognitive, physical and social activities. On the other hand, the users' engagement and direct observation of their activities in the space has been used for collecting insight into how these offered affordances are perceived and experienced in relation to the fulfillment of their activities and in reference to their different abilities. Users' insight therefore allowed to both validate architects designed solutions and explore how spatial materiality, dimensions, organisation, lighting and acoustics can further enable users' performances.

The data on the design of the architects and the experiences of the users for the two selected cases was gathered using a mixed-method approach. A summary of the research methods used for collecting and analyzing data are presented in Table 5.4-1. The following diagram in Fig. 5.4-1 illustrates how these methods were utilized throughout the study and depicts the analytical process carried out for this research. The next sub-sections subsections provide a detailed description of each method employed.

Table 5.4-1 Employed research methods for data collection and analysis

INSIGHT	DATA COLLECTION	DATA ANALYSIS
Architects' intention Collecting information about the building and mapping the design solutions implemented for improving cognitive, physical and social activities of users	a) Building's documentation review b) Semi-structured interviews with architects	e) Data coding f) Patterns analysis g) Thematic analysis
Users' experience Collecting and analysing information about influences of architectural features on experienced users' cognitive, physical and social activities	c) Walkthroughs with users d) On-site observations of users' behavior	

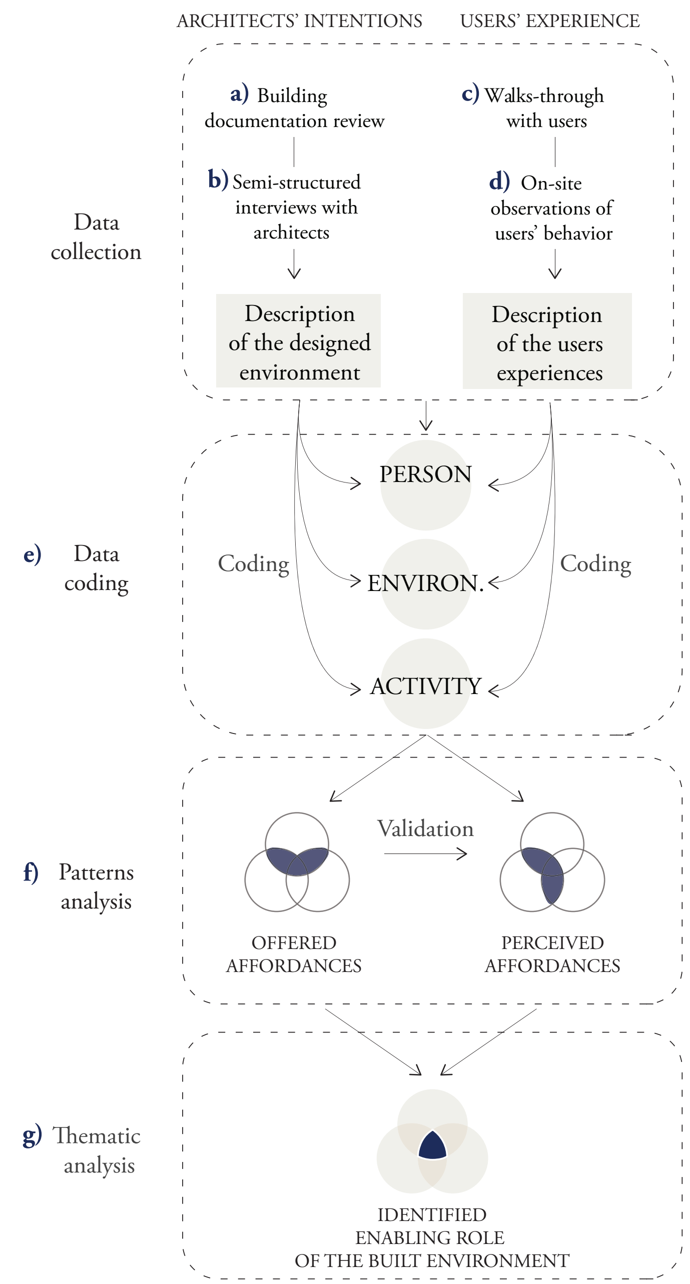


Figure 5.4-1 Process of data collection and analysis

5.4.1 Data collection

To collect data on the two case studies and on architects' and users' insights, this study employed four qualitative research methods:

a) **Building's documentation review**

The documentation of the buildings chosen as case studies was examined to collect and synthesise all the information about the design of these buildings, and the ways in which the architects addressed the needs of users with physical and sensory impairments through the design of space. The reviewed documentation includes architects' drawings, project presentations, pictures, and journal articles. Among the articles consulted are also post-occupancy evaluation articles conducted by SBi. Most of the documentation for the buildings examined was available online. Drawings and additional material were requested from the architects.

The purpose of the documentation review was to:

- verify the suitability of the two buildings as case studies for this research. The documentation review in fact made it possible to verify the initial information gathered about the two considered buildings and their approach toward accessibility and Universal Design.

- map the design solutions developed by the design teams to support users' cognitive, physical and social activities through the design of materiality, dimensions, organisation, lighting and acoustics. The mapped design solutions were subsequently discussed with the architects through semi-structured interviews.

The documentation reviewed and additional information for each case study are available in Appendix C for Vandhalla and Appendix D for Musholm.

b) **Semi-structured interviews with architects**

Semi-structured interviews were conducted with the architects responsible for the design of Vandhalla (Andreas Lauesen and Per Ravn) and Musholm (Kathrine Hegner Stærmose and Simon Philbert). All the interviews have been conducted in person except for one video-call interview with Kathrine Hegner Stærmose (AART Architects). While the interviews with Andreas Lauesen and Per Ravn were conducted at their respective offices, the interview with Simon Philbert was conducted at Musholm, the case study in which Simon participated in the design.

Interviews with architects aimed at:

- exploring architects' thoughts, feelings and beliefs towards designing for people with physical and sensory impairments

- learning about the design strategy employed in the respective projects considered as case studies

- collecting architects' considerations about how design solutions have been developed during the design phases

- learning as much as possible about the two buildings and the solutions implemented to support and improve impaired users' activities in space.

In this regard, semi-structured interviews were considered to be a valid method to gather information on the above-mentioned points, whilst still giving the architects the possibility to expand their answers, and to collect further information on the sensitivity of individual architects and the design approach of the office in which they practise (Horton, et al., 2004). The interview guide is available in Appendix E. The transcriptions of interviews are also available in the Appendixes (Andreas Lauesen – Appendix 01, Per Ravn – Appendix 02, Kathrine Hegner Stærmose – Appendix 03 and Simon Philbert – Appendix 04).

c) **Walkthroughs with users**

Walkthroughs with users formed the most important part of the project; this method allowed the generation, and collection, of detailed qualitative data by including users' personal accounts and opinions (Hanington & Martin, 2019). In fact, walkthrough fieldwork method allows for the inclusion of representative stakeholders, experts, and users for discussing and evaluating the object of study from the end user's perspective (Hanington & Martin, 2019).

In the second half of 2019, from July to December, a total of 17 users were interviewed, of which 13 were with mobility impairments, 2 with visual impairments and 2 with hearing impairments. The mobility impairments of the research participants include problems with walking, stability, strength and movement of one or more body parts. All of them used mobility aids, such as walkers, or manual or electric wheelchairs. Users with visual impairments included two blind users. One used a cane while the other had a guide dog for support. Finally, users with hearing impairments included one user who was deaf in one ear due to severe otitis and one user who was totally deaf from birth and only communicated through sign language. In order to interview this user, a sign language translator was needed, who was contacted and involved directly by the user. As both case studies are mainly attended by users with mobility impairments, users with visual and hearing impairments were recruited as participants in this study either personally by the researcher or through Dansk Blindesamfund ((Danish Blind Association) and Danske Døves Landsforbund (National Federation of the Deaf). The other participants were recruited as they were encountered on-site. The table below (Table 5.4-2) offers an overview of the users interviewed for each case study.

Table 5.4-2 Users interviewed for each case study

	VANDHALLA	MUSHOLM
Users with mobility impairments	- 4 students from Egmont Highschool - 1 user from "Back to life" rehabilitation project - 3 external users	- 2 members of Danish Muscular Dystrophy Foundation - 1 athlete of Danish Rugby in wheelchair - 2 external users
Users with visual impairments	- 1 blind user recruited from Dansk Blindesamfund (Danish Blind Association)	- 1 blind user recruited from Dansk Blindesamfund (Danish Blind Association)
Users with hearing impairments	- 1 user deaf on one ear recruited by the researcher	- 1 deaf user from Danske Døves Landsforbund (National Federation of the Deaf)

Before each walkthrough, there was an informal conversation with the participant for a mutual introduction and for facilitating the user to share their personal experiences. The opportunity to establish a direct connection with the interviewees and to observe their personal expressions or body movements within the space (Hanington & Martin, 2019) made it possible to verify their verbal responses as well as to enrich the information gathered. The walks with the users through the buildings aimed at creating an immediate knowledge of their experiences and their encounters with the materiality, dimensions, organisation, lighting and acoustic. During these walks, the space informed the user at the same time as the user acted on the space. By questioning users to describe their perceptions and actions within the physical space, the walkthrough technique allowed users to get acquainted with, and re-examine, the built environment through their senses and personal feelings (Sanoff, 1991).

Walkthroughs were a crucial method for collecting the most complex data with regard to the context being experienced and the individual experiencing it. With all users, the walkthroughs started outside the building and continued from the entrance to all investigated building environments. During the walkthroughs, the users were asked to say what they do in certain areas and how they feel when using these spaces. By asking users to describe their activities in different areas of the building, users expressed their usual challenges in relating to the space and the influence the designed space had in facilitating and supporting their intended activities in the environment. During the walks, the users not only answered the questions in relation to the investigated case study but also remembered and recounted previous experiences by providing examples of their experiences in other buildings. This data was considered as additional information to better understand contextual dynamics between the interviewed person and the physical environment.

To allow the subsequent analysis of these interviews through transcription and coding, with the permission of the users, walks were audio-recorded and, when possible, also video-recorded. Transcriptions of the interviews are available as an appendix in this study dissertation.

d) On-site observations

On-site observations were conducted in both the case studies to collect information about the users, the environment and the phenomena of users experiencing the environment. On-site observations allow the collection and extrapolation of data from the observation of events, phenomena, and behaviours as they occurred in the context (Zeisel, 1981). Observations of users' behaviour in the environment include notes on how they moved within, and interacted with, the space, as well as the contextual situation of the observed behaviour.

The focus of this non-participatory method was to:

- gain further information about significant relations that users had with the environment through the tactile, visual, and dimensional spatial characteristics (Zeisel, 1981)
- integrate the data collected through the walkthroughs by capturing further dynamics in a different contextual situation than the one of the users answering to the researcher's questions. In fact, through on-site observations, it was possible to observe the social dynamics between

users and how the environment played a significant role in supporting these.

Notes of the observations were taken on book notes, pictures, or building drawings, such as building plans and façades.

5.4.2 Data analysis

Given the focus of this research, the analysis of collected data concentrated on the performance of user activities. Specifically, the analysis referred to the affordances offered by the environment and the significance they assumed in the direct experience of the user with physical and sensory impairments. The data collected on the two case studies, and the insights of architects and users, was first coded and then grouped and framed according to the analytical model. The analysis consisted of three parts. The first was the *coding of the transcripts* of the semi-structured interviews with the architects and the walkthroughs with the users. Coding was made according to the three components of the model (i.e., the user, the environment and the activity). The second part was the *patterns analysis*, through which the key enabling mechanism was identified in the designed and experienced person-environment dynamics. The third and final part of the analysis was addressed through a *thematic analysis* for the definition of the narratives which interpret the enabling role of the investigated environmental characteristics.

e) Coding of transcripts

The first part of the analysis consisted of transcribing and coding the extensive data material gathered from the conducted interviews with architects and users of the two case studies. The interviews were transcribed in NVivo, which is a data analysis software employed in qualitative research (Welsh, 2002). Parts of the text were subsequently identified and categorised (coded), by virtue of their content, with reference to the components of the analytical model (i.e. the user, the environment and the activity). In order to develop the research on the basis of a reliable coding process (Boyatzis, 1998), the codes used in the analysis of the transcribed interviews were further defined and described as follows:

1) User

- **Mobility impairments** refers to impairments of the neuromusculoskeletal and movement-related functions of the person;
- **Visual impairments** refers to impairments in the seeing and related functions of the person. It also refers to impairments in visual acuity, visual field, and quality of vision;
- **Hearing impairments** refers to impairments in the hearing functions of the person. It also includes impairments in sound detection and discrimination.

2) Environment:

- **Materiality** refers to properties of the physical surfaces of the building and the elements within it. These also refers to the properties relating to materials such as colours, textures and consistence;
- **Dimension** refers to dimensional properties of the building and the elements within it. It also includes spatial scales and proportions;
- **Organization** refers to the organizational properties of the building and the elements within it. It also includes the spatial layout and distribution;
- **Lighting** refers to the elements in the environment which contribute to define the light-scape of the environment;
- **Acoustic** refers to the acoustic properties of the building and the materials used.

3) Activity

- **Cognitive activities** refers to the activity the person takes in the environment to:
  - understand the spatial configuration, identify spaces and elements
  - perceive the contextual situations happening around the building
- **Physical activities** refers to the activity the person takes in the environment to:
  - walk and move
  - approach and interact with physical elements in the space
- **Social activities** refers to the activity the person takes in the environment to:
  - engage in physical activities and social connections
  - have privacy

The codes, according to their definitions, were used to associate the descriptive information provided by architects and users with their reference to the three main components of the model. The attribution of the codes made it possible to examine the congruence between the user, the environment and the action, both in the architects' intentions and the users' experiences.

f) **Patterns analysis**

The analysis of the transcripts, once coded, focused on the phrases, expressions and reflections contained in the transcripts themselves (Salvini, 2015), in order to reveal how the factors regarding the user, the environment, and the activity were involved. The data collected in the empirical phase was then reprocessed to bring out the information content of the object of study, i.e. the enabling mechanisms in the person-environment relationship. The enabling mechanisms designed by the architects and experienced by the users were deepened through reflections that subsequently helped to identify how the reciprocal characteristics of the variables were linked to each other. These reflections led to the identification of patterns, i.e. common elements of the situations and circumstances (Yin, 2009). Patterns were identified between the spatial characteristics and the user activities, both in data collected on the architects' offered affordances, and the users' perceived affordances.

Through further reflection on the three components of the model and the data collected, patterns have been identified between the anticipated activities of users and the offered affordances by architects. These reflections focused on the users, the environment, and the activity. In particular, it delved into the characteristics of the users that the architects had in mind when designing the space, the characteristics of the environment being described, and the dynamics of user-environment interaction for which the solution was developed (Fig 5.4-2).

Similarly, patterns between the carried activities and the perceived affordances have been identified through reflections on the three components in regard to the affordances perceived by users. These reflections cover the personal circumstances and abilities of the interviewed users, the contextual characteristics of the environment that they are reffering in their descriptions of their experiences, and finally the activity that the users intended to perform within the built environment (Fig 5.4-3).

The patterns identified externalise congruencies between spatial characteristics and the performance possibilities offered by these. The congruencies reveal how spatial characteristics and user activities are related to each other, and how the former have the potential to enable the latter. In Chapter 6, the patterns identified are organised and presented according to the cognitive, physical or social activity enabled by the characteristics of the built environment.

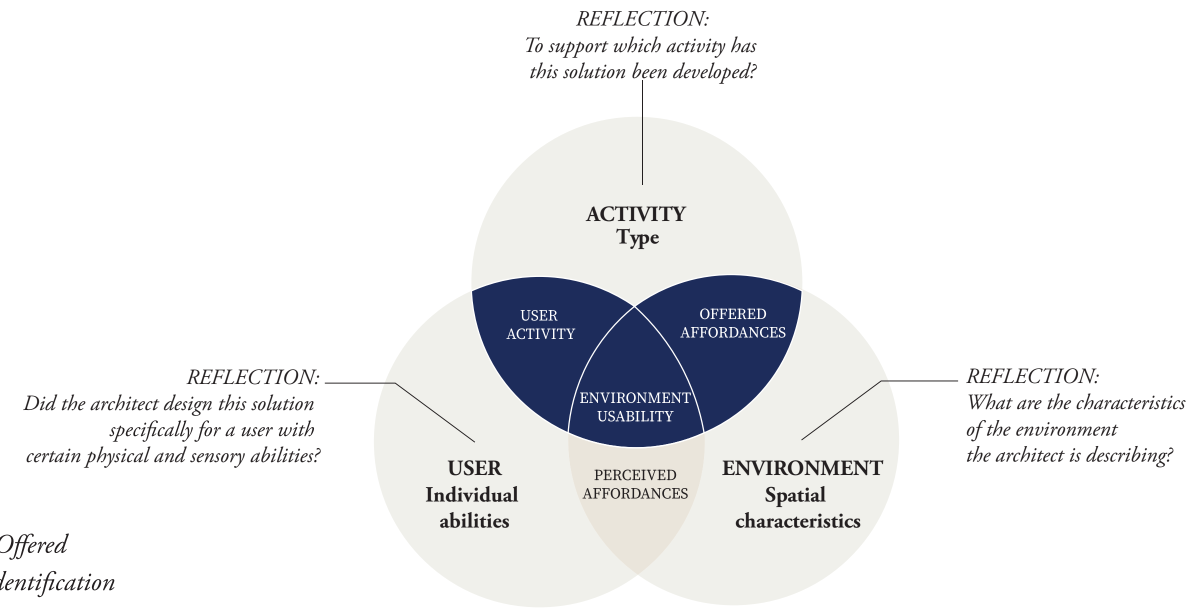


Figure 5.4-2 Offered affordances: identification of patterns

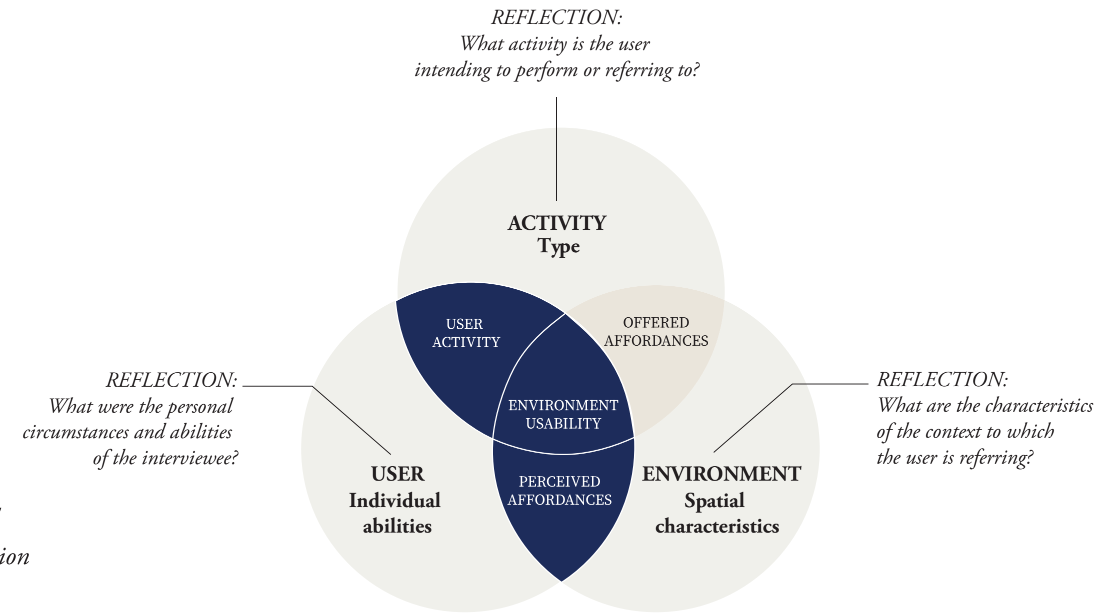


Figure 5.4-3 Perceived affordances: identification of patterns

g) **Thematic analysis**

To develop knowledge from the analysis of qualitative data (Boyatzis, 1998) this study employed a thematic analysis (Flick, 2013). The investigated relationships between the designed/experienced spatial characteristics and the supported/performed user activities shed light on the potential enabling role of the material, dimensional, organisational, lighting, and acoustics through their physical and sensory properties. The analysis of these relationships aimed at identifying coherent interpretative lines consistent with the analysed data and, thus, proceeding towards the development of design strategies related to the enabling role of the built environment. This analysis led to the identification of interpretative paths that summarise, represent, and describe the essence of the enabling mechanisms favoured by the characteristics of the environment. The identified affordances offered by the environment have been structured and presented according to the following interpretive paths, which intend to communicate the essence of the analysed enabling mechanisms offered for each architectural feature:

MATERIALITY: communicating spaces, elements, directions and contexts

DIMENSION: embracing differences in bodies and interactions

ORGANISATION: providing sensory, physical and social reach

LIGHTING: setting spaces and directions

ACOUSTICS: orienting in spaces and contexts

The analysis conducted was a transformative process in which the data collected on the influences of the environment was carefully interpreted to gain a deeper understanding of the users' experiences. This interpretation process provided valuable insights into the enabling mechanisms which motivated the investigation conducted in this study. Overall, the process of analysis was crucial in uncovering valuable information and understanding the underlying dynamics that shape the users' experiences. The results of the analysis allowed for the development of descriptions of these mechanisms, providing a deeper understanding of the relationship between the environment and the users' experiences.

6 CASE STUDY RESULTS

This chapter presents the analysis and respective results of the investigation of the two selected buildings: Vandhalla and Musholm. These two projects, as discussed in the previous chapter, were chosen as remarkable examples of how the design teams were able to translate the aim of achieving greater inclusion into solutions that were not limited to merely complying with the accessibility requirements of the Danish building regulations. The objective in both projects was, in fact, to offer solutions that would increase participation, and also stimulate activity, independence, self-esteem, and users' personal growth. In these projects, the architects developed and implemented design solutions with the intention of improving not only the possibility for the user to physically access. The architects also wanted users to be able to easily understand the space, carry out their daily activities and interact with other people. These solutions were developed during the design process as a result of a growing understanding of both the value of equity, and of the different characteristics of users and their varying ways of interacting with the environment. However, the architects had no evidence of how these solutions would be eventually perceived and experienced by end-users.

With the objective of revealing the enabling role of the built environment for the performance of impaired users, the analysis of the case studies aimed at identifying links between the characteristics of the designed architectural features and the users' activities. The design solutions implemented in Vandhalla and Musholm were identified, explored on site, discussed with the architects, and then linked accordingly to their contribution in supporting the cognitive, physical and social activities of users. Subsequently, the same buildings were explored through a phenomenological investigation, in which users were directly involved and questioned about whether, and how, the design of the built environment contributed to improving their experience and use of space. While the first analysis aims to map architects' design solutions developed with a Universal Design approach, the second analysis aims to validate these solutions and further explore how the built environment can support user performance.

This chapter is organised into two main sections:

Section 6.1 – The offered affordances: architects' intentions – presents the design solutions develeloped by architects in response to the requirements and objectives of their respective projects, and the information they used to define and integrate them during the design process. A review of the buildings' documentation, together with interviews with the architects and visits to the buildings, helped to identify and framed them within this analysis. This section presents these solutions according to their contribution to the cognitive, physical and social aspects of spatial experience. Each of these three aspects is further deepened by looking at the specific activities that the architectural characteristics enable.

Section 6.2 – The perceived affordances: users' experiences - presents the findings from the users' involvement and the investigation of their encounters with architectural features while experiencing the explored buildings. As in the previous section, the experienced characteristics of the design of the built environment are presented according to their contribution to the cognitive, physical and social aspects of usability and further deepened based on the corrisponding enabled activities.

6.1 The offered affordances: architects' intentions

In this section, based on the analytical model presented in Chapter 5, the built environments of the two case studies are analysed by first looking at the *offered affordances* in relation to users' activities in the space (Fig. 6.1-1).

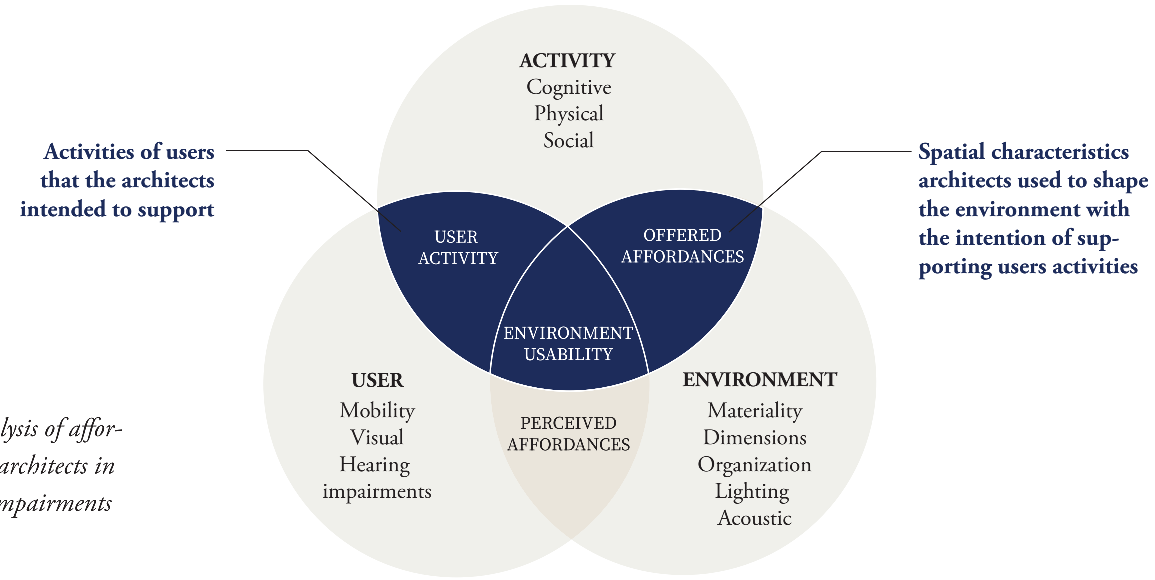


Figure 6.1-1 Analysis of affordances offered by architects in relation to users impairments and activities

The offered affordances presented in this section refer to the design solutions offered by architects in their respective projects. The descriptions and motivations for these solutions were provided by the architects during interviews or gathered from the examination of the buildings' documentation. The coding and subsequent patterns analysis of the collected data made it possible to group these design solutions according to their different contributions to user performances. The following sub-sections describe the identified patterns by refering to three categoriers of affordances:

a) cognitive affordances

b) physical affordances

c) social affordances

For each affordance category, the legal requirements of BR18 and the further indications of the SBi guidelines (that respectively refer to design contribution to the cognitive, physical and social aspects of accessibility and usability) are presented. Following the overview of the minimum level of provision is an examination of how the architects integrated these in the design, and how they have further utilised the dimensional, visual, tactile, organisational and acoustical characteristics of the built environment - all with the intention of better enabling users to orientate and interact in physical and social contexts.

Through this analysis, recurring correspondences were identified between the designed environmental characteristics and user activities. In each of the following sections, these correspondences are graphically represented through diagrams that display the activities on the left and the environmental characteristics, which are here considered as offered affordances, on the right. This allows for an easy visualization of the connections between the two. Following the graphical representation, each identified correspondence is further explained through a description of the motivations that brought architects to develop such solutions.

6.1.1 Cognitive affordances

In this analysis, cognitive affordances refer to all properties and characteristics of the built environment that architects designed to enable users to easily understand the configuration of the space, its distribution, and the contextual activities for which the environment has been built. This includes all the environmental characteristics designed to be perceived through the body's sensory capabilities and processed as information about the building's configuration, functionality and contextuality.

BR18 refers to orientation and spatial awareness in the general provisions on the design, layout and equipment of buildings. Chapter 2 of BR18, which deals with access provisions, indicates measures to ensure the accessibility of public buildings to all users, including users with sensory impairments. These measures refer to the characteristics of access areas, common accesses and paths, stairs, and general information about the building. The indications concern the use of colour contrasts and tactile surfaces for signalling any danger zones, access points or space transitions. Furthermore, in BR18, further requirements concern the use of lighting to ensure good visibility, especially of pathways and stairs.

For further guidance on the BR18's requirements, the regulation refers to the SBi guidelines. SBi indicates the importance of using colour and tactile contrasts to separate pedestrian and vehicular paths in parking areas, and to signal height differences such as steps. Visual and/or tactile contrasts of paving and wall surfaces are also indicated as solutions to improve spatial understanding and make access routes easily recognisable and navigable. The SBi also provides specific reecommendations for pathways, where the use of guiding elements on the floor, walls or ceiling is suggested, such as continuous visual and tactile elements which can provide spatial guidance. Details of the design specifications provided by the BR18 and the SBi guidelines for the improvement of cognitive usability can be found in Appendix A.

The two projects selected as case studies specifically addressed users with mobility impairments. However, in both projects, architects gained a growing understanding of the diversity of user abilities through user involvement during the design process. This encouraged them to consider users with sensory impairments too, and to integrate the recommendations indicated by BR18 and the SBi guidelines to better support users' understanding of the space and orientation within it.

We wanted to integrate sensory aspects into the physical form of the building in order to tell the same story to different users, especially in terms of wayfinding. Andreas Lauesen – Force4 (Appendix 01)

With the extension of Musholm, we also thought about other categories of disability, the vision, the hearing. The target was much wider here than in the existing building. Kathrine Hegner Stærmose – AART (Appendix 03)

This led the architects to integrate regulatory provisions within the design by developing the use of materiality and lighting, not only to define the layout and distribution of spaces, but also to allow users to better perceive the contextual situations around them. The diagram below (Fig. 6.1-2) illustrates the patterns identified between the designed architectural features and the cognitive activities they support.

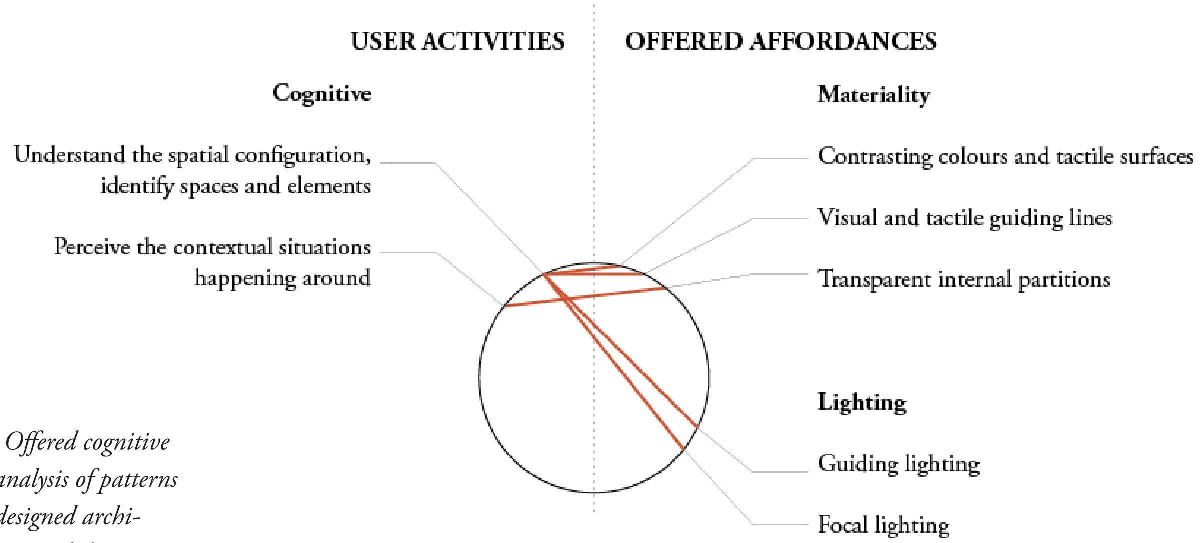


Figure 6.1-2 Offered cognitive affordances: analysis of patterns between the designed architectural features and the users' cognitive activities

The following sub-sections present, in detail, how the architects used materiality and lighting to enable users to:

- understand the spatial configuration, identify spaces and elements
- perceive the contextual situations happening around the building

6.1.1.1 Understanding the spatial configuration, identifying spaces and elements

In both projects, the architects aimed at designing spaces so that they were not only accessible and usable by people with mobility impairments, but by all users, including those with sensory impairments. In order to better define the interior spaces, their shape and distribution, the architects relied on the indications provided by BR18 and SBi's guidelines. The architects therefore worked mainly with materiality and lighting to provide visual and tactile stimuli that could be perceived by users as information for the understanding and orientation in space. To enable users to better understand the spatial configuration, and identify spaces and elements, the architects developed design solutions which refer to:

- contrasting colours and tactile surfaces
- visual and tactile guidelines
- guiding lighting
- focal lighting

Contrasting colours and tactile surfaces were used with the intention of providing visual and tactile information about the shape and distribution of the space. Furthermore, contrasting visual and tactile finishing of rooms and element surfaces was used in both the projects to offer information about the change of space, or the presence of elements within it. When approaching Musholm, in the outside area before the main entrance, different types of flooring are visually and tactilely perceptible. While the parking area is paved with smooth grey tarmac, the area surrounding the building has a lighter colour. A brick line, mostly perceptible by its difference in texture, divides and demarcates these two areas (Fig. 6.1-3). Additional visual and tactile information about the path towards the main entrance is offered by a surface area of about 1 m^2 of bricks with an irregular surface located at the beginning of this path coming from the parking area (Fig. 6.1-4). The architects decided to tactilely and visually mark this surface to the surrounding pavement to indicate and demarcate the path leading to the main entrance.

Figure 6.1-3 Musholm:
contrasting colours and tactile surfaces of the external paving

Figure 6.1-4 Musholm:
contrasting tactile surface of the external paving

On the inside, to facilitate spatial awareness, Vandhalla's architects used strong contrasts between doors and walls, floors and walls, and floors and ceilings. In this case, the architects decided to use highly contrasting colours, such as black and grey, for the floor, ceiling and doors, and white for the walls (Fig. 6.1-5). Visual contrast was also used for symbols and signage text. With the same intention, throughout the building, the orientation signs are in strong dark contrast to the white walls and text (Fig. 6.1-6).

Figure 6.1-5 Vandhalla:
contrasting colours at the entrance

Figure 6.1-6 Vandhalla:
contrasting doors in the corridor

In Vandhalla, architects used colours other than black and white to characterise the bathrooms and the three changing rooms A-B-C in the swimming pool. Each of the three changing rooms has a different recognizable colour, respectively yellow for the uni-sex changing room (A), blue for the women's changing room (B) and yellow-green for the men's changing room (C).

These three colours are used for each changing room for the letters on the access doors (Fig. 6.1-7) and for the wall tiles in the entrance area of the swimming pool (Fig. 6.1-8). Colours here were also used to help users to identify elements in the space such as the lockers in the changing room and the sanitary facilities in the bathrooms. In each changing room, the lockers are infact characterized by the same colour used for the wayfinding (i.e. yellow for the uni-sex changing room (A), blue for the women's changing room (B) and yellow-green for the men's changing room (C)) which creates a visual contrast with the white tiles (Fig. 6.1-9). The bathrooms, which are located both inside the changing rooms and along the corridor leading to the small gym, have coloured tiles that provide a contrast to the white sanitary facilities and accessories (Fig. 6.1-10).

Figure 6.1-7 Vandhalla:
coloured letter corresponding to the men and women changing rooms

Figure 6.1-8 Vandhalla:
coloured tiles corresponding to the men and women changing rooms

Figure 6.1-9 Vandhalla:
coloured lockers in contrast with the wall

Figure 6.1-10 Vandhalla:
coloured tiles in contrast with the accessories and sanitary facilities

In Musholm, the architects used materials, such as wood and concrete. With these materials, the architects created the contrast of colour between the rough grey concrete walls and the brown wooden slatted ceiling with the dark floor. The doors of the meeting rooms are also made of wood, contrasting with the light-coloured walls and dark floor. These materials are present at the entrance (Fig. 6.1-11) and along the corridor leading to the meeting and changing rooms (Fig. 6.1-12).

It is worth mentioning that in Musholm, architects carefully used contrasting colors and textures for the lockers in the changing rooms to aid users in identifying them in the space. The locker doors have a strong black and white contrast, used in a chequered pattern (Fig. 6.1-13). On each door, the number of the corresponding locker is not only in contrasting colours, but also tactually perceptible to enable visually impaired users to recognise their locker more easily.

Figure 6.1-11 Musholm:
contrasting colours and materials at the entrance

Figure 6.1-12 Vandhalla:
contrasting doors in the corridor

Figure 6.1-13 Musholm:
contrasting and tactile locker doors

Visual and tactile guiding lines have been used in Musholm to offer users visual and tactile information about the main internal routes, such as the route along the activity ramp and the corridor leading from the reception to the meeting and changing rooms. In the reception area at the entrance of the building, a white line, contrasting in colour with the rest of the dark flooring, is clearly visible (Fig. 6.1-14). This line, which is designed as an artistic element with a soft, curved profile, is intended to lead and invite the user from the entrance to the multi-purpose hall. From there, the line continues along the red activity ramp. A particularly prominent element in Musholm is the ramp around the large multi-purpose hall. The 110-metre ramp is easily identifiable by its bright red colour that contrasts with the neutral colour of the wood used for the multi-purpose hall. The contrast between the white line and the red colour of the ramp characterises this oblique distribution element as a running track to follow up to the highest point (Fig. 6.1-15). At the end of the ramp, the white line curves again (Fig. 6.1-16), inviting the user to use the lift or to walk back down the ramp to the starting point at the entrance.

In the corridor leading from the entrance to the changing room, the architects decided to experiment with a different solution. In this corridor, a wooden strip is visible in the flooring (Fig. 6.1-17). Initially, this strip was designed as a groove for water to provide visually impaired users with an acoustic guide to follow. However, for reasons of maintenance and practicality, this groove was subsequently enclosed in wood, creating a perceptible visual and tactile contrast with the rest of the flooring.

Figure 6.1-14 Musholm:
white guiding line on the floor at the entrance

Figure 6.1-15 Musholm:
activity ramp

Figure 6.1-16 Musholm:
white guiding line on the floor at the upper level

Figure 6.1-17 Musholm:
wood guiding line on the floor

Guiding lighting was used in both projects for the delineation of transition zones and for marking directions along paths. At the entrance to Vandhalla, this choice is immediately visible. Here, two linear, continuous light elements are positioned along the upper corners where the vertical walls meet the ceiling (Fig. 6.1-18). The type and location of these lights help the user to better define the configuration of the space and suggest to them the path to the other functional areas of the building. With the same intention, in Musholm, the small hanging bulbs placed at a short distance from each other along the corridor offer a reference point for users to follow along the direction leading from the entrance towards the corridor where meeting and changing rooms are located (Fig. 6.1-19).

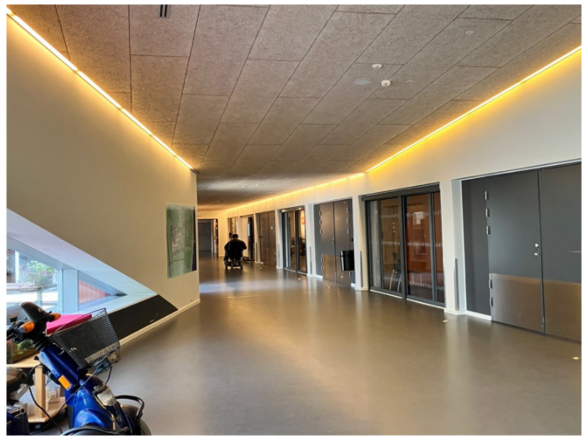


Figure 6.1-18 Vandhalla: linear light elements at the entrance

Figure 6.1-19 Musholm:
light bulbs along the corridor

Focal lighting was instead used for supporting users to facilitate the identification of spaces and furnishing elements. Both in Vandhalla and Musholm, pendant lights and skylights were used to relate the illumination with specific activities or to set the tone of the interior environments. At the entrances, the architects of both projects opted for pendant lighting elements to illuminate the spaces dedicated for meetings, conversations and sometimes even meals. The ceiling-suspended pendants illuminate the below surfaces locally. Whereas in Musholm the pendants are evenly distributed throughout the entire reception area, offering greater flexibility in furnishing for different situations and events (Fig. 6.1-20), in Vandhalla this type of lighting is limited to the table area at the entrance (Fig 6.1-21). A special feature of both projects is also the presence of skylights. These, illuminate the inner areas of the building, including the changing rooms in Vandhalla (Fig. 6.1-22) and the entrance in Musholm, by offering a more intimate tone provided by the natural zenithal light (Fig. 6.1-23)

Figure 6.1-20 Musholm:
pendant luminaries at the entrance

Figure 6.1-21Vandhalla:
pendant luminaries at the entrance

Figure 6.1-22 Vandhalla:
skylight in the changing room

Figure 6.1-23 Musholm:
skylight at the entrance

In Vandhalla, an additional type of linear focal lightingwas used to mark the presence and position of specific elements in space, such as the doors, the lockers and the pools. This type of lighting is present, for example, above the access door to the pool from the changing room corridor (Fig. 6.1-24) and above the lockers in the changing rooms (Fig. 6.1-25). The same lighting is used above both pools, the large rectangular one and the small circular one, where linear light elements delimit and define the edges of the pools below (Fig. 6.1-26) (Fig. 6.1-27).

Figure 6.1-24 Vandhalla:
linear lighting elements over the door

Figure 6.1-25 Vandhalla:
linear lighting elements over the lockers and the door

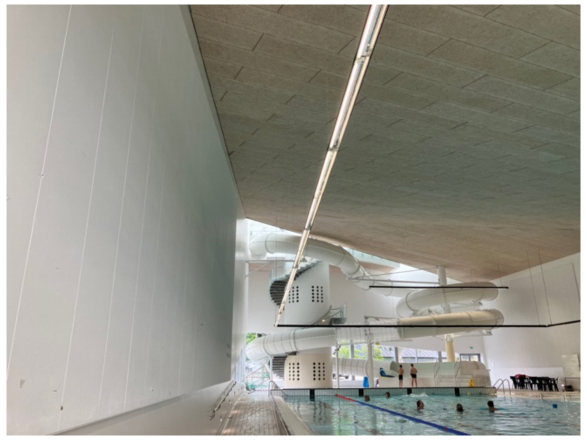


Figure 6.1-26 Vandhalla:
linear lighting element over the rectangular pool

Figure 6.1-27 Vandhalla:
linear circular lighting element over the round pool
(© Stevie Kørvell - Egmont Højskolen)

6.1.1.2 Perceiving the contextual situations happening around the building

In order to improve the understanding of the building's contextual situations in both projects, the architects used transparent internal partitions to allow users to have better visibility toward the adjacent spaces.

Transparent internal partitions were used not only to ensure good natural lighting of the spaces, but also to visually connect the interior spaces. The visibility offered by the transparent partitions not only facilitates a visual connection between users in adjacent rooms, but also allows the user to have an anticipation of the types of rooms and the activities in them. In addition, this visibility allows users to have a greater awareness of their position within the building and a greater sense of which route to take to get to other areas of the building. In Vandhalla, the areas where the main activities take place (i.e. the swimming pools, the meeeting room, the gyms and canteen) are equipped with glass partitions. These partitions not only allow visibility between the rooms (Fig. 6.1-28) (Fig. 6.1-29), but also allow visibility from the corridor (Fig. 6.1-30) (Fig. 6.1-31). Similarly, in Musholm, the doors to the multi-purpose hall have a glazed surface that allows visibility into the hall from the main entrance (Fig. 6.1-32). The architects at Musholm have designed the multi-purpose hall with a focus on visibility and natural light. In particular, they have ensured that there is full visibility between the hall and the adjacent ramp. This allows users to easily navigate the building and helps to create a sense of openness and spaciousness. However, near the staircase, visibility is limited. To mitigate this, the architects have included windows in the wall of the staircase (Fig. 6.1-33). These windows allow users to maintain visual contact with the multi-purpose hall. This helps to ensure that users have a continuous sense of connection to the rest of the building.

Figure 6.1-28 Vandhalla: transparent partition between the two swimming pools

Figure 6.1-29 Vandhalla: transparent partition between the meeting room and the swimming pool

Figure 6.1-30 Vandhalla: transparent partition between the corridor and the canteen

Figure 6.1-31 Vandhalla: transparent partition between the corridor and the main gym

Figure 6.1-32 Musholm: transparent partition between the entrance and the multi-purpose hall

Figure 6.1-33 Musholm: transparent partition between the ramp and the multi-purpose hall

6.1.2 Physical affordances

In this analysis, physical affordances refer to all the properties and characteristics of the built environment that architects design to provide the user with opportunities to physically perform and actively engage with and within the built environment. This includes the ability to access, move, and take actions that involve the use of one's body and the interaction with the physical elements of the space.

The BR18 requires buildings to be accessible by all. Chapter 2 (i.e. Access) and Chaper 9 (i.e. Building Layout) of the BR18 give specific dimensional requirements in order to ensure acess to the building and its functions to all users. These requirements mostly refer to access conditions in terms of width, free passage areas, flooring eveness, gradients of level difference equalizations, and protection of eventual stairs and ramps. The BR18 indications are defined by minimum/maximum dimensional requirements. With regard to the layout and organisation of spaces and furnishing elements, the measure only refers to the arrangement of toilets and the distribution of any fixed seating. For the design of public toilets, BR18 lists the dimensional requirements and the positions where sanitary facilities must be established. For the design of fixed seating, BR18 requires additional space to be provided for people with wheelchairs.

The SBi guidelines further clarify the indications of BR18 and provide additional dimensional requirements by categorising them according to the level of accessibility to be considered in the project (i.e. levels A-B-C, where level A is the highest and C the lowest). Details of the design specifications provided by the BR18 and the SBi guidelines for the improvement of physical usability can be found in Appendix B. The detailed information included in the SBi guidelines refers to dimensional requirements, as with the BR18 provisions. However, SBi guidelines consider the possibility that diversity in user needs can be met with a diversity of solutions. In this perspective, equity is addressed by SBi by stating that, for example, everyone must be able to enter a door in a dignified manner, but not necessarily the same door.

In both projects, physical accessibility and usability were of utmost importance. Target users of Vandhalla and Musholm were people with physical impairments who use a variety of mobility aids, ranging from electric and manual wheelchairs to other aids such as walkers and canes. One main concern for the architects was, therefore, users' difficulty in walking, moving and overcoming differences in height.

For this reason, the architects fulfilled the requirements provided by BR18 and SBi and paid particular attention to space dimensions and the organisation of elements. The design teams of Vandhalla and Musholm both aimed to create spaces which everyone could access, move around in, and feel safe. However, the next step for them was to better consider the varying ways in which different users would interact with the space, and to develop the design solutions accordingly.

We realized, by knowing a bit more about how different users are that treating everybody equal, you sometimes have to treat them in different ways. So it is all about giving them the offer of experiencing the space even if in a different way. Per Ravn – CUBO (Appendix 02)

The important thing was that we had to create the basis for everyone to feel safe and welcome. Then we worked with a strategy where we didn't think everyone could do everything, but everyone had to have their own space and be challenged differently on their skills. Kathrine Hegner Stærmose – AART (Appendix 03)

This led the architects to think about how a number of different solutions for user-environment interaction could be more effective and inclusive, rather than one solution that would more or less suit everyone or no one. The diagram below (Fig. 6.1-34) illustrates the patterns identified between the designed architectural features and the physical activities they support.

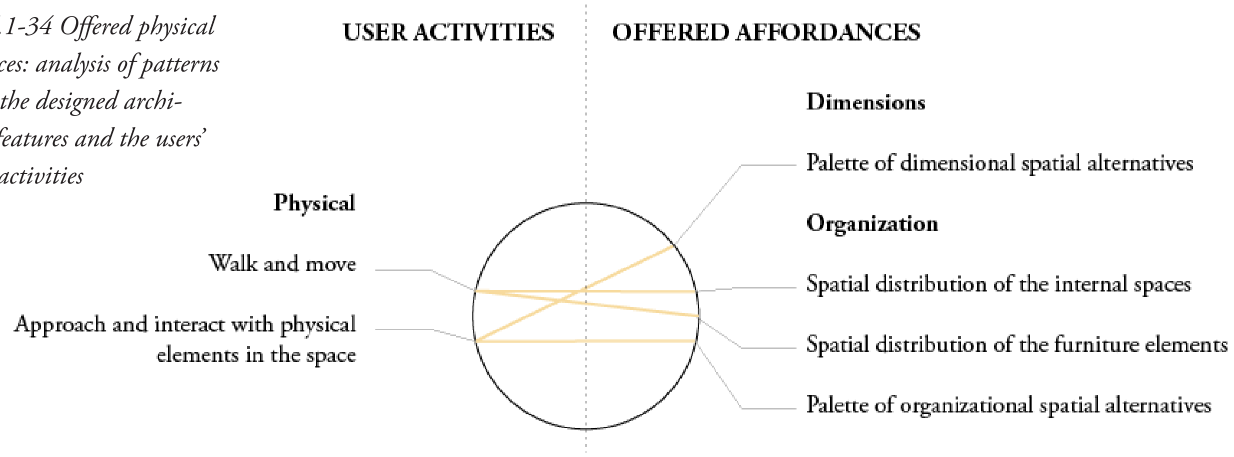


Figure 6.1-34 Offered physical affordances: analysis of patterns between the designed architectural features and the users' physical activities

The following presents the design solutions architects developed to enable users to:

- walk and move
- approach and interact with physical elements in the space

6.1.2.1 Walking and moving

In order to make it easier for users to walk and move around the building's interior spaces, the architects fulfilled the dimensional requirements of the higher levels of accessibility indicated by the SBi guidelines. To enable users to better move within the building by reducing distances, changes of directions, and minimising encounters with obstacles, the architects developed design solutions which refer to:

- the spatial distribution of the internal spaces
- the spatial distribution of the furniture elements

The spatial distribution of the internal spaces around the central functional hub was developed in Vandhalla by Force4 and Cubo from the first phase of the competition. This was mainly done by shortening the distances and offering linear, wide, and continuous paths within the building to improve its usability for people in wheelchairs (Fig. 6.1-35). From the previous research conducted by Force4 for the Fremtidens handicapbolig (Future housing for disabled people) project, the architects gained knowledge from the users about their preferences in moving through the spaces, avoiding too many maneuvers with the wheelchair. In Vandhalla, this translated into organizing the spaces so as to have continuous flows and no blind corridors. To do this, the design team developed an organisation with a central functional hub in which the changing rooms are located, and from which it is possible to access the areas distributed around it, such as the swimming pool area and the gyms. In addition, the cabins located at the entrance to the changing rooms (in grey in the figure) have two entrances: one directly from the corridor and one from the changing rooms. This was done to allow users to avoid long distances and to provide direct access to the changing rooms without the need to do additional maneuvers.

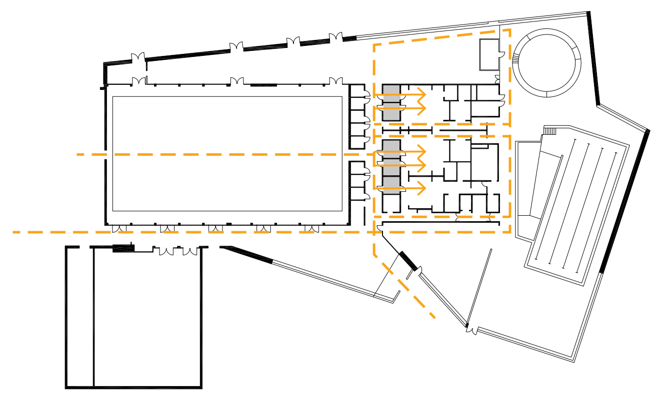


Figure 6.1-35 Vandhalla: distribution of spaces around the central functional hub

The spatial distribution of the furniture elements was carefully designed in both projects in consideration of the space required for wheelchair users, and to avoid the presence of any elements that would obstruct paths and spaces and thus require additional manoeuvring. This is particularly visible in both projects in the distribution of seats within the changing rooms. Whereas in traditional changing rooms there are usually fixed benches placed in the centre of the room, in Vandhalla and Musholm, the architects developed different solutions to provide unobstructed spaces. In Vandhalla, the seats designed by the architects, although placed in the centre of the room, are fitted with wheels that allow them to be easily moved if additional space is needed to accommodate any bulky walking aids (Fig. 6.1-36). In Musholm, on the other hand, the seats are fixed and placed on the wall of the changing room, offering the central space completely free and unobstructed (Fig. 6.1-37).

Figure 6.1-36 Vandhalla: movable seating

Figure 6.1-37 Musholm: fixed benches along the wall and unobstructed central space

6.1.2.2 Approaching and interacting with physical elements in the space

As indicated by the SBi guidelines, with a perspective in line with the Universal Design approach, in both projects the architects considered the diversity of people, their characteristics, and their needs and abilities in interacting with the built environment. On the basis of these considerations, the architects, instead of offering one-size-fits-all solutions, developed a palette of dimensional and organisational settings that offered users the possibility to choose the most suitable solution for their needs.

A palette of dimensional and organisational spatial alternatives was what makes these two projects special in their approach to inclusion. The architects understood and included the diversity of users, and the ways in which they interact with space, in the design of the built environment by offering different physical settings usable by users with different abilities for carrying out the same activity. During the design process of both projects, the meaning of 'equity' was developed through a better understanding of users' needs and expectations. In the case of Vandhalla, while at the beginning of the competition, the concept of equity was interpreted by Force4 and Cubo as the need to offer the same solution to all users, in the second phase it changed to the intention to offer different solutions to meet the needs of a wider variety of users. Similarly, in Musholm, the intention to design a facility that could stimulate and challenge users in new activities led the architects to stop thinking that all users would have to do things the same way. The special character of the selected projects and the sensitivity of the architects gave room for the development of solutions that better consider the diversity of users, and that are more conducive to their activities. For these solutions, the design teams relied on various resources, including their own work experience, internal pre-project research, client involvement and disability experts. The understanding of diversity and the interpretation of the concept of equity that the two design teams have developed are visible through solutions that allow users to choose between different situations of interaction with the physical space. These solutions include.

- different ways of getting access into the pools,
- bathrooms of different sizes and typology
- furnishings and accessories placed at different heights and positions.

Different ways of getting access into the pools

In the first design phase, the architects of Vandhalla planned to design the pool with a ramp as the only option for entering the water, so that everyone would access the pool in the same way. However, user and disability expert feedback between the first and second design phase made the design team think about the need to consider other additional ways of getting into the water. Although the ramp was considered an optimal solution to allow wheelchair users to enter the water with their own mobility aid and without having to use a lift, this solution was not optimal for everyone. The involvement of users during the design process helped the architects to recognise that for users who do not use a wheelchair but have difficulty walking, the ramp was in fact too long. This understanding of the variety of users and uses led Force4 and Cubo to design, in addition to the ramp, different options for the water descent. In the final design, three ways to access the pool were designed: the ramp, the stairs, and the elevated edge of the pool.

The ramp, present in both the 25-metre pool (Fig. 6.1-38) and the circular hydrotherapy pool (Fig. 6.1-39), is an innovative solution in Vandhalla's design, offering users direct access to the water, without the need for transfers or the use of lifts. Stairs, also present in both pools (Fig. 6.1-40), were added in the second phase as an alternative offered to other users with mobility impairments. The designers' desire to offer as many descent options as possible also led them to define a third option. At the long side of the 25-metre pool, the architects created a difference in level, connected by a ramp. This difference in level raises the edge of the pool and enables users to sit on it to enter the water (Fig. 6.1-41).

Figure 6.1-38 Vandhalla: descent ramp in the big pool

Figure 6.1-39 Vandhalla: descent ramp in the small pool

Figure 6.1-40 Vandhalla: stairs in the big pool

Figure 6.1-41 Vandhalla: elevated edge of the pool

This difference in the edge height, which is lower on one side and higher on the other, has been designed to allow users to decide on the point of the edge with the height that best corresponds to their body or wheelchair measurements.

Bathrooms of different size and typology

During Musholm's design processs, the designers, with the collaboration of Bexcom (disability consultancy company) organized focus groups of users with different impairments. It was evident from the focus groups that users had very different preferences regarding the size of the bathrooms. Some preferred small bathrooms, where they could easily find the support of the handles on the walls. Others, who need access with larger electric wheelchairs, required bigger spaces, both for maneuvering and for accessing the sanitary facilities. The discussion with the users continued in an exploratory phase, in which the designers tested 1:1 reproductions of bathrooms of various sizes with the users. This allowed the designers to define 3 bathrooms of 3 three different sizes (i.e. small, medium and big) to implement in the final project (Fig. 6.1-42/43/44/45).

Figure 6.1-42 Musholm: bathroom in three different sizes

Figure 6.1-43 Musholm: small bathroom

Figure 6.1-44 Musholm: medium bathroom

Figure 6.1-45 Musholm: big bathroom

Furnishings and accessories placed at different heights

At Musholm, from the very beginning, the program of the building stated the intention to offer a space where differences were considered and welcomed. Musholm's project offers different solutions for accommodating different needs or individual solutions that can be adapted according to users' differences. This approach is already visible from the entrance where the reception counter (Fig. 6.1-46) and the coat hanger have been designed in two heights (Fig. 6.1-47) to make them accessible to users in wheelchairs, as well as, for example, to people of short stature, children or persons with limited mobility in the upper limbs. In Musholm, the designers also addressed the diversity of body sizes and physical abilities with furniture solutions and sanitary placed at different heights (Fig. 6.1-48) or that can be adjusted in height through automatic systems (Fig. 6.1-49).

Figure 6.1-46 Musholm: reception counter in two heights

Figure 6.1-47 Musholm: coat hanger in two heights

Figure 6.1-48 Musholm: urinals in two heights

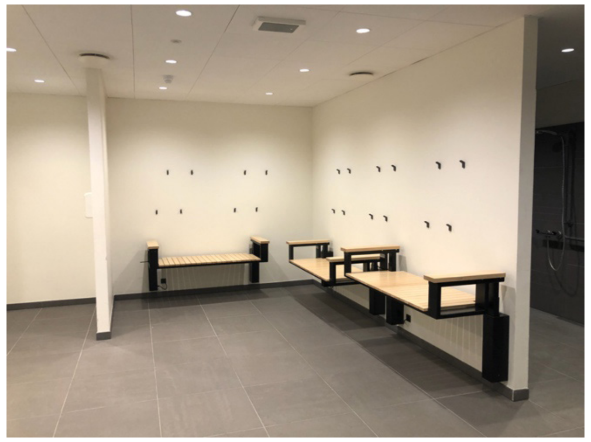


Figure 6.1-49 Musholm: benches adjustable in height

6.1.3 Social affordances

In this analysis, social affordances refer to all the properties and characteristics of the built environment that offer users the possibility to engage in physical activities and social connections, as well as to have individual privacy.

In the BR18 building regulations and SBi guidelines, there are no indications of how the space and its features should be designed to support individual participation, social interactions and privacy. The only indication that mentions personal user satisfaction concerns the provision of windows to offer visibility to the external landscape. Guidelines state that user satisfaction in this regard depends largely on the object seen through the window, whose important function is to create visibility and contact with the surroundings. However this indication mainly refers to the benefits on the individual's circadian rhythm and psychological state.

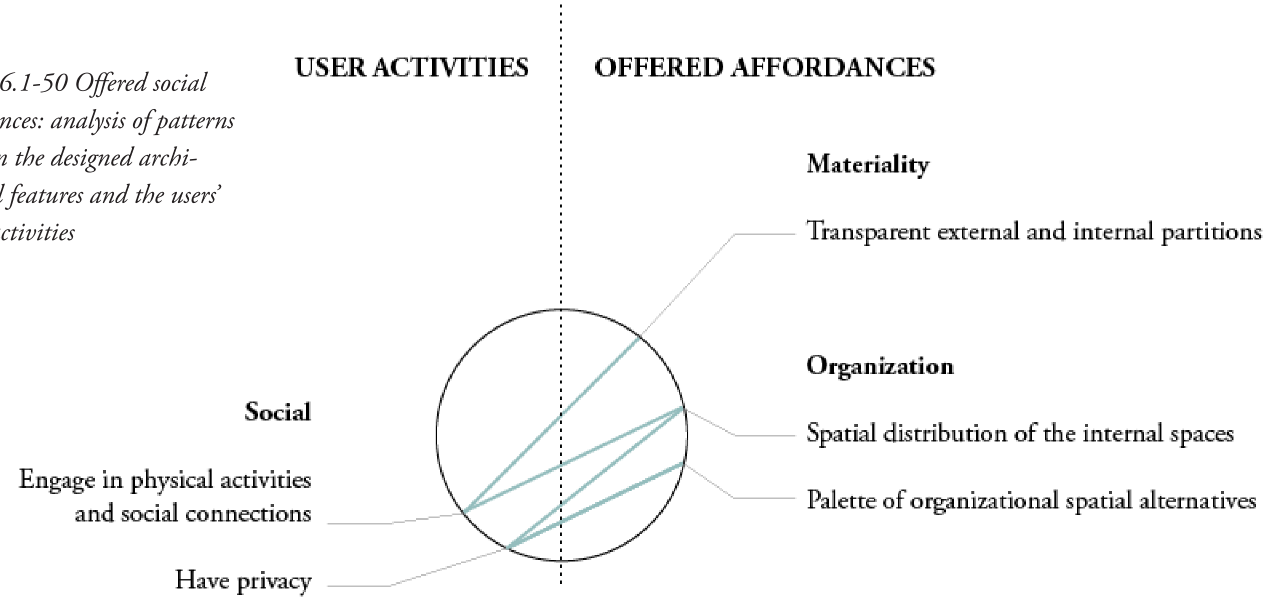
Public buildings, especially those dedicated to sport and leisure, are spaces for socialisation, integration and gathering. In these buildings, access is guaranteed and extended to all citizens. The social relevance of sports and leisure buildings, however, must not forget the importance of the issue of privacy, which is very individual, and dependent on the different areas of the buildings. The architects have considered the aspects of socialisation and privacy both in the spaces dedicated to activities and the more private ones - not only in the changing rooms, but also in the spaces dedicated to rehabilitation. For these reasons, beside considering the visibility toward the surroundings, the architects in both buildings paid attention to the visibility between spaces. Offering or blocking internal visibility was used in the different spaces as a means to stimulate users to participate or to provide them with more intimate spaces.

We wanted to create visual connection. A visual contact. But that also is very individual. Everyone has different things about their body. Some people are very private, even if it is a public space. But we knew was good to have some visual connection because it could be something that challenge you, when you see others moving [...] but we put filters in between. So you can have the feeling of being together but still ypou are in a private position. Per Ravn – CUBO (Appendix 02).

The important thing we considered for this large sports facility is that when people come to this place they should feel safe, they can feel comfortable while challenging their limits. Kathrine Hegner Stærmose – AART (Appendix 03).

Being aware of users' individual preferences and needs, the architects wanted to offer the possibility of different types of involvement and interaction with other occupants. Transparencies, which divide the spaces dedicated to different physical activities, were used to offer users the possibility of visual connection and thus interaction with other occupants. The interior spaces were also distributed in such a way as to offer both direct interactions between users, and a gradual transition from more public to more private spaces. In Vandhalla, the further division and organisation of the changing room space offered users a wide range of privacy alternatives to choose from. The diagram below (Fig. 6.1-50) illustrates the patterns identified between the designed architectural features and the social activites they support.

Figure 6.1-50 Offered social affordances: analysis of patterns between the designed architectural features and the users' social activities



The following presents the design solution architects developed to enable users to:

- engage in physical activities and social connections
- have privacy

6.1.3.1 Engaging in physical activities and social connections

The social dimension refers to the impact that the design of a space has on the interactions and relationships between the occupants of that space. This includes not only the physical needs of the users, such as the functional interaction with the built environment, but also how the space promotes or hinders social connections and engagement in physical activities. Architects considered how the design of a space can encourage or discourage socialization and participation among the occupants, and worked to create spaces that foster positive interactions and engagement The analysis of the two case studies led to the identification of design solutions that architects developed to favour visual connections and, thus, users and their participation. The identified solutions are the use of:

- the transparent external and internal partitions
- the spatial distribution of the internal spaces

Transparent external and internal partitions in both cases are present, not only to ensure adequate illumination of all spaces, but also to provide visual connections between interior spaces as well as to exterior surroundings (Fig. 6.1-51) (Fig. 6.1-52). In Musholm, the transparent partitions at the entrance, designed as a meeting space where tables and seating are placed, offer a direct view of the two other outdoor meeting spaces, the rear garden (Fig. 6.1-53) and the inner courtyard (Fig. 6.1-54).

Similarly, at Vandhalla, the glass window at the entrance allows direct visibility from the tables located at the entrance and those located outside (Fig. 6.1-55). Moreover, the glass windows on the façade allow one to see inside the pool, to get a preview of the activities taking place and thus to feel stimulated to participate (Fig. 6.1-56).

While the visibility between interior and exterior is present in both buildings, the visibility between interior spaces is more prevalent in Vandhalla. Transparent partitions between the activity areas allow full visibility of what is happening in the adjacent space (Fig. 6.1-57). Transparent partitions are present between the corridor and the great hall, and between this and the rehabilitation gym. Transparent partitions are also present between the two swimming pools (Fig. 6.1-58), and between the therapy pool and the rehabilitation gym. By using transparent partitions, architects ensured the preservation of temperature and acoustics in each room while also creating a sense of cohesion and continuity between the

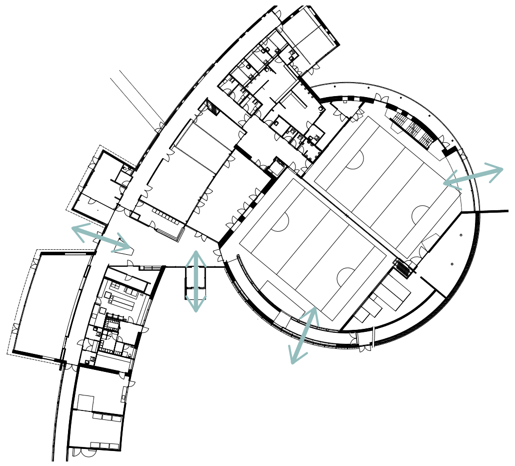


Figure 6.1-51 Musholm: visibility between the interior and exterior spaces

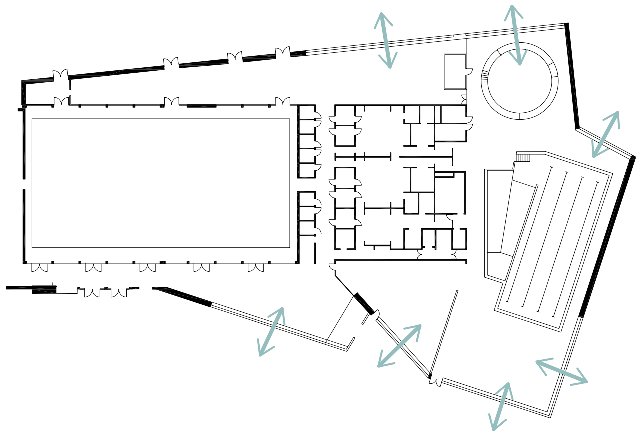


Figure 6.1-52 Vandhalla: visibility between the interior and exterior spaces

Figure 6.1-53 Musholm: transparent partition between the entrance and the rear garden

Figure 6.1-54 Musholm: transparent partition between the entrance and the inner courtyard

Figure 6.1-55 Vandhalla: transparent partition between the entrance and the exterior meeting space

Figure 6.1-56 Vandhalla: transparent partition between the exterior and the swimming pools

different areas. This allows users to easily observe and acknowledge the presence of others as well as creating a sense of transparency and openness that can foster trust and inclusivity.

The spatial distribution of the internal spaces, in Musholm, has been considered and designed so as to strengthen the possibility of user participation in sports activities. Most buildings designed to accommodate users with impairments are usually developed with the idea of facilitating users' activities as much as possible. However, Musholm's project took a different perspective. At the beginning of the planning phase, Musholm's architects planned to design a single-storey building. Later, during the design process, they developed alternative solutions, which were shared during initial focus groups with the users. Among the proposed solutions, the idea of a two-storey building connected by a long circular ramp was preferred by the focus group participants. From the response of the focus group, the architects decided to proceed with this solution and characterise the ramp by designing five platforms along it (Fig. 6.1-59). The platforms, designed in collaboration with the design company Keingart, offer the possibility to engage in atypical activities with the aim of challenging users in different ways. All the platforms are accessible from the ramp and overlook the multipurpose hall. The first platform is a removable stage which faces towards the multi-purpose hall (1). The second platform is an activity room which can be opened and used as a spectator balcony (2), or closed off and used as a gaming/cinema room. In the third platform (3) a wood playing-zone for children is established (Fig. 6.1-60). Here children can climb and slide down into a pool of soft balls. The fourth is a spectator platform (4), while the last platform is the starting point for the aerial cableway (5) which, at ceiling height, crosses the hall and ends on the opposite platform. The architects' intention was to design the ramp, not only to connect the two floors, but also to make it an integral part of the multi-purpose hall and a space to accommodate and stimulate unusual and enjoyable activities that users do not often have the opportunity to try.

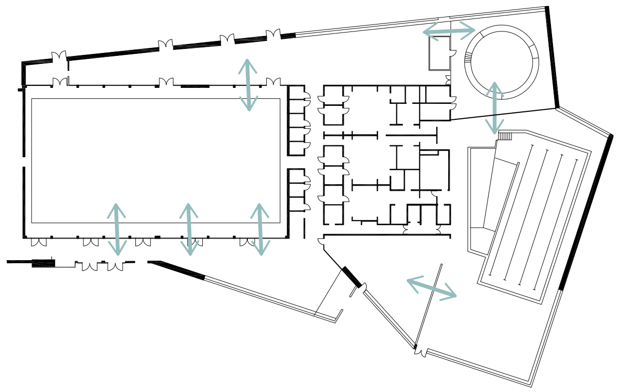


Figure 6.1-57 Vandhalla: internal visibility between activity areas

Figure 6.1-58 Vandhalla: transparent partition between the swimming pools

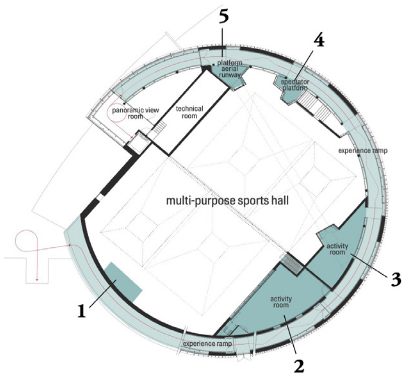


Figure 6.1-59 Musholm: activity ramp along the multi-purpose hall with 4 plateaus for user engagement

Figure 6.1-60 Musholm: plateau with a wood structure to climb

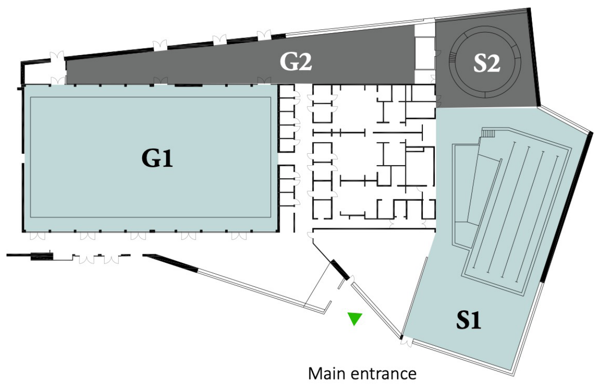


Figure 6.1-61 Vandhalla: distribution of the activity areas

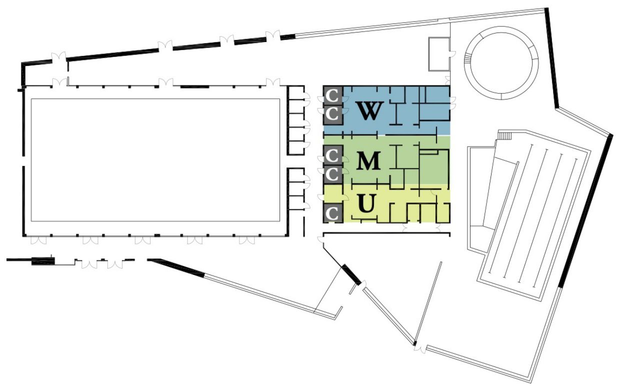


Figure 6.1-62 Vandhalla: changing rooms division and private cabins

6.1.3.2 Having privacy

Although users in public spaces will expect to be exposed to other users present to some extent, the aspect of privacy has assumed importance in the design of rehabilitation spaces and changing rooms. The architects' main intention was to offer spaces where users could have the feeling of being together with others, although with the possibility of having more private spaces. In order to achieve this, the architects worked with:

- the spatial distribution of the internal spaces
- a palette of organisational spatial alternatives

The spatial distribution of the internal spaces, especially in Vandhalla, was designed with the intention of offering a smooth transition from more to less exposed spaces depending on the activities performed within them. The internal distribution of Vandhalla consists of a central functional hub dedicated to bathrooms and changing rooms, around which the areas for sports and rehabilitation activities are distributed. This distribution, in addition to favouring direct paths between the different functional areas, was designed to ensure that users would feel comfortable performing their more private activities while being in public spaces. The architects decided to place the main gym (G1) and swimming pool (S1) near the entrance where they could be more visible from the entrance. More private activity areas such as the rehabilitation area (G2) and the small swimming pool (S2) have been placed at the back of the building, offering more intimate spaces away from the entrance and less accessible to outside visitors (Fig. 6.1-61).

A palette of organisational spatial alternatives was also offered in Vandhalla's changing rooms so as to offer users the possibility to choose where they preferred to change their clothes and get ready for the gym or the swimming pool activities. The functional hub in which the changing rooms are located offers three different spaces: one dedicated to women (W), one to men (M) and a third as a unisex space (U) (Fig. 6.1-62). This was done to allow users requiring assistance to use the changing room that best suits their individual situation. In particular, the architects wanted to offer a unisex changing room in case the caregivers were of a different gender than the users. In each of these, the architects have placed small cabins (C) that the user can choose to use if they need more privacy.

6.2 The perceived affordances: users' experiences

In this section, based on the analytical model presented in Chapter 5, the built environment of the two case studies is analysed by looking at the *affordances* perceived by users in relation to their activities in the space (Fig. 6.2-1).

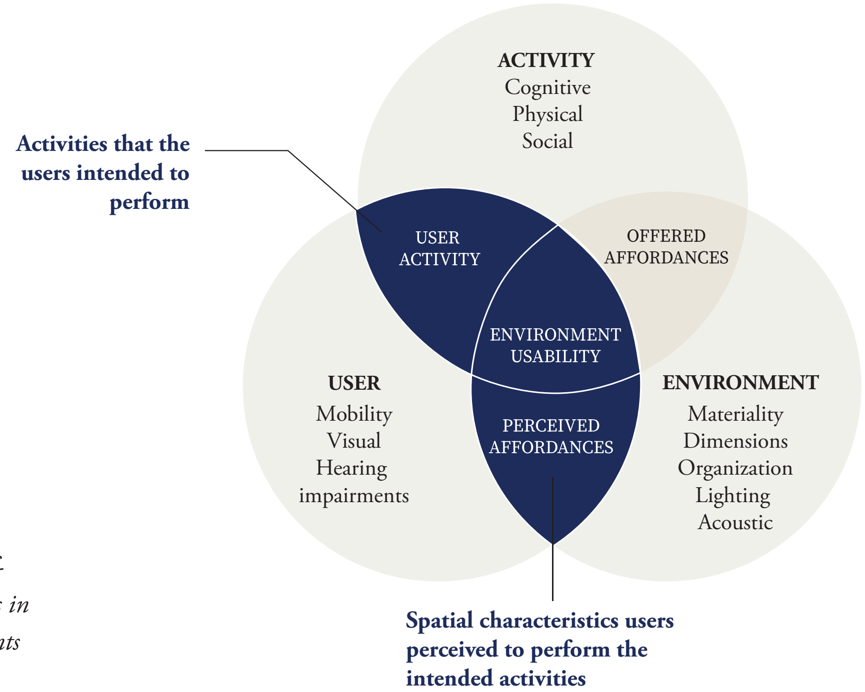


Figure 6.2-1 Analysis of affordances perceived by users in relation to their impairments and activities

The perceived affordances presented in this section refer to the dimensional, organisational, visual, tactile and acoustic environment's characteristics which have been perceived by users as a support to perform their cognitive, physical, or social activities, irrespective of whether architects intended to offer such possibilities or not. As for the analysis of the offered affordances, the coding and subsequent patterns analysis of the collected data made it possible to group these design solutions according to their different contributions to user performance. The following sub-sections describe the identified patterns by refering to three categories of affordances:

a) cognitive affordances

b) physical affordances

c) social affordances

For each category, users' needs, intentions and expectations based on their different physical and sensory capabilities are presented. Furthermore, for each category, users' experiences of environmental characteristics are presented by describing and analysing how materiality, dimensions, organisation, lighting and acoustic properties supported users' intentions to orient and interact in physical and social contexts.

As in the previous section on the offered affordances, the analysis of the perceived affordances aimed at identifying recurring correspondences between the experienced environmental characteristics and user activities. In each of the following sections, these correspondences are graphically represented through diagrams that display the activities on the left and the environmental characteristics, which are here considered as perceived affordances, on the right. This allows for an easy visualization of the connections between the two. Following the graphical representation, each identified correspondence is further explained through a description of how users perceived and and engaged with the built environment in order to carry out their intended activities.

6.2.1 Cognitive affordances

Cognitive affordances refer to all the properties and characteristics of the space that users perceived and processed as information to understand the configuration of the space, its distribution, and the contextual activities for which the environment was built.

The interviewed users, according to their different abilities and needs, related to the built environment in different ways and perceived the architectural features which enabled their understanding of the surrounding spaces and contexts. The properties of materiality, organisation, lighting, and acoustics proved to be influential in improving users' cognition of space (Fig. 6.2-2).

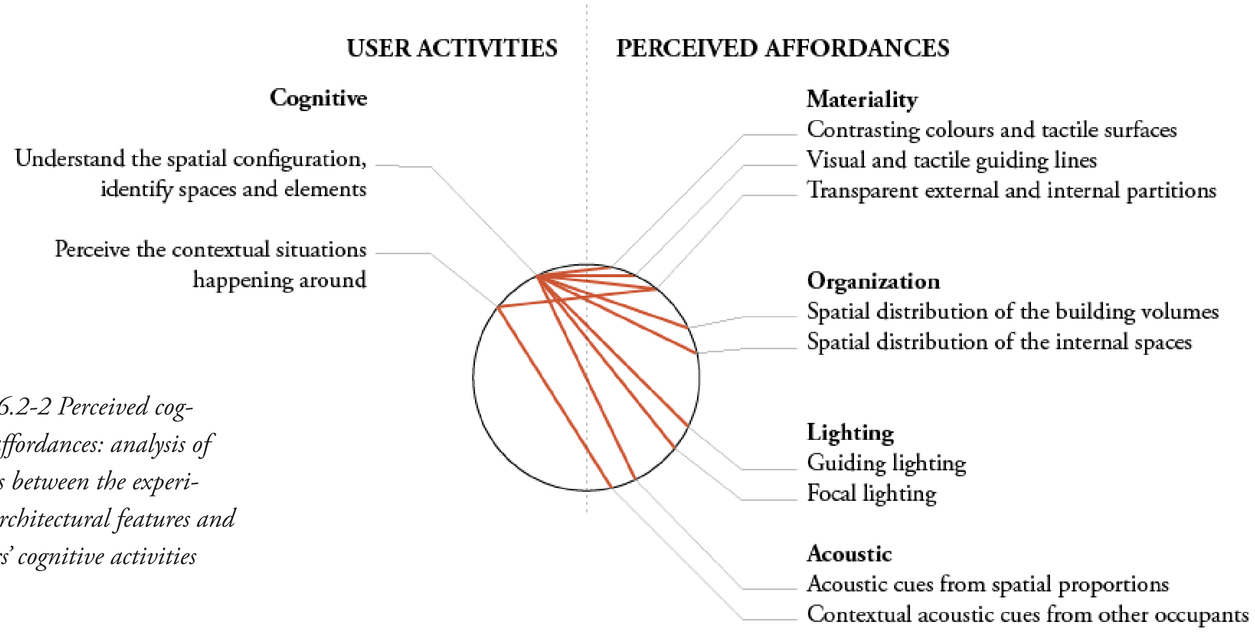


Figure 6.2-2 Perceived cognitive affordances: analysis of patterns between the experienced architectural features and the users' cognitive activities

The following presents which characteristics of the built environment users referred and related to:

- understand the spatial configuration and distribution, identify spaces and elements
- perceive the contextual situations happening around the building

6.2.1.1 Understanding the internal spatial configuration, identifying spaces and elements

Above all, users who were unfamiliar with the building expressed a desire to understand its physical layout and the possible activities that the building offers from the outside. This was evident for all the interviewed users, both those with mobility and sensory impairments. For people with mobility impairments, the main concern was to anticipate from the outside of the building whether they would encounter barriers. For users with visual and hearing impairments, on the other hand, the main objective was to perceive useful information that would enable them to better understand the building's spaces and its distribution. Especially for blind users, the major concern was finding the entrance to the building. Indeed, the blind users interviewed generally described the entrance as a safe place where they could easily find people to ask for help in case of need.

From the entrance, users continued to search for information about the building and directions to rooms such as the changing rooms or the main activity room. As from outside, understanding the interior spatial distribution of a building was a challenge, especially for blind users. As they had no visual information, they were at a great disadvantage when they had to identify the reception area or navigate towards functional spaces such as the changing rooms, the gym or the swimming pool. The blind users described all these experiences as very demanding in terms of energy and time. During the walkthroughs, an analysis was made of to which features users referred when speaking about their experience of approaching the building for the first time and understanding its internal spaces. The analysis of data collected from the on-site observations and wlakthroughs led to the identification of the most influential built environment characteristics to which users referred:

- contrasting colours and tactile surfaces
- visual and tactile guiding lines
- transparent external and internal partitions
- spatial distribution of the building volumes
- spatial distribution of the internal spaces
- guiding lighting
- focal lighting
- acoustic cues from spatial proportions

Figure 6.2-3 Musholm: building volumes of different materials

User: deaf user (non-regular user of the building)

User activity: cognitive - understand the functions within the building

Perceived affordance: materiality - contrasting colours and tactile surfaces

User's quote (appendix 21):

It is clear this is the main entrance, the building on the right is the main space and, on the left, there are probably offices or other functional spaces

Figure 6.2-4 Musholm: tactile surfaces of the external paving

User: blind user (non-regular user of the building)

User activity: cognitive - identify the entrance

Perceived affordance: materiality - contrasting tactile surfaces

User's quote (appendix 20):

I feel like there are too many different surfaces, I could easily get lost out here, but the edge between the asphalt surfaces is really good for finding my way, it just takes me a while to figure out where to go.

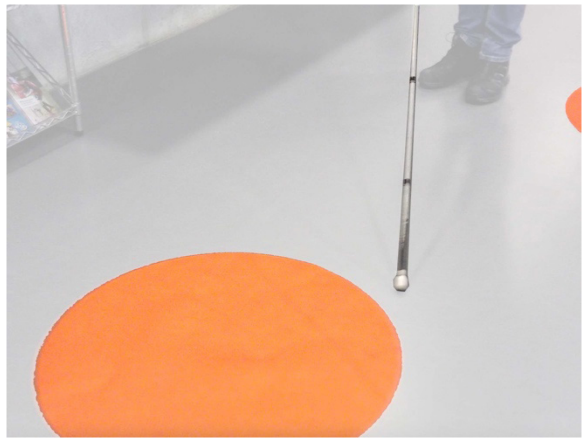


Figure 6.2-5 Musholm: temporary carpet in the reception area

User: blind user (non-regular user of the building)

User activity: cognitive - recognising the area of the building

Perceived affordance: materiality - contrasting tactile surfaces

User's quote (appendix 20):

I feel there is something going on here, maybe here there is the reception or something similar.

The contrasting colours and tactile surfaces provided users with useful information about the building's internal layout and distribution from outside the building. The materials used for the building's façades, such as the bricks and wood used iin Vandhalla and Musholm respectively, were not only appreciated on an aesthetic level, but were also perceived as information to better understand where the main activity room was located. Particularly in Musholm, a deaf user paid particular attention to the different materials of the volumes that make up the building, using them as information to hypothesise the presence of different functions within each volume (Fig. 6.2-3). Standing in front of the building, the user distinguished three volumes. The central volume clad in metal, the one on the left in wood and the one on the right, also in wood but of a darker colour and differentiated at the lower part by the presence of wood slats. These three volumes, visually differentiated by the different materials, were recognised as three volumes with three different functions inside. The user's hypothesis was that in the central volume was the entrance, in the one on the left the offices and in the one on the right the main room.

Also outside the building, the tactile contrast of the floor surface partially helped a blind user to find his way to the entrance (Fig. 6.2-4). In this situation, the user perceived the presence of different textures and recognised this as useful information for finding his way to the main entrance. However, he also confessed that he was somewhat confused by the presence of too many different surfaces and that understanding the logic of these to find his way to the entrance would take him a long time.

The materials chosen by the architects for the finishing and covering of the horizontal and vertical surfaces of the interiors were also used by users as information on the type of environment they were in, or to identify certain elements in the space. This was observed during the walkthroughs with a blind user and two users with mobility impairments. In Musholm, a blind user, after entering the building, perceived the presence of carpets at the entrance and assumed that he was close to the reception desk (Fig. 6.2-5). Although the carpets were indeed in front of the reception, they were however only temporarily placed for a conference that was taking place in the multi-purpose hall during the walkthrough. This indicates that different flooring surfaces can be perceived and associated with the presence of specific spaces or functions.

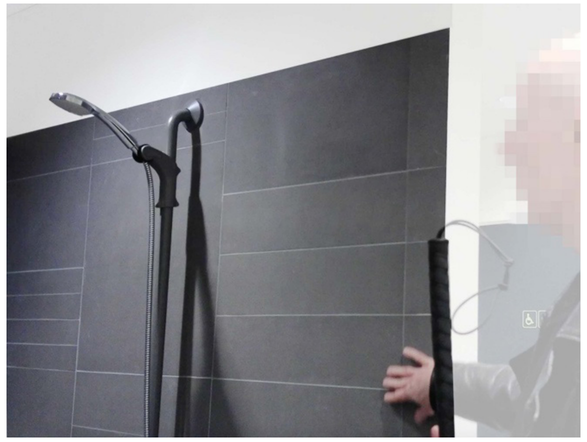


Figure 6.2-6 Musholm: tiles in the shower area

User: blind user (non-regular user of the building)

User activity: cognitive - recognising the shower area

Perceived affordance: materiality - contrasting tactile surfaces

User's quote (appendix 20):

There's nothing on the floor to indicate that we are in the showers, but I've noticed that the wall here has tiles and tiles usually suggest water, which is a good information for me

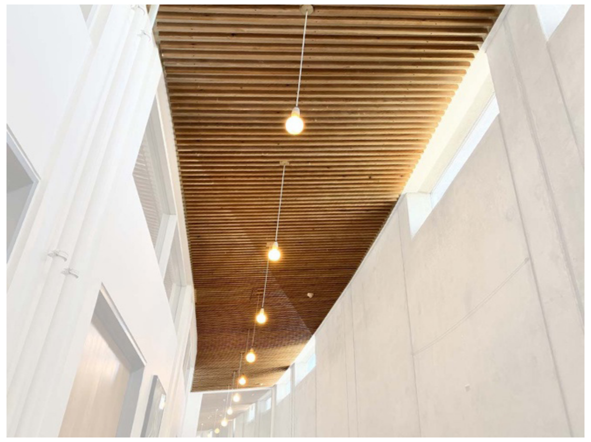


Figure 6.2-7 Musholm: wooden ceiling

User: user with mobility impairments (regular user of the building)

User activity: cognitive - recognising the area of the building

Perceived affordance: materiality - contrasting tactile surfaces

User's quote (appendix 19):

I can't see much of what's around me, the ceiling is one of those few things. I know where I am by the kind of ceiling I see.

Figure 6.2-8 Vandhalla: coloured tiles of the cabin

User: user with mobility impairment on the left side of her body (regular user of the building)

User activity: cognitive - identify the best changing room according to her abilities

Perceived affordance: materiality - contrasting coloured surfaces

User's quote (appendix 11):

When I changed my assistant, the first time we were here, she asked me which cabin I preferred to use, and I just told her: the yellow one.

In the Musholm changing room, the blind user was able to identify the location of the shower area by tactilely perceiving the different tile covering in that area (Fig. 6.2-6). Touching the walls, the user perceived the change from a smooth surface to one covered with tiles. The perception of the presence of tiles thus provided the user with information about the possibility of the presence of water and thus the identification of the shower area of the changing room. The user also mentioned that he didn´t perceive any change in floor surface. This indicates that it would be helpful for him to have some kind of tactile indication or marker on the floor to indicate the transition from one area to another, such as from the changing area to the shower area. This could be in the form of a perceptible line or a different texture on the floor, which would provide a clear and easily recognizable signal to the user that he was entering a different space.

Interestingly, the use of different materials also proved to be an important orientation element for a user with severe mobility impairments. The user was using a wheelchair with a reclined backrest and therefore had a lying position that limited his view to the upper part of the room's walls and the ceiling. As he turned from the reception area towards the corridor leading to the changing rooms, he explained that seeing this ceiling helps him better recognise where he is (Fig. 6.2-7).

At Vandhalla, the use of colour in the design of the toilets and changing rooms serves a dual purpose. Not only does it effect the appearance of the space, but it also allows for users to orient themselves and recognise the most suitable bathroom for them to use. This appeared to be particularly beneficial for a user with mobility impairments, as the colour of the toilet served as a clear indication of which facility was most appropriate for her to use. One woman with a mobility impairment on the one side of her body said that the yellow colour of the toilet was the clue she gave to her new assistant when asked which toilet she preferred to use. The yellow cabin had in fact the necessary features, such as handles on the side where she has the most strength, to accommodate her impairment. (Fig. 6.2-8).

Figure 6.2-9 Musholm: white paving line at the entrance

User: deaf user (non-regular user of the building)

User activity: cognitive - identify the way to the changing rooms

Perceived affordance: materiality - visual guiding line

User's quote (appendix 21):

It looks like a sort of art installation. But it also says, a practical purpose, you know, to walk into that door.

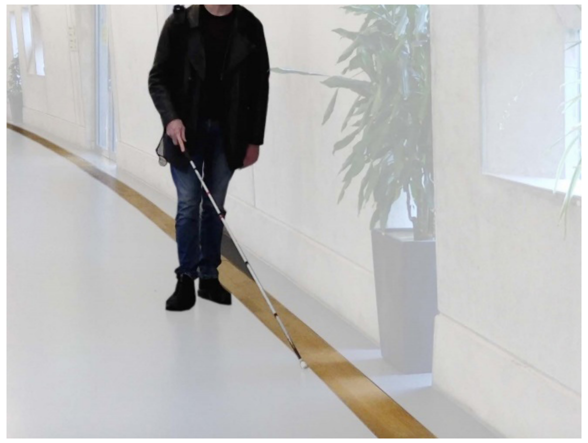


Figure 6.2-10 Musholm: wood paving line along the corridor

User: blind user (non-regular user of the building)

User activity: cognitive - identify the way to the changing rooms

Perceived affordance: materiality - tactile guiding line

User's quote (appendix 20):

It is actually a very good pathfinder because there is a different sound to it.

Figure 6.2-11 Musholm: transparent external partitions

User: user with mobility impairments (non-regular user of the building)

User activity: cognitive - understand the internal spatial distribution

Perceived affordance: materiality - transparent external partition

User's quote (appendix 18):

I can see from here that there is a nice ramp. This makes me think all the spaces inside are accessible and I will not have many problems.

The visual and tactile guiding lines undoubtedly supported users in understanding which directions to take in order to navigate the building and experience its different environments. In Musholm, two different types of guiding lines were analysed to understand their contribution, especially for users with hearing and visual impairments. The white curved line, present at the entrance and directed towards the multi-purpose hall, was highly appreciated by a deaf user. From the entrance, he immediately noticed the line on the floor and hypothesised its function of suggesting the way to the visitor (Fig. 6.2-9). What was most appreciated by the user was the fact that this guiding line was in no way a reminder of any disability condition, but instead enriched the aesthetics of the space as well as facilitating orientation.

The corridor leading to the changing rooms in the building includes a guiding line created by using a different material, wood, for the floor surface in this area, which creates a contrast with the rest of the flooring (Fig. 6.2-10). As a result, the blind user, using a cane, was able to perceive the difference in materiality and follow this as a guide along the corridor. While the line itself does not create visual contrast, the different reverberation perceived by the cane made it possible to distinguish the contrast between the wood surface and the rest of the flooring, making it easy to follow.

Transparent external and internal partitions provided additional information about the rooms inside the building, the activities taking place, and the people occupying these spaces. From the openings in both Musholm and Vandhalla, users were able to get a preview of the interior spaces. From the outside of Vandhalla it is, in fact, possible to see the entrance space and the pool area. In Musholm, the glass windows offer a view towards the entrance, but also towards the ramp (Fig. 6.2-11). In particular, the possibility to see the ramp for a user with mobility impairments was not only information about how to get to the upper level but also a revealing element of the building's spirit of inclusiveness.

Figure 6.2-12 Musholm: building volumes distributed around the entrance

User: deaf user (non-regular user of the building)

User activity: cognitive -identify the entrance

Perceived affordance: organisation - building volumes organizaed around a central space

User's quote (appendix 21):

I know that this is where I have to go inside because the other buildings sort of lead into this entrance because they're forming like a triangle.

Figure 6.2-13 Musholm: internal building areas distributed around the entrance

User: deaf user (non-regular user of the building)

User activity: cognitive - understand the internal distribution

Perceived affordance: organisation - internal areas organizaed around a central space

User's quote (appendix 21):

Yeah, it's a central spot. I could see when I entered where the gym is. I can also see on my left there is a dining room and a corridor probably leading to the changing rooms or similar.

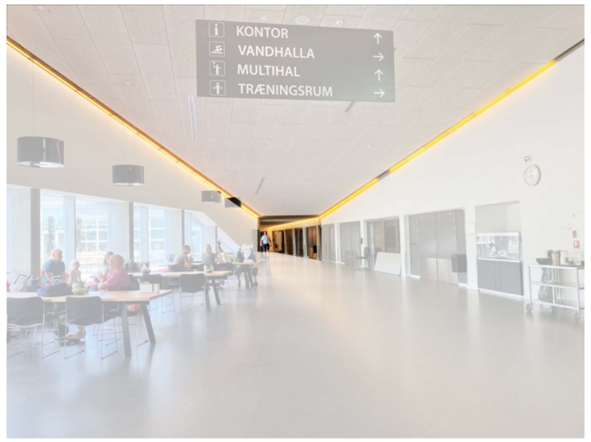


Figure 6.2-14 Vandhalla: linear and continuous lights in the main corridor

User: user with hearing impairments (non-regular user of the building)

User activity: cognitive - finding the way from the entrance

Perceived affordance: lighting - guiding lighting

User's quote (appendix 14):

I feel that I should continue in that direction. I don't know what's there, but I think it's the main way.

The spatial distribution of the building volumes played a critical role in facilitating orientation and understanding of the built space, especially for the deaf user. At Musholm, a key feature that was particularly appreciated was the full and unobstructed view of the building's architectural volumes from the outside. The volumes, arranged in a curved configuration around the central entrance, offers users full visibility towards each volume of the building. In addition to allowing the user to have visibility and understanding of the volumes that make up the building, this distribution, in the user's experience, reinforces the directionality towards the entrance as the main destination point, inviting the user in that direction (Fig. 6.2-12).

The spatial distribution of the internal spaces contributed to support orientation once the user entered the building. In Musholm, the distribution of the different functional areas around the entrance was perceived both outside and inside the building. Once inside the building, the deaf user repeated the same comment, emphasising the feeling of being in a central space from which he could have good visibility and thus easy understanding and orientation of the building's constituent areas. This distribution was particularly appreciated by the deaf user who, being able to communicate only through sign language, is unable to ask for and receive directions from staff or other building occupants. The wide view from the entrance to the different areas allows him to have a preview of the spaces around him, and to perceive the activities taking place within them without the need to ask for further information (Fig. 6.2-13).

The guiding lighting was mainly perceived in the case of Vandhalla. Upon entering the building, all users immediately noticed the two continuous linear lights positioned on either side of the ceiling. For many, this type of lighting was interpreted as a directional signal to follow (Fig. 6.2-14). The same type of lighting, also used in other areas of the building, helped to provide information to users about the internal layout. Similarly in the changing room, the same type of lighting is considered by a user as a clue for the direction to take to the swimming pool (Fig. 6.2-15).

Figure 6.2-15 Vandhalla: linear and continuous lights in the changing room

User: user with hearing impairments (non-regular user of the building)

User activity: cognitive - finding the way to the swimming pool

Perceived affordance: lighting - guiding lighting

User's quote (appendix 14):

As at the entrance, here too it is clear that the light shows you the way

Figure 6.2-16 Vandhalla: linear lights over the swimming pool

User: user with hearing impairments (non-regular user of the building)

User activity: cognitive - identify the pool area

Perceived affordance: lighting - focal lighting

User's quote (appendix 14):

The lighting here is really focal and selective. It is easy to see the space.

Figure 6.2-17 Vandhalla: entrance located in a niche

User: blind user (non-regular user of the building)

User activity: cognitive - identify the main entrance

Perceived affordance: acoustic - spatial acoustic cues from entrance's proportions

User's quote (appendix 13):

I can feel is another space here, the acoustic is also different, so I suppose the entrance should be somewhere here

The focal lighting used at Vandhalla contributed greatly to improving the users' ability to see and identify the presence of important elements such as doors, lockers and swimming pools. At Vandhalla, the use of lighting by means of continuous linear elements was differentiated in the different rooms. While the positioning of these elements along pathways provided directional information and a contribution to user orientation, the use of the same type of lighting at activity spaces contributed to their spatial identification and delimitation. According to the users, the linear light elements located above the pools not only allow them to swim on their backs without having light in their eyes, but also help to delimit the area of the pools below and give a better perception of them in space (Fig. 6.2-16).

The acoustic cues from spatial proportions have greatly supported a blind user, whose main challenge was to identify where the entrance was located, especially when visiting the building for the first time. In the case of Vandhalla, the location of the entrance in a niche in the façade allowed the user to easily identify it (Fig. 6.2-17). After walking by tapping his stick along the façade of the building, the user stated that he found himself inside the niche as he perceived a different acoustic and assumed the presence of the entrance. From this change in acoustics, the user guessed the position of the door, which he immediately identified by hearing the sound of the automatic sliding doors opening.

Figure 6.2-18 Musholm: transparent partition between rooms

User: deaf user (non-regular user of the building)

User activity: cognitive - knowing what activity is taking place in the room

Perceived affordance: materiality - transparent internal partitions

User's quote (appendix 21):

Usually, there are doors, and I don't know what's behind them. Here, I can look through the glass and see who is inside.

Figure 6.2-19 Vandhalla:
noise that suggests the presence of people and their activities in space

User: blind user (non-regular user of the building)

User activity: cognitive - finding the way from the entrance

Perceived affordance: acoustic - contextual acoustic cues from other occupants

User's quote (appendix 13):

Usually, when I hear other people's presence, I go in that direction.

6.2.1.2 Perceiving the contextual situations happening around the building

An important aspect for the users in their orientation and understanding of the building turned out to be the possibility of gaining insight, not only into the built environment, but also into the situations and contexts taking place within it. While this was not a major problem for users with mobility impairments, it was of particular importance for users with visual and hearing impairments. To this end, users with sensory disabilities referred to all sensory cues they found in the environment. These cues mainly referred to the auditory field for users with visual impairments and to the visual field for users with auditory impairments. Specifically, the identified characteristics of the built environment which support user perception of the contextual situations were:

- transparent external and internal partitions
- contextual acoustic cues from other occupants

Transparent external and internal partitions, in both case studies, were perceived as a good way to obtain information about current situations and the people occupying the surrounding rooms. This was especially observed in Musholm with a deaf user who, by being able to see through the rooms, was aware of what kinds of spaces were around him, whether these were occupied by other people, and what kinds of activities were taking place in them (Fig. 6.2-18). During the walkthroughs, the user also pointed out that people often knock before entering a room to get permission to enter. Not being able to receive this auditory input, the ability to see through also allows him to have that information.

Contextual acoustic cues from other occupants supported blind users gathering information about the space and the activities within it. The acoustic cues collected from the users were mainly determined by the size of the room and the materials used for floor, wall and ceiling coverings. Additionally, other acoustic cues came from the presence of the people inside those rooms and, of course, the type of activity the other users were performing. In Vandhalla, a blind user walking down the corridor next to the gym became aware that he was near the canteen thanks to an open door that allowed him to hear the activities inside (Fig. 6.2-19). This helped him to understand the functionality of the room and the activities that were taking place in it. The acoustic source was also used by him as a guide on the direction to take for reaching the canteen.

6.2.2 Physical affordances

Physical affordances refer to all properties and characteristics of the space that users perceived and interact with in order to easily access, move and perform actions that involved the use of their body and direct interaction with the physical elements of the space.

The interviewed users, according to their different abilities and needs, related to the built environment in different ways and perceived different features as supportive to move and act easily in the space. This analysis revealed the importance for users to not encounter obstacles when moving around the building, and being able to choose between spatial design alternatives that best suit their physical activities (Fig. 6.2-20).

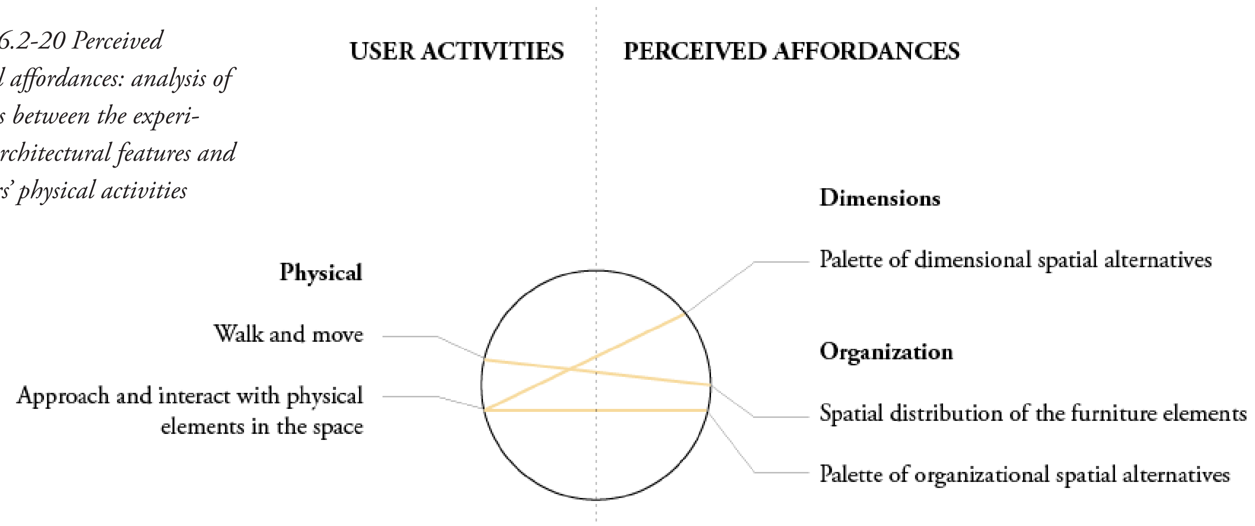


Figure 6.2-20 Perceived physical affordances: analysis of patterns between the experienced architectural features and the users' physical activities

The following presents which characteristics of the built environment users referred and related to:

- walk and move
- approach and interact with physical elements in the space

6.2.2.1 Walking and moving

Most of the users who attend and use the buildings of Vandhalla and Musholm are users with mobility impairments. The mobility impairments of the users of these buildings include problems with walking, stability, strength and movement of one or more body parts. Many of these users also use mobility aids such as canes, walkers or wheelchairs, both manual and electric. The users interviewed during this study expressed the importance of being able to move and act in all areas of the building, and the possibilities of interaction with the physical environment despite their reduced mobility or the use of mobility aids. During the interviews, users did not mention accessibility problems, rather they often spoke of the importance of being able to perform activities independently. In this sense, the interviews with the users revealed the architectural features that contributed to the users' independence and stimulation of their physical activities in space, thus contributing to their physical and psychological well-being. This analysis led to the identification of the most influential built environment characteristics which refer to the spatial distribution of the furniture elements.

The spatial distribution of the furniture elements in the space had a significant influence on the freedom of movement of the users along the paths and within the rooms. This aspect was particularly noted along the activity ramp and inside the changing rooms in Musholm. According to a wheelchair user, the benches placed along the ramp, which are necessary to provide a resting place for those who need it, are not located along the pathway but in the thickness of the windowed wall; they therefore do not constitute an obstacle to the pathway. The user further explained that despite the slight slope of the ramp, moving along it with a wheelchair requires constant effort. Placing the seats so that they do not obstruct the pathway allows the wheelchair to be pushed without having to make additional manoeuvres and efforts (Fig. 6.2-21).

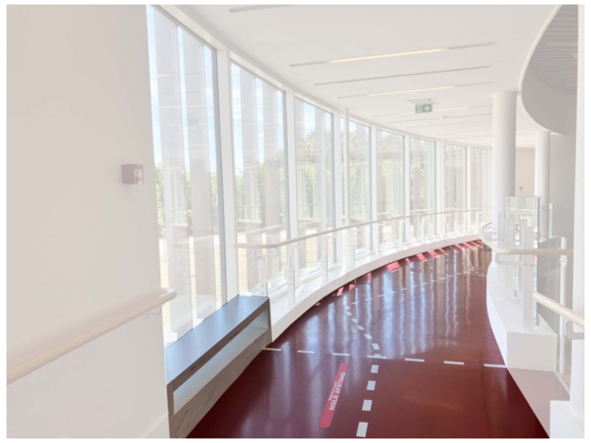


Figure 6.2-21 Musholm: seats placed in niches along the ramp

User: user with mobility impairments (regular user of the building)

User activity: physical - moving along the ramp

Perceived affordance: organisation - distribution of the furniture elements

User's quote (appendix 18):

When I have my manual wheelchair, it is more difficult to go up the ramp, but the thing I like is that the seats are not on the way, otherwise it would be impossible for me to get around them while pushing the chair.

Figure 6.2-22 Musholm: lower height of the coat rack

User: user with mobility impairments (regular user of the building)

User activity: physical - hanging the coat

Perceived affordance: dimensions - dimensional alternative

User's quote (appendix 18):

It might sound stupid, but it is frustrating to have to ask others to do things I can do very well by myself, like hanging up my coat.

Figure 6.2-23 Musholm: user with electric wheelchair entering the big bathroom

User: user with mobility impairments (regular user of the building)

User activity: physical - using the bathroom

Perceived affordance: dimensions - dimensional alternative

User's quote (appendix 16):

Usually, when I enter other bathrooms there is no way for me to close the door. Here there is enough space to enter, turn and close the door.

6.2.2.2 Approaching and interacting with physical elements in the space

During the interviews, users referred to the ease of interaction with certain physical elements and expressed the importance of being able to carry out private and non-private activities due to the wide range of different solutions and variations of dimensions, room sizes, and layouts.

The palettes of spatial dimensional and organisational alternatives turned out to be essential for users to carry out activities independently. In Musholm, wheelchair users immediately mentioned the reception desk and the two-height coat rack. They explained that it is not so common to walk into a building and be able to look the staff in the eyes or to be able to hang up one's coat by oneself (Fig. 6.2-22). For them, these two elements represent the business card of the entire building, where they will certainly find other detailed solutions that take into account their difficulty in reaching objects, and interacting with spaces and people while seated. As emerged from the focus groups during the design process of Musholm, users with different mobility and sensory abilities showed different preferences on the dimensions of the toilets. These different preferences are especially apparent among users with limited mobility who use aids of various sizes, and blind users. While the former stated the importance of having spaces that can accommodate bulky aids such as electric wheelchairs and possibly also shower beds (Fig. 6.2-23), for the latter, the small size of the bathroom allows them to better reach all the bathroom fixtures without having to move or touch too much.

The same result can be seen for the bathrooms in Vandhalla and the arrangement of the assistive elements within them (Fig. 6.2-24). Especially among the respondents with mobility impairments, each person expressed bathroom preferences based on the assistive equipment present and its arrangement. Each person used the toilet in which they were best able to move around, make transfers, support themselves, etc.

In Vandhalla, during the observations conducted in the main pool, it quickly became clear that users had different preferences on how to access the pool. Depending on whether they were accompanied or alone, whether they entered with a wheelchair or not, or whether they had the strength to transfer from the wheelchair to the edge of the pool, everyone entered the pool according to the mode they preferred. Some used the ramp, others the stairs, others the elevated edge of the pool (Fig. 6.2-25). Everyone entered in their own way.

Figure 6.2-24 Vandhalla: organisation of sanitary and grab bar

User: student with mobility impairments (regular user of the building)

User activity: physical - use the bathroom

Perceived affordance: organisation - organisational alternative

User's quote (appendix 12):

I've tried the other bathrooms and they could work for me, but the yellow one has everything in the right place for me.

Figure 6.2-25 Vandhalla: elevated edge of the swimming pool

User: student with mobility impairments (regular user of the building)

User activity: physical - enter into the pool area

Perceived affordance: dimensions - dimensional alternative

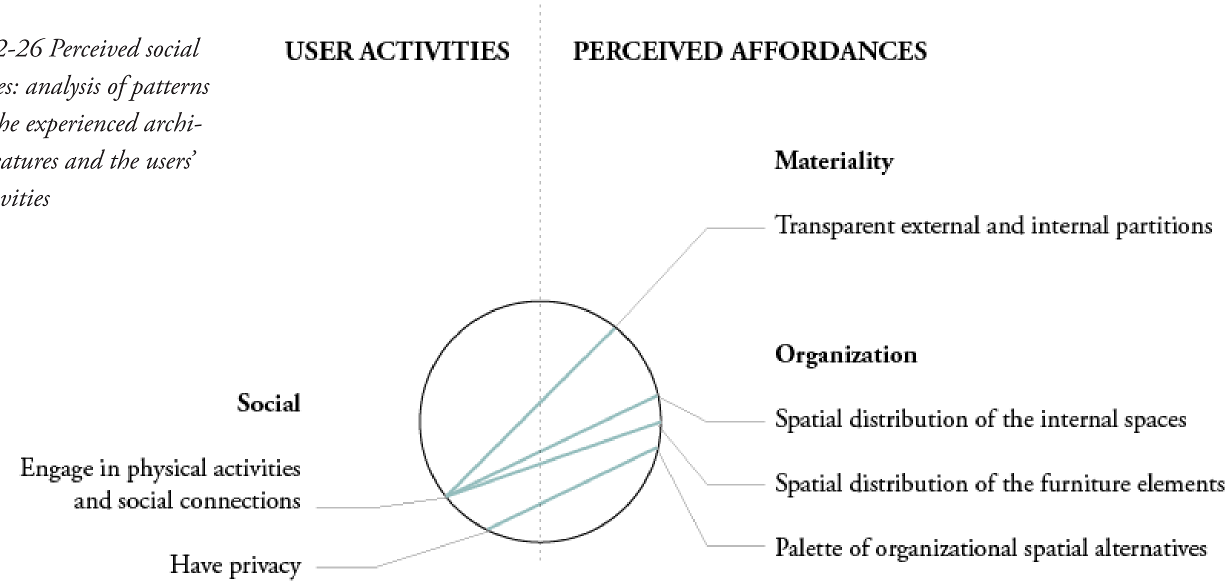
User's quote (appendix 18):

It would be impossible for me to sit at the floor level for entering the pool. So, either I enter from the ramp, or I sit on the edge and then jump into the water.

6.2.3 Social affordances

Social affordances refer to both the properties and characteristics that supported and stimulated the social interactions and active participation of users, and those that offered them the possibility of more private spaces.

Figure 6.2-26 Perceived social affordances: analysis of patterns between the experienced architectural features and the users' social activities



The identified characteristics supported users to:

- Engage in physical activities and social connections
- Have privacy

6.2.3.1 Engaging in physical activities and social connections

During the observations, the strong social character of both buildings was immediately visible. The social-relational dynamics observed during the investigation confirmed the general intention of these buildings to host and facilitate interaction between people during sports and recreational activities. One aspect that emerged from the users' words was the frequent reference to the presence of other users in the environment and how the visual and spatial connection within and between the areas of the building influenced their interactions with the other users and occupants.

The characteristics of the built environment that users referred to with regard to visual and spatial connection are the:

- transparent external and internal partitions
- spatial distribution of furniture elements

Figure 6.2-27 Musholm: transparent partitions along the ramp

User: deaf user (non-regular user of the building)

User activity: social – engage in the game and maintain visual connection toward outdoor

Perceived affordance: materiality – transparent external partitions

User's quote (appendix 21):

I can see the game, but I can also see if someone is coming, or I can check my children playing outside

Figure 6.2-28 Vandhalla: opening between the gyms

User: user with mobility impairments (regular user of the building)

User activity: social – feeling motivated in doing rehabilitation activities

Perceived affordance: materiality – transparent internal partitions

User's quote (appendix 12):

While I do my exercise here, I see other people doing rehabilitation in the small gym and I feel less lonely

Figure 6.2-29 Musholm: benches distributed along the wall of the changing room

User: deaf user (non-regular user of the building)

User activity: social - relating with the others in the changing room

Perceived affordance: organisation - distribution of the benches along the wall

User's quote (appendix 21):

If I´m sitting here, and someone is sitting on the other side we can communicate, and I have a clear view all around what's going on.

The transparent external and internal partitions, especially for people with hearing disabilities, turned out to be extremely important in influencing their experiences and interaction with contexts, situations, and people in surrounding spaces. Indeed, the inability to hear creates a strong disconnection between the hearing-impaired user and other people, which, if not supported by alternative means of connection, leads them to feel isolated and alienated due to the difficulty of interacting socially. It was clear from the interviews with deaf users that a better social connection with the surrounding contexts and people is linked to the presence of transparent partitions, or open spaces, which allow them a better visual connection. Transparent partitions offered users greater visibility and contact with the contextual situations happening both inside and outside the building. This was particularly noticeable, for example, along the activity ramp in Musholm, where the deaf user was able to have an excellent view of both the outdoor spaces and the multi-purpose hall (Fig. 6.2-27). The user thus expressed the possibility of watching the game and activities in the multi-purpose hall while also checking on his children engaged in other activities outside the building.

Interestingly, the visual connection between indoor environments also proved to be an important social aspect for users with mobility impairments. Users with severe mobility difficulties, who could not actively participate, were observed enjoying watching the activities in the main gymnasium of Vandhalla through the glass partitions along the corridor. Likewise, users performing physical rehabilitation exercises felt motivated by seeing other users performing similar exercises in the adjacent spaces (Fig. 6.2-28).

The spatial distribution of the furniture elements also played an important role in enabling users to have a clear understanding of the space they were in and the people within it. The seating arrangement along the walls in the changing rooms of Musholm, for example, allowed the interviewee not only to communicate easily with the other users sitting opposite him, but also to have a good view towards the door and not to be surprised or frightened by other users entering the changing room (Fig. 6.2-29).

Figure 6.2-30 Vandhalla:
small gym for rehabilitation exercises

User: user with mobility impairments (regular user of the building)

User activity: social – feeling comfortable in doing rehabilitation activities

Perceived affordance: organisation – distribution of the rehabilitation area in a less exposed place

User's quote (appendix 08):

When I play badminton it's fine to be in the main gym, but for rehabilitation exercise, I prefer to do it here. I feel less exposed.

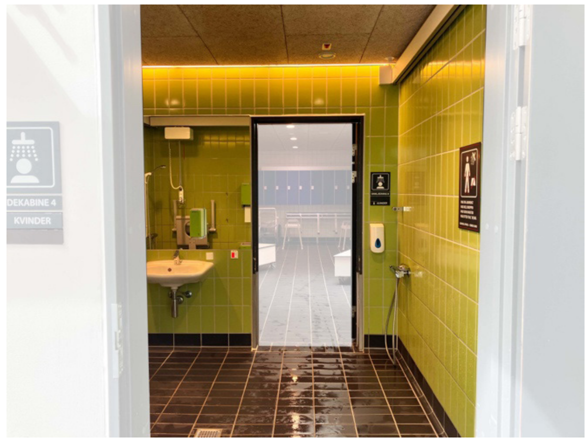


Figure 6.2-31 Vandhalla:
small cabins in the changing rooms

User: user with mobility impairments (regular user of the building)

User activity: social – feeling comfortable undressing in the changing room

Perceived affordance: organisation – alternatives of spaces where to get undressed

User's quote (appendix 06):

I had many surgeries, and my body is full of scars. I don't mind anymore, but I don´t feel good to undress in front of others.

6.2.3.2 Having privacy

Sports and leisure buildings imply the presence of many users and the sharing of the same spaces, even for more intimate and private activities such as changing before and after the sports activity within the dedicated spaces. The need for privacy, although being very individual, was found to be one of the main concerns of people with mobility impairments for two main reasons. Some users expressed a sense of discomfort at showing their bodies structurally different from others or with scars from undergoing surgery. A further reason was the expressed need for more privacy during physical rehabilitation exercises in which the user recovers or develops their body's abilities after an accident or illness. In contributing to fulfill this need for privacy, the design aspects which played an influential role according to the interviewed users were:

- the spatial distribution of the internal spaces
- the palette of organisational spatial alternatives

The spatial distribution of the internal spaces contributed to offer users spaces that they perceive as more private and suitable to less social activities, such as rehabilitation or relaxation after physical activity. In this respect, the small gym in Vandhalla was highly appreciated for the possibility of having a more intimate and less exposed space (Fig. 6.2-30). The interviewed user expressed, in addition to the fact of being less exposed, a feeling of a better connection with the therapist. The intimate space also allowed for more direct communication in regard to personal health conditions.

The palette of organisational spatial alternatives offered within the changing rooms was found to be the right solution architects integrated in the design, so as to allow users to choose between different possibilities and degrees of privacy according to individual preferences. Most of the users who talked about possible uncomfortable situations in the changing rooms were users with mobility impairments. These users spoke about the preference of not showing their bodies in front of other users because of malformations or scars. The same users therefore expressed a preference to change in more private spaces like the small cabins (Fig. 6.2-31).

6. 3 Summary table

Table 6.3-1 Offered and perceived affordances in space

COGNITIVE AFFORDANCES			
User activity	**Identified architectural features**	**Offered affordances**	**Perceived affordances**
Understanding the spatial configuration, identify spaces and elements	MATERIALITY	- Contrasting colours and tactile surfaces	- Contrasting colours and tactile surfaces
		- Visual and tactile guiding lines	- Visual and tactile guiding lines
			- Transparent external and internal partitions
	ORGANISATION		- Spatial distribution of the building volumes
			- Spatial distribution of the internal spaces
	LIGHTING	- Guiding lighting	- Guiding lighting
		- Focal lighting	- Focal lighting
	ACOUSTIC		- Acoustic cues from spatial proportions
Perceiving the contextu-al situations happening around the building	MATERIALITY	- Transparent internal partitions	- Transparent external and internal partitions
PHYSICAL AFFORDANCES			
User activity	**Identified architectural features**	**Offered affordances**	**Perceived affordances**
Walking and moving	ORGANISATION	- Spatial distribution of the internal spaces	
		- Spatial distribution of the furniture elements	- Spatial distribution of the furniture elements
Approaching and interact-ing with physical elements in the space	DIMENSIONS ORGANISATION	- Palette of dimensional and organisational spatial alternatives	- Palette of dimensional and organisational spatial alternatives
SOCIAL AFFORDANCES			
User activity	**Identified architectural features**	**Offered affordances**	**Perceived affordances**
Engaging in physical activi-ties and social connections	MATERIALITY	- Transparent external and internal partitions	- Transparent external and internal partitions
	ORGANISATION	- Spatial distribution of the internal spaces	- Spatial distribution of the internal spaces
			- Spatial distribution of the furniture elements
	ACOUSTIC		- Contextual acoustic cues from other occupants
Having privacy	ORGANISATION	- Palette of organisational spatial alternatives	- Palette of organisational spatial alternatives

7 DISCUSSION

This chapter discusses the knowledge developed from this study and how it can be framed around cognitive, physical and social categories of usability to provide architects with insights into the enabling role of architectural design.

This study pursued the research question:

How can we develop UD strategies for the design of sports and leisure buildings that can better enable the activities of users with physical and sensory impairments and thus support their participation and inclusion in society?

This research question led to the identification of the two main objectives of this study:

1) Develop knowledge on the enabling role of the built environment in improving the spatial experience of users with mobility, visual and hearing impairments;

2) Frame the knowledge on the impaired users spatial experiences of sport for providing architects with design stregies for more accessible, usable and inclusive sport and leisure buildings.

Knowledge of the enabling role of dimensional, visual, tactile and acoustic properties of architecture has been developed by studying the built environment of two sports and leisure buildings, which were designed with the intention of supporting and stimulating impaired users in their activities. In these buildings, the built environment and its inherent potential to enable user activities were analysed in relation to both the enabling mechanisms designed by the architects and those experienced by the users. This chapter discusses on the findings of this study.

Cognitive, physical and social categories were used in this study as drivers for both investigating and analysing how the materiality, dimension, organisation, lighting and acoustic properties of the built environment influence impaired users' activities in space. This chapter concludes presenting how the knowledge gained from the investigation of the enabling role of architectural design can be framed around these three categories which characterise the enabled performance and refer to the main aspects of usability.

This chapter is organised into six sections:

Section 7.1 – The anticipation of users' experiences - discusses how architects, through the developed design solutions, have aimed to improve user experience by considering differences in perception and use.

Section 7.2 – The embodied experience of the built environment discusses the knowledge provided by the phenomenological investigation of users' spatial experiences and how this knowledge contributed to reveal how the characteristics of the built environment supported and stimulated users' activities in space.

Section 7.3 – Offered and perceived cognitive affordances

discusses the results of the analysis of offered and perceived affordances to support users to understand the built environment, its constituent elements and the contextual situations that occur within it.

Section 7.4 – Offered and perceived physical affordances

discusses the results of the analysis of offered and perceived affordances to support users to move and interact with the built environment.

Section 7.5 – Offered and perceived social affordances

discusses the results of the analysis of offered and perceived affordances to support users to engage in social connection and to have privacy.

Section 7.6 – The role of the built environment in enabling cognitive, physical and social activities - discusses the meaning that the developed knowledge assumes in relation to Universal Design perspective, and how this knowledge is framed, so as to offer architects the possibility to better address users and their needs by exploiting the potential enabling role of architectural design.

7.1 The anticipation of users' experiences

The architects of Vandhalla and Musholm were asked to design buildings that could accommodate sport and leisure activities with special attention paid to impaired users. Users with mobility impairments were the initial target of the design process of these two projects. Architects took steps to ensure that users would not encounter any obstacles while performing their activities and experiencing the building. This involved designing spaces and features that are easily accessible and usable by users with limited physical strengths or reduced abilities.

Physical accessibility was the necessary and fundamental requirement. However, the aim of both projects was to offer users an environment in which they could feel safe, as well as thrive in physically and socially. The stated intention was not only to *accommodate* impaired users, but also to give them an opportunity to challenge their physical abilities in a safe and inclusive environment. The goal of the architects behind the design of these buildings was not just to ensure compliance with accessibility regulations, but also to create spaces that actively encourage user engagement and participation. Through the use of unique design solutions, such as the wheelchair-accessible swimming pool in Vandhalla and the ramp for challenging activities in the multi-purpose hall of Musholm, these buildings offer users the opportunity to experience the space in new and more satisying ways. Starting from the building's program and vision, architects went beyond relevant regulations and guidelines for accessible design, such as the Building Regulations (BR) and the guidelines provided by SBi and developed solutions that were tailored to the specific needs and desires of the clients. In other words, the architects not only met the minimum standards of accessibility, but they also went above and beyond to create spaces that encourage active use by people with impairments.

The user involvement during the design processes allowed architects to get to know the needs, desires, constraints, and opportunities of impaired users in their interaction with the built environment. The direct involvement with the users, together with their previous working experience and research, also gave architects the possibility of better addressing the diversity of users' experience of space and thus the value of equity. In both projects, the architects did not aim for one-size-fits-all solutions, but preferred to offer alternatives in terms of spaces, and thus uses, from which users could choose according to their needs and wishes. The increased awareness of the diversity of users, in their abilities and thus also in their perception and use of space, made the architects broaden the target group of users so as to design spaces that can be easily experienced by people with sensory impairments too. However, the main focus, due to the type of regular users of both facilities, remained on users with mobility impairments.

Objective of both projects was also to represent significant examples of impactful architectures for user inclusion. This was achieved through a collaborative effort between the clients, architects, where equity and inclusiveness were set as the main design drivers. Throughout the design process and the understanding of users' differences and needs, the architects continuously evolved and refined these solutions, integrating them seamlessly into the final project. The final design solutions were determined by the project's mission, the architects' experience and the knowledge they gained through the design process. These solutions were analyzed with a focus on how the design of the built environment intended to offer an improved usability by supporting users' differences in orienting, acting and relating with others.

7.2 The embodied experience of the built environment

The process of being directly engaged in and interacting with the environment while also being questioned about their experience, allows users to develop a more comprehensive and profound understanding of both the environment and their personal experience within it. This method of engagement encouraged reflections, allowing users to not only perform their activities in the environment but also to analyze and process the factors influencing their experiences. For many users, paying attention to their feelings and the effects of the environment on their daily activities, as well as exploring the environment in detail, was an unfamiliar process. During the interviews and walkthroughs, users were able to focus on these aspects in order to understand and communicate why certain features were so important to them. This also afforded them a greater awareness of their experiences as persons with impairments. What is interesting, in fact, is that some of them stated that they also increased their awareness as impaired users, realising how their activities can be influenced by the built environment in which these take place. This reflects the phenomenological process of knowledge described by Merleau-Ponty in which the person, through the experience of the external world, develops awareness of the environment as a perceived object, but also gains greater awareness of their own person, as a perceiving subject.

The user's body revealed itself both as the main mediator of perceptions, and as a means to perform in the space, both physically and socially. Users' different sensorial and bodily plasticities conditioned their relation with the environment and its characteristics, additionally, users' personal and intellectual characteristics - through different expectations, intentions, and knowledge - shaped their experiences and thus also their responses during the investigation. The diversity of users involved was reflected in a diversity of responses and personal accounts of how each person perceives and experiences the environment. Each analysed person-environment encounter was unique and defined by personal intentions, structures, skills, and knowledge, as well as different environments and contexts, which all together mediated the character of their different spatial experiences.

Overall, the process of direct engagement and interaction with the environment through questioning and reflection allows for a deeper understanding of both the environment and the individual's personal experience within it. This approach not only encourages the analysis and processing of the factors influencing the user's experience, but also highlights the importance of the user's body, sensorial and bodily plasticities, and personal and intellectual characteristics in shaping their perception and experience of the environment. Through this process, users gained a greater awareness of their own experiences, as well as the ways in which the built environment impacted their activities. This approach also highlights the diversity of responses and experiences among different users, highlighting the importance of considering the unique perspectives and experiences of each individual in the design and evaluation of the built environment.

7.3 Offered and perceived cognitive affordances

Offered cognitive affordances

The sensory and physical properties of the environment make a significant contribution to the users' orientation in space. The senses are the means by which people can gather clues about the environment and then process them as information about the composition of the building, the activities and contextual situations taking place within it. Upon this, architects developed design solutions by integrating the indications from SBi guidelines, and by working with sensory architectural features such as the materiality and the lighting to provide users, especially those with visual or hearing impairments, with tactile and visual cues. By working with the materiality and the lighting, the architects intended to help the users both to identify the space they were in and to get directions on how to move around.

Properties of materiality were used, both as tactile and visual cues, to offer better orientation and understanding of the surrounding spaces. In both projects, the physical space was defined through the use of contrasting colours in order to better visually define the shape of the space and the elements within it. Surfaces of different tactility and color were used in Musholm as guiding lines, both for the entrance and the main distribution. In Vandhalla, on the other hand, evident visual cues for orientation have been offered through the use of directional lighting. Lighting was also used in both projects to create atmosphere according to the space. The use of different light source concentration, and contrast with the surroundings, was designed by architects with the intention of communicating different functionalities of space. This was the case of the pendant lights and the skylights which are present both in Vandhalla and in Musholm. In order to facilitate orientation and understanding of the space, the architects also used transparent partitions in the dividing elements between one space and another. This was done to ensure the right lighting and transition between the internal spaces. However, the use of glazed doors and the presence of openings to maintain visibility between the different building areas was designed to also provide users with a continuous visual connection to their surroundings and thus a greater capacity for orientation.

Perceived cognitive affordances

Especially for the users who had never visited these buildings before, the biggest concern they showed once they entered was to understand what kind of building they had entered, how the spaces were distributed, and which direction to take in order to head to the spaces where the different activities were taking place. This was even more evident for blind users; their greatest challenge was to be able to figure out where to access the building, and understand its general configuration, through tactile or acoustic spatial cues. The use of differences in the materiality of the flooring in Musholm provided the blind user with contrasting tactile surfaces, both to identify the entrance and to follow the directionality of the internal corridor. While the use of too many contrasting tactile surfaces in the exterior area required special attention to understand their logic and thus the direction to be taken, the simple wooden guiding line used for the corridor provided a very clear reverberation of the different materiality to follow. Differences in the tactility of materials were also perceived as indicating a different functionality of the space; the presence of tiles suggested the presence of showers, and the carpeting made the user assume that it corresponded to the reception area. In Vandhalla, on the other hand, the blind user interviewed identified the entrance and the internal direction to follow through acoustic cues. These cues were offered by the lowering of the ceiling in the case of the entrance hall and by the voices of other users in the case of the corridor.

For the deaf users interviewed, the visual cues of the environment helped them to better orient themsleves. The materials and colours used helped users to associate them with the areas of the building; for example, the materials used for the façade suggested the different functions of the parts of the building. A better legibility of the building and its interior spaces was perceived in Musholm, where the organisation of spaces around a central point offered the deaf user the possibility of having visibility of the various destinations from a favourable viewpoint. An improved legibility was also perceived through the transparencies both on the façade and between the interior spaces. The transparencies supported not just the visibility of the various areas of the building, but also a visual contact with the surroundings, the activities carried out, and the occupants present. Finally, additional visual cues perceived by users with hearing impairments were identified in the lighting. Especially in Vandhalla, guiding lighting and focal lighting attracted the user's attention by providing both directionality and better spatial legibility.

Three users with mobility impairments also noted how the transparency, colour and type of material were respectively helpful to their orientation in space. The first user, thanks to the transparencies of the Musholm façade, noticed the ramp and thus understood the volume distribution of the multi-purpose hall, and the possibility of access to the upper floor. The second referred to the colours used for the bathrooms and changing rooms in Vandhalla, and mentioned the correspondence between colour and the type of bathroom best suited to his needs. The third user, on the other hand, mentioned the type of material used for the ceiling of the corridor in Musholm. He explained how, from a reclined position in his electric chair, the view of the wooden slat ceiling allows him to better understand where he is located in the building.

7.4 Offered and perceived physical affordances

Offered physical affordances

The two buildings examined focused on ensuring that users with mobility impairments could have access to all spaces but, above all, that they could carry out activities as independently as possible. For this reason, in addition to avoiding the presence of possible mobility obstacles, the intention was to offer spaces that could be easily used by people who usually have difficulty interacting with physical space due to reduced mobility, lack of strength or the use of mobility aids. While the guidelines essentially provide guidance on the necessary and appropriate dimensions for the accessibility of common spaces, the architects of Vandhalla and Musholm went further, developing solutions that better support differences in physical user-environment interaction.

This approach is mainly visible in the offering of a palette of alternatives from which users can choose when performing their activities. Particularly with regard to bathrooms, where the needs are very different and the physical environment can be a great obstacle, the architects of both projects offered bathrooms of different sizes and equipped differently in order to increase the compatibility between the built environment and the user. In the case of Vandhalla, the different options for descending into the pool are a further example of how the same action can be performed in different ways according to the user's personal conditions and circumstances. Although the pool ramp is the element that symbolises this project's sense of inclusion, the real aspect that distinguishes the usability of the pool lies in the alternatives offered by the architects for descending it, such as the staircase and the raised pool edge. In the case of Musholm, the same approach is visible in the solutions that consider different ways for the user to approach the built environment, such as the reception desk, the coat rack and urinals placed at two heights, or the benches and toilets equipped with a mechanism that allows adjustment to the height most compatible with the user's needs.

Perceived physical affordances

While the investigation of users' experiences with orientation and understanding the building concerned all three types of users, only users with mobility impairments and blind users referred to the ability to move and act in space. This could be likely because these users face greater challenges than users with hearing impairments in terms of moving and interacting with the physical environment. For those with mobility impairments, limited strength, movements, and the use of any mobility aids can make it difficult to move around a building and use certain types of equipment, hindering their ability to move and act independently. Similarly, blind users, who struggle more in identifying elements within the space, experience limited abilities to both move and interact with the environment.

Interviews with users revealed that while users with mobility and visual impairments primarily focused on factors that aided their movement and actions within the building, none of them identified the impact of rooms distribution in the building on this aspect. Despite architects' efforts to create short and continuous paths, users were not able to perceive this aspect. This may be due to the fact that while these aspect is beneficial to users, it is difficult for them to recognize and evaluate in their direct experiences with the space. However, these users did highlight the importance of the arrangement of furniture elements and the availability of various spatial settings for performing activities. Users with mobility impairments referred to their daily difficulties in interacting with the physical environment and expressed appreciation for being able to access, move and stay in all areas of the explored buildings, despite their reduced mobility or use of mobility aids. Especially for users with bulky wheelchairs, the possibility of obstacle-free spaces allows them to avoid awkward manoeuvering. Similarly, for visually impaired users, obstacle-free spaces and paths allow them to move freely and safely without the risk of tripping or hitting furniture elements.

For users moving with a wheelchair, the possibility of interacting with the elements of the space while sitting was determined by where these elements were positioned and whether they could also be reached from the sitting position. Difficulties with movement and physical interaction for users with mobility impairments were experienced as facilitated by the wide palette of solutions designed to accomodate the diversity of bodies and abilities. In Musholm, the presence of three bathrooms of different sizes was also a good solution for a blind user. Indeed, he stated that he prefers small spaces, especially bathrooms, where movement is limited, as is the space to be discovered and thus the possibility of running into obstacles. However, this user's concern was to be able to recognise the size of these bathrooms from the outside and thus choose the one best suited to his needs.

7.5 Offered and perceived social affordances

Offered social affordances

Another important feature of the selected case studies was the intention to provide spaces that encouraged and stimulated the user to participate in activities, and to interact with other occupants, while maintaining the desired degree of privacy. Individual privacy and relationships with others have an established importance in buildings for sports and recreational activities, and the architects were aware that the balance between these aspects is very personal. Although similar and easily comparable, the two considered case studies differ slightly in their conditions of use. Musholm is a center for holidays, sporting events, and conferences, while Vandhalla is a building housing a swimming pool and gym for daily sports activities and rehabilitation. While both facilities provide opportunities for leisure and physical activity, the primary focus and intended usage of the two buildings differs. Musholm is primarily used for recreational activities such as holiday vacations and sports events, while Vandhalla is designed for ongoing, daily use by local residents for sports activities and for rehabilitation. From this difference, it follows that while Musholm is a project oriented very much towards stimulating participation and interactions, Vandhalla, on the other hand, had to guarantee users the possibility of more privacy - especially in the changing rooms and rehabilitation spaces.

In Musholm, the stimulation of active participation and movement is encouraged by spaces that offer the user the opportunity to engage in unusual activities. The activities offered in Musholm are challenging, yet safe, and have been designed to push the limits of what participants are able to achieve physically and mentally. These activities are in fact designed to provide a sense of accomplishment and boost self-confidence, as well as promote physical fitness and mental wellness. The ramp itself is not only a pathway to the upper floor, but also an experiential space from which to view the multi-purpose hall and access the activity platforms where users can try more challanging physical engagement.

In Vandhalla, while interaction with other occupants is offered through transparent partitions between activity areas, privacy is offered through a gradual distribution of spaces; areas for more social activities are close and visible from outdoors or from the entrance, while areas for rehabilitation and changing rooms are less exposed.

Perceived social affordances

In both Musholm and Vandhalla, users reported feeling a sense of comfort and belonging from the moment they entered the facilities. Some users mentioned they perceived the care in the choices made by the architects, which contributed to the overall sense of inclusion. Althought users were unable to explain this feeling through specific reasons, they attempted to describe it through more abstract concepts such as “good karma” or a “positive feeling”. One of the interviewed users was able to elaborate more on his experience, explaining that he could tell, from the details around him, that the attention to disability was present without being visible and stigmatising as he had seen in other buildings. From the very first approach to the buildings, the users perceived the atmosphere the architects wanted to convey. Although this feeling stemmed mainly from the quality of the designed space, many users also associated the feeling of inclusion by referring to the kindness and helpfulness of the staff.

The results from the analysis of users experiences show the significant contribution of architectural features to the social aspects of the spatial experience of users, particularly those with mobility and hearing disabilities. The transparency of the partition walls between the interior spaces, in which different activities take place, proved to be a very important feature in stimulating users to participate in physical activities both actively and passively. For a user with mobility impairments the possibility to see the presence of the ramp through the external transparent partitions in Musholm, was the revealing element of the building’s spirit of inclusiveness. In Vandhalla, the internal transparent partitions between the big and small gym, allowed users doing rehabilitation to have a visual contact with other users doing similar activities and thus feeling less alone in their journey to regain lost physical skills. For users with severe mobility impairments who could not actively participate, on the other hand, the transparent partitions between the main corridor and the big gym allowed them to watch the activities of others and passively participate.

The visibility offered in both buildings by transparent partitions was also of particular importance for deaf users. They explained the importance of being able to see into adjacent spaces, not only to better understand the surrounding context, but also to be able to have a more direct connection to the situations and the occupants of the adjacent spaces. This aspect came together with the organisation and arrangement of interior spaces and furniture, which allowed hearing impaired users to have full visual contact with interlocutors. As anticipated by the architects, the aspect of visual connection turned out to be a very subjective one. The organization of spaces and the provision of both open and more intimate spaces showed to have a significant impact on users' experiences. While some users appreciate the possibillity to maintain a continuous visual connection to surrounding spaces and people, others expressed a need for more intimate spaces where they could perform more demanding and less social activities, such as rehabilitation exercises. Especially in Vandhalla, these users appreciated the design of less exposed spaces that provided a better sense of privacy and intimacy, such as the small gym and the cabins of the changing rooms.

In addition to visual cues, acoustic cues, such as the sound of people talking or the characteristic noise of certain sports and leisure activities, also proved important for visually impaired users, as they provided information about the presence and position of other people in a space and the activities in which they are engaged. This has offered users not only the possibility to better orient themselves within a building but also, if they wish, to engage in social interactions with other occupants.

7. 6 The role of the built environment in enabling cognitive, physical and social users performances

The UD trend envisages a shift towards performative requirements to align the legislative framework with a design practice that better understands and meets the needs of users in their relationship with the built environment. Such requirements should enable architects to analyse, understand, and meet user needs with solutions that go beyond the minimum requirements set by the current prescriptive approach. Based on this assumption, this research was conducted through an exploratory investigation aimed at verifying and identifying the potential of the characteristics of the buillt environment in supporting and stimulating user activities, so to inform architects on how these characteristics can be designed to improve usability, hence participation and inclusion.

In order to develop strategies for architectural practice in the form of performative requirements, it was necessary, in this study, to work with categories that would allow the characteristics of the environment to be associated with their enabling potential within the person-environment relation, thus facilitating architects to address usability. The three categories of cognitive, physical and social were therefore proposed in this study to address usability by investigating the activities that the environment can enable. The same categories were in fact employed, through the theory of affordances, in relation to the potentials of the environment in enabling users cognitive, physiocal and social performances (Table 7.6-1).

Table 7.6-1 Cognitive, physical and social categories in relation to: usability evaluation, users performances and affordances design

	USABILITY **- evaluation -**	**PERFORMANCE** **- user experience -**	**AFFORDANCES** **- design -**
COGNITIVE	• the ease with which users understand the environment	• understand the environment	• how architectural design can make users easily understand the environment
PHYSICAL	• the ease with which users act in the environment	• act in the environment	• how architectural design can make users easily act in the environment
SOCIAL	• users' satisfaction with their personal experience of the environment	• behave and participate in the environment	• how architectural design can make users satisfied with their personal experience of the environment

With the aim of developing knowledge on how to address these three categories of usability, the theory of affordances provided the framework with which to analyse and synthesise the contribution of the environment in offering users the possibility of performing cognitively, physically and socially.

Although these are significant categories reflecting the main aspects of usability, the inherent complexity of user experience of the built environment calls for some reflection. During the analysis, it was observed that sometimes these categories can be interconnected or nested within each other; the wheelchair-accessible swimming pool in Vandhalla is a significant example of this. Being able to descend into the pool via the ramp is not only a possibility to perform the physical action of descending, but also represents the possibility for the user not to use lifts that may compromise the sense of dignity of the action itself, thus affecting the more personal and social aspect. Additionaly, it is important to note that while the use of this categorization allows to address the complexity of spatial experiences, it is not meant to simplify it. Rather, the aim is to associate the observed mechanisms with aspects of users spatial experiences that could be meaningful for their understanding.

As this study has shown, the built environment can play a crucial role in enabling user activities and thus in supporting and stimulating the use of sports and leisure buildings for people with mobility, visual and hearing impairments. Design strategies that can inform architects on how design elements and features are related to user performance pave the way to better respond to human differences through design. The performance-oriented design strategies presented in the next chapter intend to drive the practice to creatively rethink the use of materiality, dimension, organisation, lighting and acoustic properties towards a different approach that exploits them in relation to their role in enabling users' cognitive, physical and social performance.

8 PERFORMANCE-ORIENTED DESIGN STRATEGIES FOR INCLUSIVE SPORTS AND LEISURE BUILDINGS

This chapter presents performance-oriented design strategies based on the analysis conducted in this study. The main objective of this study is to frame the findings from the investigation of users' spatial experiences to inform architects on how to design architectural features that are more attuned to the needs and interactions of users with the built environment. The study aims to communicate to architects how the characteristics of the environment, such as materiality, dimensions, organization, lighting, and acoustic can play an enabling role in supporting the performance of individuals, particularly users with mobility, visual, and hearing impairments.This knowledge is oriented to support architects in understanding the influence of architectural features on the performative character of spatial experience, so that they can creatively develop solutions that better support and stimulate users' activities in sports and leisure buildings. The strategies are organised into 5 sections, one for each environmental characteristic investigated. For each characteristic, the respective enabling role in users' spatial experience is presented according to the cognitive, physical, and social aspects.

8.1 Materiality – communicating spaces, elements, directions and contexts

Architecture is made up of, and characterised by, materials. Each material has properties that are perceivable by embodied users, primarily visually and tactilely. Users with visual abilities are able to acquire information about the elements and volumes that make up the environment by visually perceiving such properties as colour, shape, texture. These properties help users to define physical space and understand their surrounding environment. In addition, properties such as colour and texture of materials, by drawing attention to specific volumes within the space, can help users to focus and easily identify these within a context. Beyond the visual experience, the tactile experience of materials can offer the possibility to explore and orient in the environment. Direct bodily contact with material texture can offer users a spatial reference point that can compensate or complement visual perception, thereby enabling spatial cognition.

Through visual and tactile person-environment interactions, material qualities can influence users' experiences in many ways. The following presents the identified cognitive and social affordances that the properties of different building materials can offer to users while experiencing the built environment.

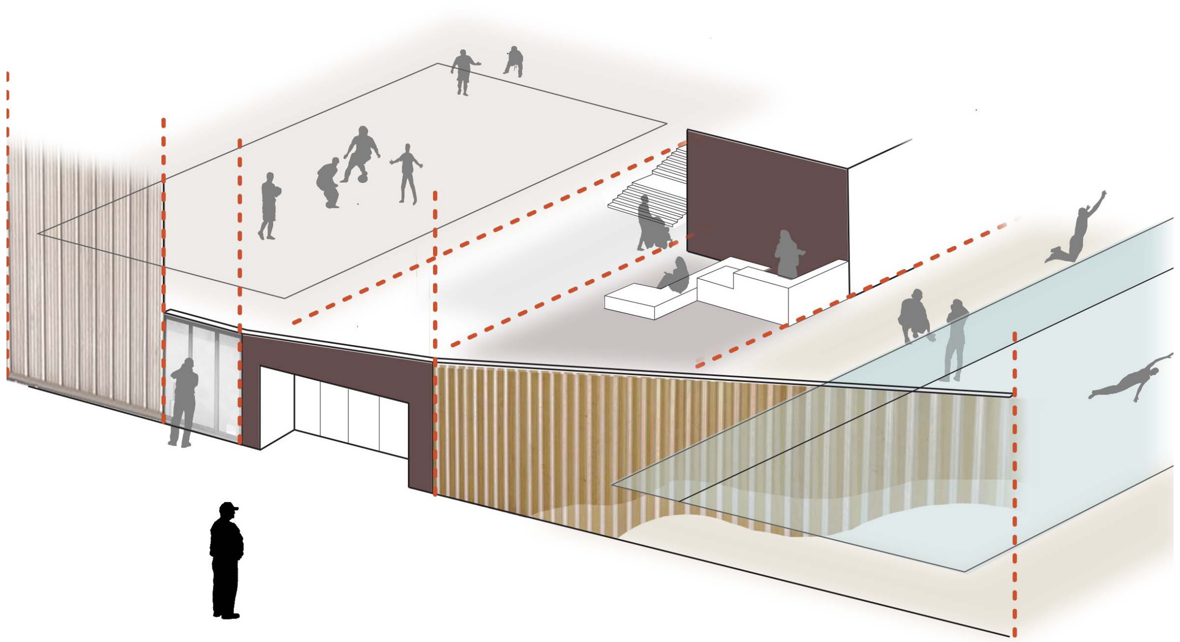


Figure 8.1-1 Materiality communicates the identity of spaces and their functionality

Cognitive affordances

Materiality can communicate the identity of spaces and their functionality. The expressive character of the chosen materials, together with the position in which they are used, are the vehicles through which the meaning of the space can be conveyed from the cognitive point of view. Through the visual and tactile perception of materials, users can obtain information about the environment they are experiencing and recognise the space they are inhabiting. By associating the presence of certain materials with specific spaces and functions, the user can orient themselves more easily because they can perceive the materials and understand the information they acquire through the perception of the material. From this premise, the choice and arrangement of materials is therefore important to be a guide for the user's association of meaning. Distinguishing the treatment of the façade of volumes that make up the building can provide information on the activities carried out within it. The diversification of the materials used for external cladding, in terms of type, colour and texture, can thus be visually perceived and processed by associating them with different internal functions. The external cladding used for the space that houses the main activity, such as the gym, can thus, for example, be distinguished from the cladding used for the entrance. This allows the user to get a preview of the organisation of the interior spaces even from outside the building. For interior spaces, characterising a space by treating the floor, walls and ceiling with identifying materials can support the user in recognising it. For example, as shown in the diagram (Fig. 8.1-1), the materials used for the façade could be used to anticipate the corresponding interior spaces and suggest to users the variety of functions housed in the building. Especially for interior room surfaces, with which the user can have direct contact, the characterisation of the space can also take place through the use of different surfaces perceivable not only visually but also tactilely. For example, the reception area can be distinguished through the use of a different flooring than in the rest of the building, with a material that is easily perceived through its different reverberation when walking or using a cane. Considerations on the positioning of the identifying cladding must also be made in relation to different modes of perception and points of view. While floor and wall coverings can be perceived both visually and through direct contact, the ceiling covering can only be perceived visually. However, this perception is particularly relevant when the user's point of view is from a lying or reclined position.

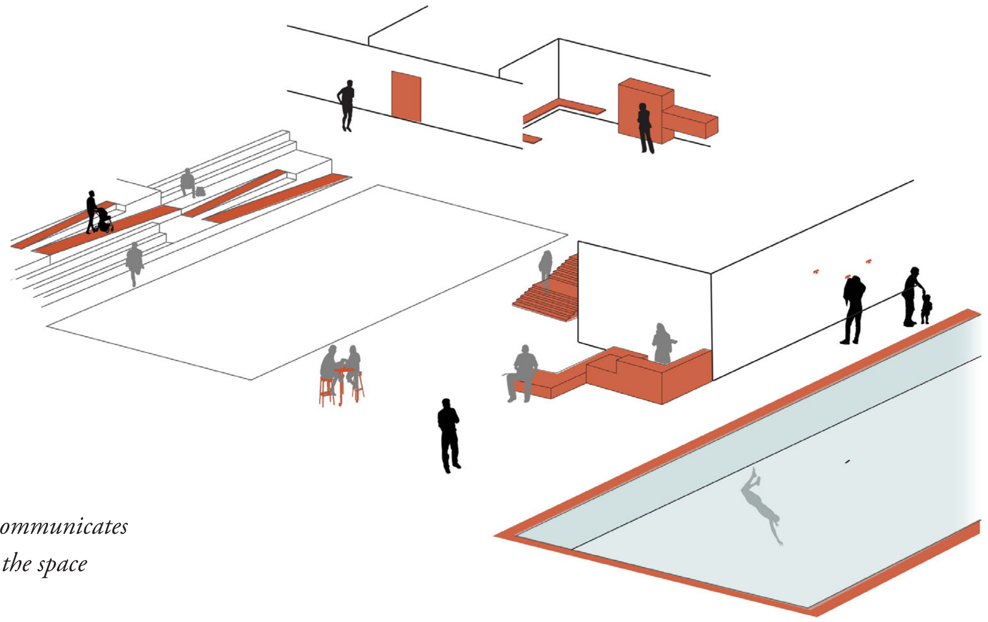


Figure 8.1-2 Materiality communicates the presence of elements in the space

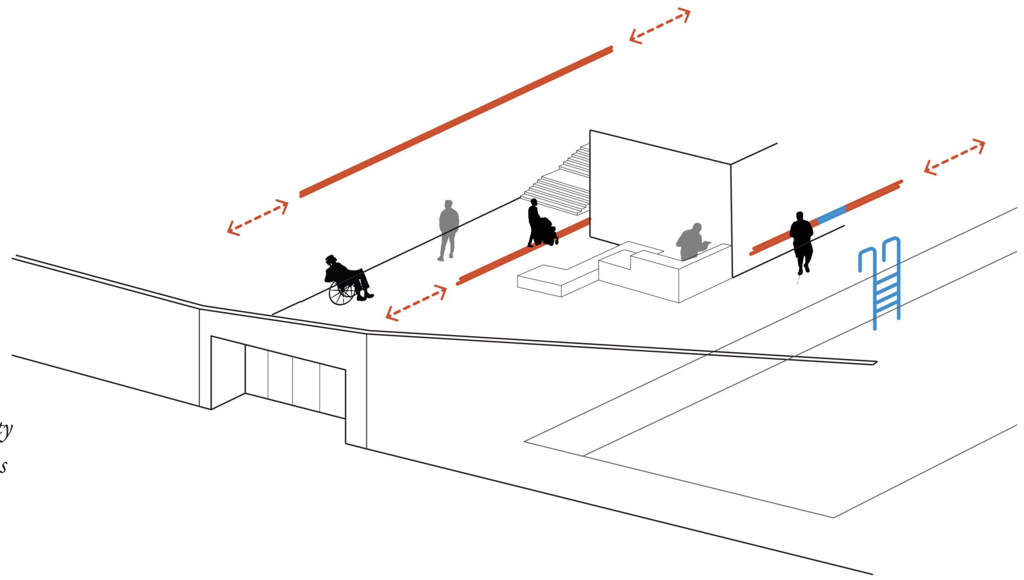


Figure 8.1-3 Materiality communicates directions

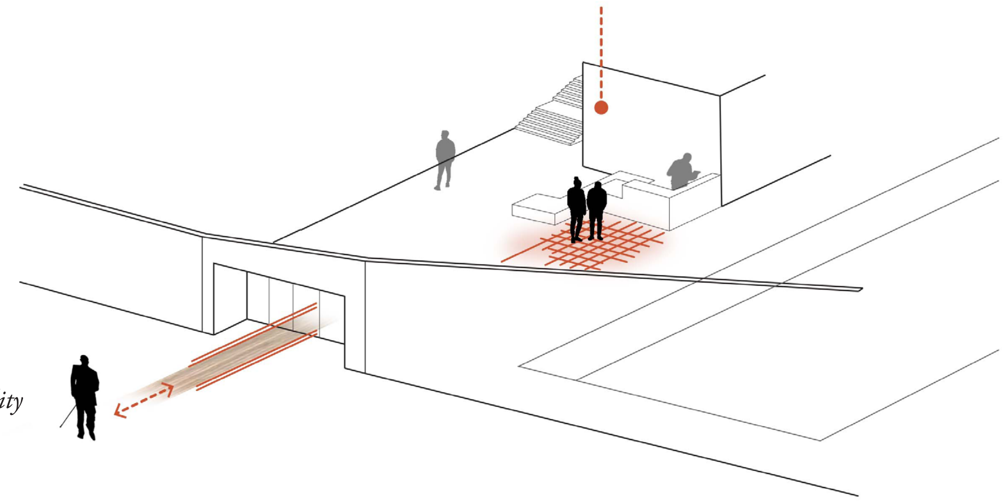


Figure 8.1-4 Materiality communicates directionality

Cognitive affordances

Materiality can communicate the presence of elements in the space. Colours and textures can play an important role in drawing user attention to certain elements within a space. By treating building elements and furnishings or support elements, such as handrails or handles, that contrast with the rest of the environment, users can easily identify and distinguish these elements (Fig. 8.1-2). This is particularly important for elements such as doors, stairs, ramps, other distribution elements and furniture. Using visually and tactilely contrasting materials for these elements can make them more easily recognizable in the space, which can be especially beneficial for users with impaired vision.

Cognitive affordances

Materiality can communicate directions. When contrasting colors or textures are placed along a path, they can guide users moving through a space or corridor, improving wayfinding and ease of navigation. Visually and tactilely distinguishable materials can direct users around the building. These can be achieved through the use linear elements of contrasting materials on floor, ceiling, walls (Fig 8.1-3). Additional elements such as the handrail, for instance, other than providind physical support, they can also provide directional indications and information about the environment through the use of visual and tactile contrasts. For example, a change in material and color of the handrail can indicate access to a secondary route, such as a ladder to the pool as shown in the figure.

The tactile properties of the flooring material can also play a role in indicating directionality. For example, a smooth, polished surface may suggest a path space that is meant to be walked on, while a rough, textured surface may suggest a space for being, where people are meant to linger and sit (Fig. 8.1-4). The flooring material has a distinct grain or pattern that runs in a specific direction, it can be used to guide and inform users. Additionally, the use of contrasting materials, such as a smooth flooring material transitioning to a rough one, can also be used to indicate a change in direction or purpose of the space.

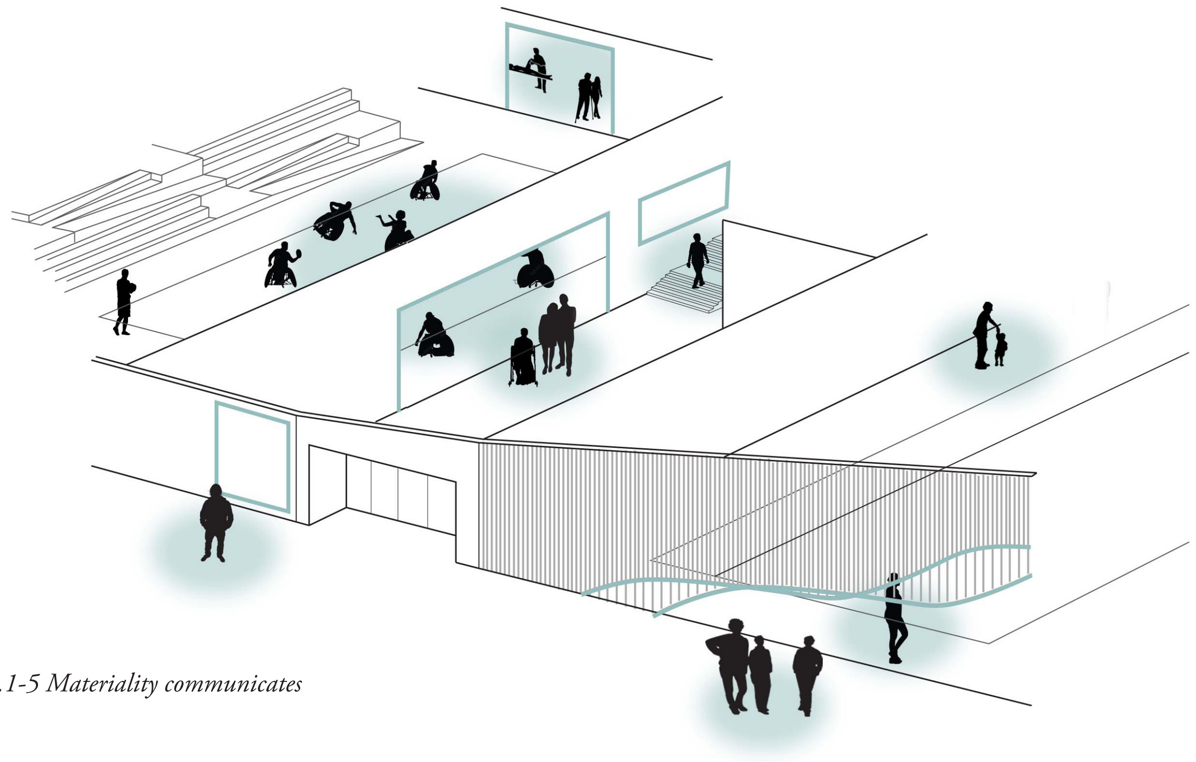


Figure 8.1-5 Materiality communicates contexts

Social affordances

Materiality can communicate contexts. The transparency of the materials used to divide spaces can greatly impact the visual connection between them and their occupants. Transparent partitions can offer a visual connection between spaces, providing a view into adjacent areas and enabling spatial cognition, communication, and social connection with other occupants (Fig. 8.1-5). This can be especially beneficial for people with hearing impairments, as they can be more fully aware of the activities and contexts of the surrounding spaces.

Transparent partitions between different activity areas can increase the sense of cohesion among occupants, which can help stimulate physical activity and motivation for those with mobility impairments. Furthermore, for those with severe mobility impairments, transparent partitions can allow for passive participation in physical activities, allowing them to enjoy watching the activities even if they are unable to actively take part.

However, the visual connections provided by transparent partitions may compromise the sense of privacy, which can be important depending on the type of activity and the individual preferences of the user. It is important to consider the type of activity taking place in a space when determining the appropriate level of transparency. For example, spaces where collective activities take place such as swimming pools or gyms may benefit from a higher degree of transparency, as they are meant to be visible from the outside and internal communal spaces, while spaces intended for more private activities such as changing rooms should have a lower degree of transparency. Additionally, in intermediate spaces such as rehabilitation or meeting spaces, the ability for occupants to modulate the degree of transparency can offer more flexibility and allow them to decide the appropriate level of privacy for their needs.

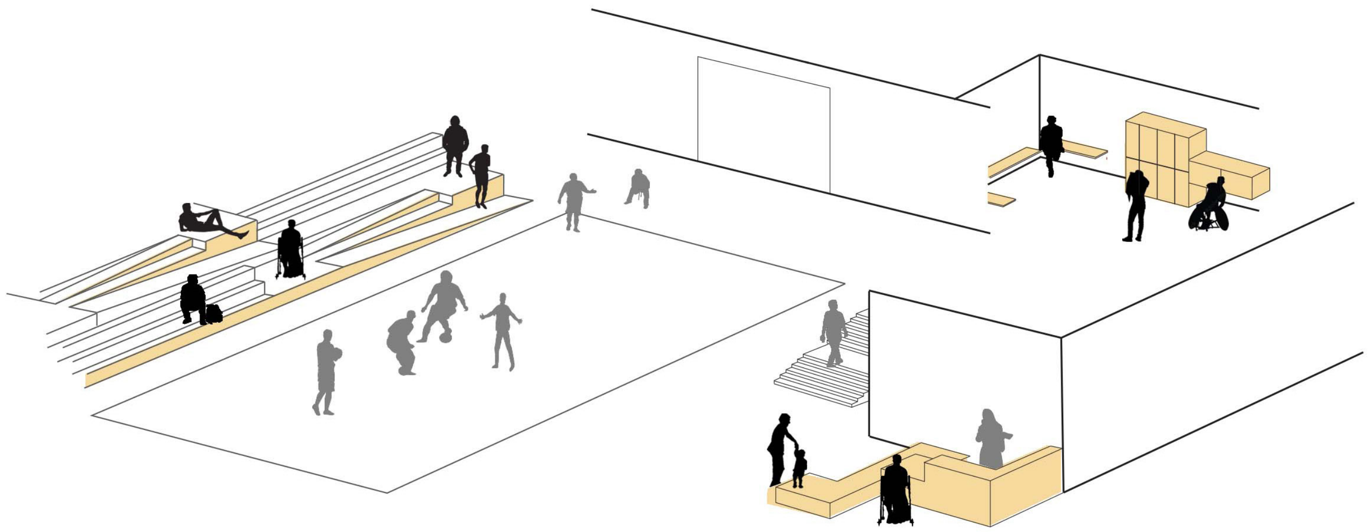


Figure 8.2-1a Dimensions embrace differencies in bodies and interactions

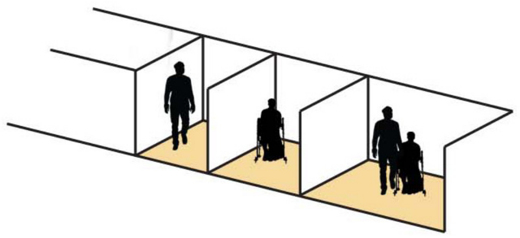


Figure 8.2-1b Dimensions embrace differencies in bodies and interactions

8.2 Dimensions – embracing differences in bodies and interactions

The dimensions and proportions of architecture are fundamental to user experience of space. Architectural dimensions strongly influence the possibility for users with different physical and sensory characteristics to interact with the environment, thus, to carry out their activities within the space. The diversity of physical and sensory abilities, as well as the diversity of bodies and positions from which the environment is experienced, determines whether or not users can physically interact with the space. In order to accommodate this diversity, the size of the space and the position of equipment should provide an adequate match in diversity.

Physical affordances

Dimensions can embrace differencies in bodies and interactions. Although it is preferable to provide the same spaces and the same modes of use for all users the possibility of interacting with the physical elements of the space from different positions and different heights can allow physical interaction by users of different sizes and abilities (Fig. 8.2-1a). Additionally, incorporating adjustable features such as height-adjustable seats or lockers, can ensure that everyone is able to interact with these elements, regardless of their physical characteristics and abilities. Especially in spaces that involve multiple interactions with the physical environment such as bathrooms, offering spaces characterised by different dimensions can accommodate individual needs and broaden the range of users who can easily use these spaces (Fig. 8.2-1b). This can, in fact, allow persons with different mobility and sensory abilities to choose the most suitable space to access, and use safely and independently. Different sized bathrooms can facilitate the movement of users with different abilities and using different aids. Especially for mobility-impaired users, who are limited by the use of mobility aids, larger bathrooms are essential to be able to get access and move around easily without the need to make many manoeuvres. Larger spaces also allow the presence of more than one person, such as an assistant. Conversely, smaller bathrooms make it easier and quicker for visually impaired users to explore the space, offering reference points that are easy to reach and use, as well as reducing the risk of encountering physical obstacles.

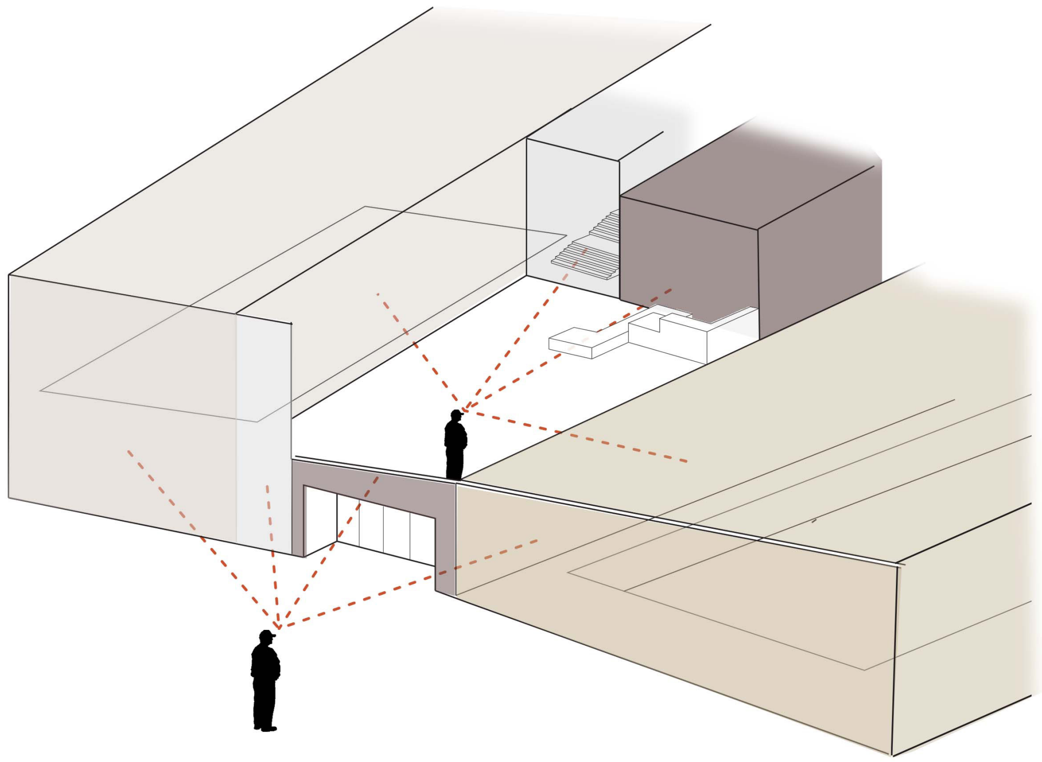


Figure 8.3-1 Spatial organisation provides sensory reach

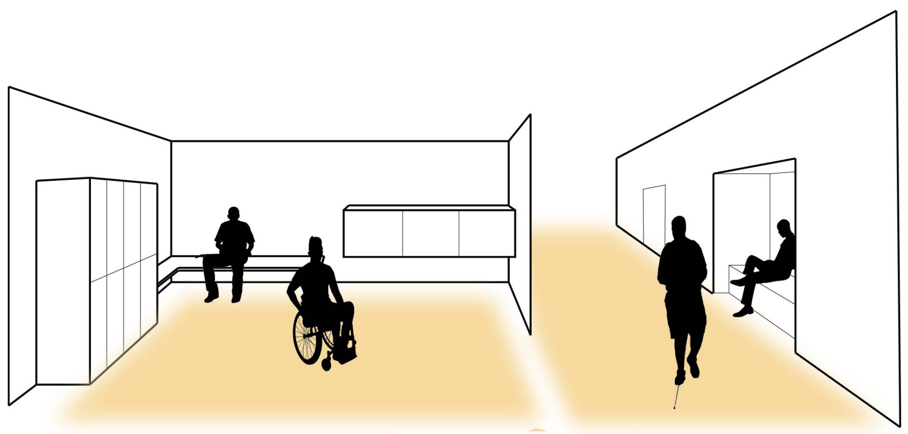


Figure 8.3-2 Spatial organisation provides physical reach

8.3 Organisation – providing sensory, physical and social reach

A building consists of spaces and furniture elements organised according to the spaces' functions, their relationships to each other, and the routes required to move from one space to another. Similarly, furniture elements are distributed throughout the space to suit different uses. The organisation and distribution of spaces and furniture elements, by providing optimal conditions for person-environment interaction, can facilitate the user's ability to reach the space sensorially and physically. Furthermore, spatial organisation that allows the user to have good legibility of the space allows the user to have a visual connection with the other users of the building, thus supporting the possibility of social interactions.

Cognitive affordances

Spatial organisation can provide sensory reach. The distribution of the building's volumes around a central node can facilitate the user's awareness of the building configuration. For all users, whether with impairments or not, the possibility of having a complete view towards the building areas and significant program elements, such as the circulation elements (i.e. stairs, elevators and ramps), provides them with visual information that can support the user to read the building configuration and the physical relation among spaces. This is as valid from the outside as it is from the inside (Fig. 8.3-1). The possibility of having a complete view of all the volumes that make up the building from the outside allows the user to read its parts and hypothesise its distribution. Similarly, the internal distribution of spaces and rooms around a central node allows better visibility to all the main internal spaces and destinations. Similarly, the internal organisation, with spaces and rooms arranged around a central node, offers an improved visibility to all of the main internal spaces and destinations. This central node, often serves as a focal point that connects all of the other spaces within the building and therefore allows for easy orientation, making it easy for occupants to move throughout the building and find their desired destinations.

Physical affordances

Spatial organisation can provide physical reach. Organisation can facilitate users' movement in the space and offer users the best conditions to interact with and within the space, especially for users with mobility and visual impairments. This can be achieved by carefully arranging furniture along the walls, rather than in the middle of the room, which allows for a clear and unobstructed path for users to move freely without having to circumvent any obstacles (Fig. 8.3-2). For example, along the corridors, the placement of seats or other furniture in niches allows users with visual impairments to walk, keeping the wall as a reference and guide, without tripping over any furniture elements.

Social affordances

Spatial organisation can provide social reach. The way in which spaces are arranged in the building can greatly impact the visibility and social connections between building occupants. When internal spaces are arranged in a way that can be easily seen from by building's occupants, it can encourage their social connections and participation in activities. The location of spaces dedicated to main activities, such as a swimming pool or gym, in a way that are visible from the outside, allows users to have an anticipation of the activities offered and feel more motivated to enter and participate. Additionally, within the building, arranging spaces around central nodes where users can view others activities can also stimulate both active and passive participation (Fig. 8.3-3a). Additionally, within each room where collective activities are planned, the arrangement of furniture that does not obstruct visibility to the rest of the room allows users to maintain clear visual access to other people, thus facilitating social connections. In particular, seating arrangements that allow visual contact with the entire room and other seating can, in addition to providing users with a greater awareness of their surroundings, enhance conversations and social relations. However, sports and leisure buildings also contain spaces that require a greater degree of privacy, such as rehabilitation or changing rooms. For spaces dedicated to physical rehabilitation, the degree of exposure can be both motivating and disturbing. In these spaces, the sense and need for privacy is a very individual aspect; the presence of spaces with varying degrees of exposure allows the user to choose one that is appropriate for their needs and preferences (Fig. 8.3-3b). For example, in the case of changing rooms, while some users prefer communal changing rooms for a sense of security and the possibility of mutual help, other users prefer individual cabins where they can change in total privacy. The availability of different levels of privacy in a space can provide users with the flexibility to choose an environment that best suits their individual needs for social interaction or intimacy. Having a variety of options allows users to choose their environment to their specific needs, whether they require a quiet space to rest or a more open and social space to meet with others. Additionally, the presence of private spaces can also provide a sense of security and comfort for users who may need a space to retreat to when feeling overwhelmed or stressed. Ultimately, the presence of more or less private spaces can greatly enhance the overall user experience by allowing users to have control over their environment and feel more at ease.

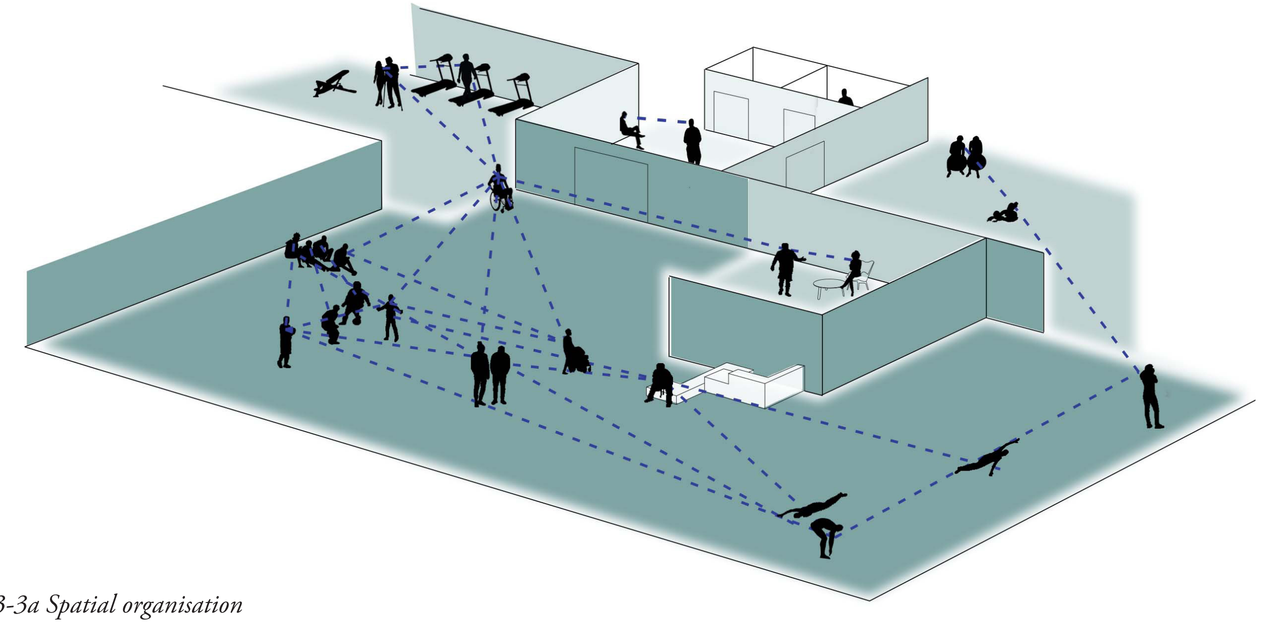


Figure 8.3-3a Spatial organisation provides social reach

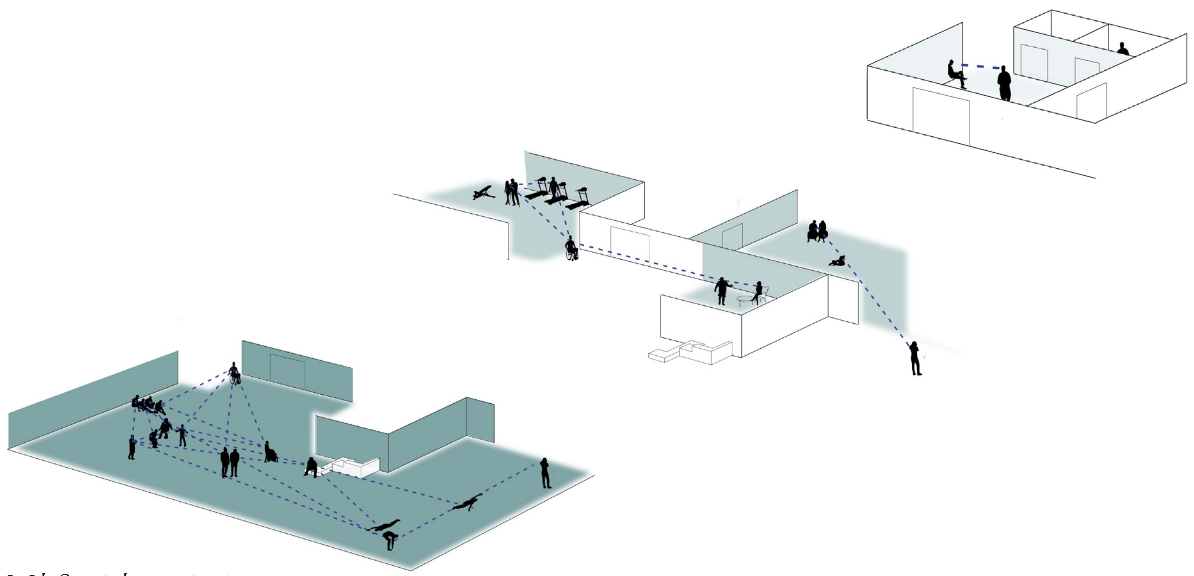


Figure 8.3-3b Spatial organisation provides different levels of social reach

Figure 8.4-1 Lighting sets spaces

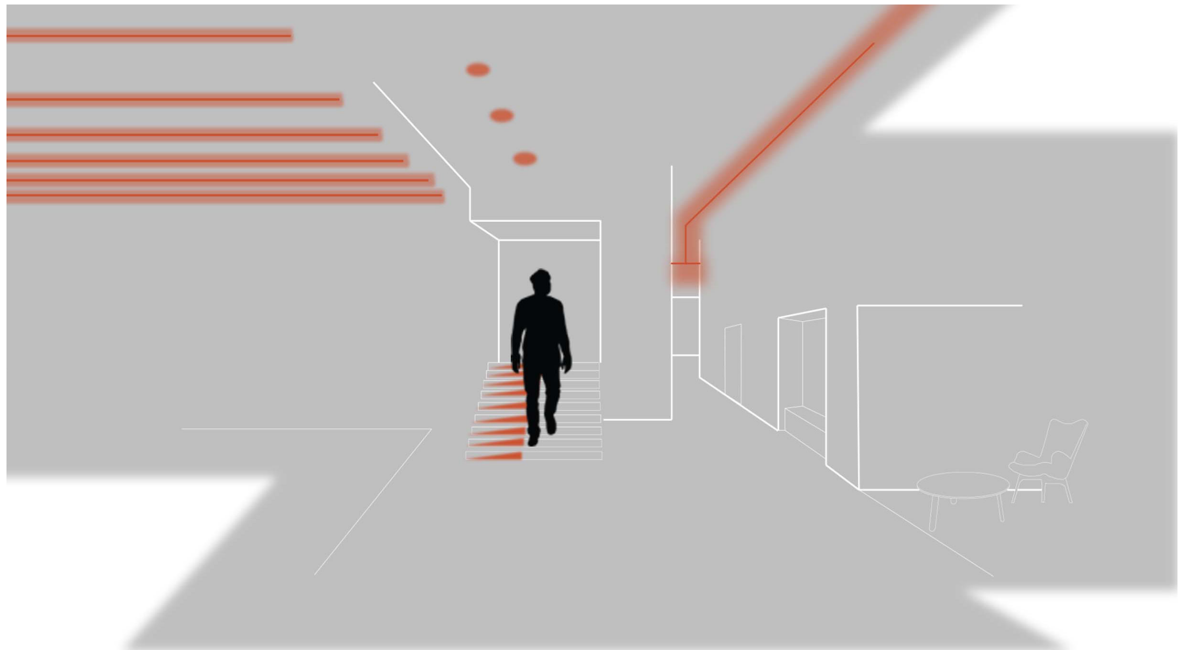


Figure 8.4-2 Lighting sets directions

8.4 Lighting – setting spaces and directions

Artificial light illuminates and shapes physical spaces. Besides offering well-lit environments, the lighting design can create contrasts and shadows which better support users to recognize the different spaces and to identify the elements within them. Moreover, lighting elements can guide users in the space by marking possible directions to follow.

Cognitive affordances

Lighting can set spaces. Lighting plays an important role in shaping and enhancing spaces by communicating their physical and functional characteristics to users. Good lighting design can be used to define the shapes of a room, making it easier for users, especially those with low visual capacity, to understand the dimensions and proportions of the space. Furthermore, the use of lighting elements suited to the different activities housed in the building makes it easier for users to understand the space and the experiences for which the space is intended. For example, diffuse and intense lighting can suggest to the user that they are in spaces intended for collective activities, such as the entrance or the main sports activity room, while more punctual or soft lighting can suggest the presence of more individual or relaxing activities, such as rehabilitation spaces or areas for more private social interactions. Additionally, light positioned and distributed in correspondence with important elements can be perceived by users as a focal element on which to shift their attention. For example, lighting elements located in correspondence with elevators, ramps, stairs, accesses, furniture, or above the activity spaces, can draw the attention of users and help to define these elements in the space (Fig. 8.4-1). This can greatly enhance the user experience by making it easier for them to navigate the space and understand the different functionalities of the different areas.

Cognitive affordances

Lighting can set directions. Lighting can provide cues about the layout of the space and the direction in which users should be heading. This is particularly important for individuals with low visual and hearing abilities, who may have difficulty navigating large buildings such as those dedicated to sports and leisure activities. One way to utilize lighting as a navigational aid is to use sequential or linear lights along paths (Fig. 8.4-2). These lights can serve as a signpost, providing clear visual cues about the spatial distribution of the environment and the direction in which the user should be heading.

8.5 Acoustics – orienting through spaces and contexts

The design of the built environment can provide important acoustic information that complements the visual and tactile information that users typically rely on. Careful consideration of the spatial and physical properties of a space can support user understanding of the space and its context. Acoustics is an indirect design parameter, but it is directly influenced by other design parameters such as the materials used, the size of the spaces, and their organization. For example, the materials used for the surfaces can have a direct impact on the haptic perception of the built environment. This can be perceived through the reverberation of the flooring underfoot or, for blind users, through the differences in sound of a cane encountering and tapping on varying surfaces. Similarly, the dimensions and proportions of a space can directly impact the acoustic spatial properties perceived by providing information about the identity and functionality of the space. And, the organization of different activity areas with special attention to acoustics can allow users to locate them through audible cues, facilitating them in navigating the building and meeting other occupants. Overall, careful design of the spatial and physical properties of the built environment can provide users with a more complete understanding of their surroundings and enhance their overall experience.

Figure 8.5-1 Acoustic orients user in spaces

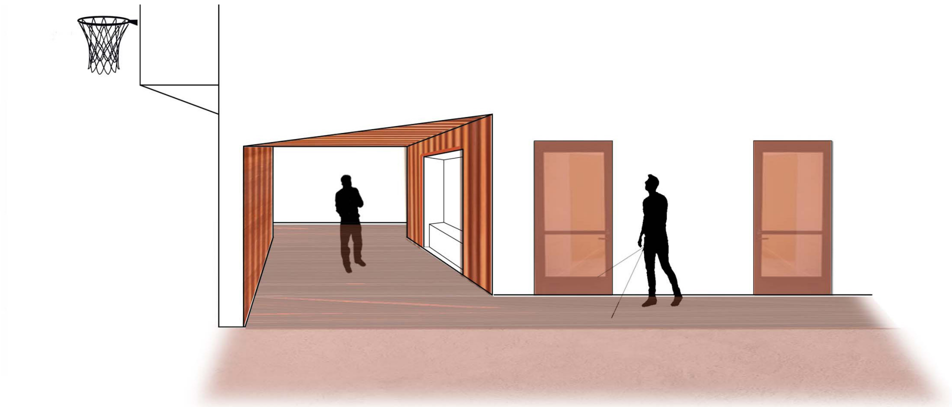
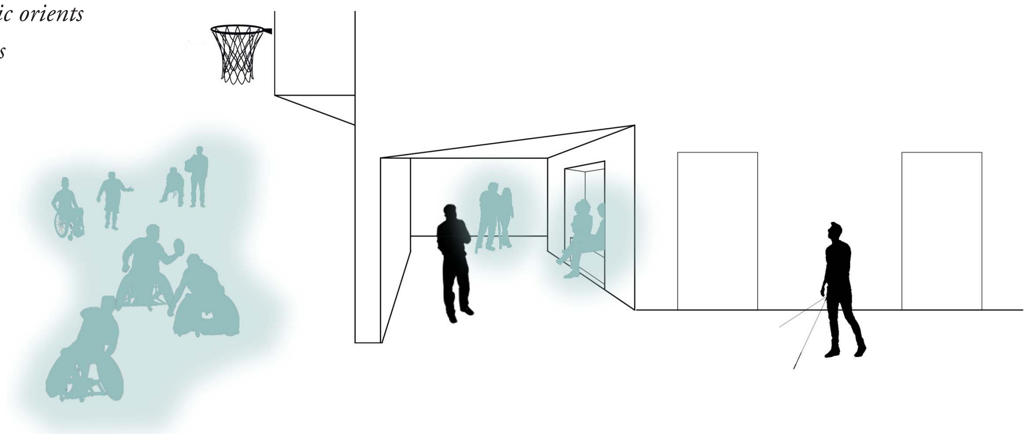


Figure 8.5-2 Acoustic orients user through contexts



Cognitive affordances

Acoustics can orient through spaces. Acoustics give shape and character to space, providing users with information about the place and the contextual phenomena occurring around it. The way sound bounces and echoes within a space can give the user information about the dimensions and materials of the space, helping them to form a mental image of their surroundings. This is particularly important for visually impaired users, who rely on acoustics to provide information about the space they are experiencing. The design of the spatial dimensions and materiality of a space can be used as parameters to support users in their mental spatial reconstruction. For example, contrasts in spatial dimensions and surface materiality can be perceived through a contrast in acoustics, allowing users to associate them with a transition between different functional areas (Fig.8.5-1). By highlighting spatial transitions through contrasting acoustics, users can be informed about the presence of important areas such as the main entrance or reception. This can help users to navigate the space more easily and increase the overall usability of the environment.

Social affordances

Acoustics can orient through contexts. Sounds and noises are often an indicator of human activity within a space. Acoustic cues within the built environment can provide important information to users, particularly those who are blind or visually impaired, about the contextual situations happening in their surroundings. By listening to the sources and types of sounds, the number of voices, and the words of others, visually impaired users can form an understanding of the functionality of the space and the number of people present (Fig. 8.5-2). These cues can be used by visually impaired users to better understand the types of activities taking place in adjacent spaces. For example, blind users may use the presence of noise as a way to direct themselves to spaces where other people are present. This can help them to navigate and orient themselves within the environment, as well as participate in activities. The spatial organization of different areas can play a critical role in providing acoustic cues for visually impaired users. By designing spaces in such a way that the acoustic cues are clear and easy to understand, visually impaired users can more easily access the information they need to relate to others and participate in activities.

8.6 Summary table

Table 8.6-1 Architectural affordances for usability

Enabled performance	Architectural features	Affordances
Cognitive understand the environment	MATERIALITY communicates the identity of spaces, their functionality, the presence of furniture elements and directions	**Contrasting colour and tactile surfaces** can be used to distinguish different spaces and activities. The perception of materials can also be used to provide information about the environment and aid in wayfinding.
		Visual and tactile guiding lines along a path can improve wayfinding and make it easier for users to navigate a building. These guiding lines can direct users towards specific areas and provide information about the environment.
		Transparent partitions can offer visual connection between spaces, providing a view into adjacent areas and enabling spatial cognition
	ORGANISATION provides sensory reach	**Spatial distribution of the building volume**s around a central node can facilitate the user's awareness of the building configuration
		Spatial distribution of the internal spaces around a central node allows better visibility to all main internal spaces and destinations, improving visibility and orientation
	LIGHTING sets spaces and directions	**Focal lighting** in correspondence with important elements and according to the functionality of the space can help users navigate and understand it
		Guiding lighting can serve as signposts and provide clear visual cues about spatial distribution and direction
	ACOUSTIC orients through spaces	**Acoustic cues from spatial proportions and materiality** provide users with information about the space, helping them form a mental image of their surroundings.
Physical act in the environment	DIMENSIONS AND ORGANISATION embrace differences in bodies and interactions	**Palette of spatial alternatives in size and positioning** of furniture and aid elements can offer the user the possibility to choose the setting that better fit with the individual needs
	ORGANISATION provides physical reach	**Spatial distribution of the furniture elements** that do not obstruct the path can help users move around easily and interact with the space safely
Social behave and participate in the environment	MATERIALITY communicates contexts	**Transparent partitions** between different activity areas can increase the sense of cohesion among occupants, which can help stimulate physical activity and motivation
		Transparent partitions can compromise privacy It is ideal to have the ability for occupants to modulate the degree of transparency and control over their level of privacy.
	ORGANISATION provides social reach	**Spatial distribution of the internal spaces and furniture** impact the visibility towards other building occupants thus facilitating or blocking social connections
		Palette of organisational spatial alternatives allows users to choose an environment that best suits their individual needs for social interaction or intimacy
	ACOUSTIC orients through contexts	**Contextual acoustic cues from other occupants** can offer users information about the contextual situations happening in their surroundings

9 CONCLUSION

This dissertation presented a study for developing knowledge on the enabling role of the environment in the spatial experiences of users with mobility, visual, and hearing impairments. The literature review and observation of architectural practice have highlighted the need for architects to better understand the user's embodied experience of space in order to creatively respond through the design of more inclusive spaces. The person-environment relation was therefore used in this research as a framework for analysing and understanding the dynamics that occur between people with physical and sensory impairments, and the perceptual characteristics of the built environment. The materiality, the dimensions, the organisation, the lighting and the acoustics of the built environment were observed and analysed from the perspective of users who live and experience them directly. Throughout this analysis, the enabling mechanisms, which emerged in the encounter of the person with the built environment, have been observed and examined in order to better understand usability as perceived from the individual perspective. From the investigation of individual, contextual spatial experiences of two examined sports and leisure buildings, the analysis of environmental influences on the performances of people with different impairments and abilities offered insight on how to design for improved usability.

In order to carry out such an investigation, this project developed an anlytical model to steer the analysis of impaired users' spatial experiences for the identification of the environmental influences. The structure of the developed analytical model allowed the complexity of the person-environment relation to be systematically addressed and analysed, revealing recurring patterns between personal characteristics, types of activity, and influential environmental characteristics. The exploration of person-environment-activity patterns showed how users, depending on their impairments, referred to different ways of experiencing the environment. People with mobility impairments spoke of the importance of being able to access, move, and physically interact with the elements in the space. Visually impaired users focused on their sensory perceptions and how these can be interpreted as cues to create a mental image of the physical environment around them. Finally, the hearing-impaired users, who, more than the others, spoke about the social aspects, especially about the ability to be aware of, and participate in, the surrounding social contexts.

The investigations of impaired users' different experiences in relation to the built environment showed how spatial materiality, dimension, organisation, lighting, and acoustics can improve users' experiencies by supporting and empowering their cognitive, physical, and social activities in the space. The perceptual cues offered by the environment can, in fact, be provide users with information for their better orientation and understanding of spaces and contexts. The visual, tactile, and acoustic properties of the space and its materiality can support users to better identify and recognize the physical environment. The visibility and the organisation between spaces can support users to visually and socially connect with other contexts and users. Alternatives of dimensional and organisational characteristics can better go along with the differences of bodies abilities and sizes, by offering users the opportunity to choose the solution which better suits their needs, both physical and social.

This collected, embodied understanding is what enables the recognition of the important role of the properties of the built environment on aspects of accessibility, usability, and inclusion. On the one hand, it provides a better understanding of the perceptions, attitudes and behaviours of users with limited abilities in the built environment. On the other, it provides knowledge about the cognitive, physical and social value of built environment characteristics for users' activities in sports and recreational buildings.

The following section presents the contribution of this study in relation to the set objectives. The chapter concludes by reflecting on the limitations of this study and advancing hypotheses for possible future research for the development of the practice of Universal Design.

9.1 Research objectives and related contributions

This research set two main objectives:

Research objectives

1) Develop knowledge on the enabling role of the built environment in improving the performance of users with mobility, visual and hearing impairments;

2) Frame the knowledge of the impaired users' spatial experiences of sports and leisure buildings to provide architects with design stregies for more accessible, usable and inclusive sport and leisure buildings.

The study reported in Chapter 6 supported a deeper understanding of the impaired spatial experience of sports and leisure buildings. This gave important insight into how the design of spatial materiality, dimensions, organisation, lighting, and acoustics improved building usability by enabling users' activities in the space. The enabling mechanisms identified in this study have been classified according to their impact on users' orientation, action, and interaction with others. By organizing these mechanisms into cognitive, physical, and social categories, this study provides a framework for synthesising how the design of the built environment can improve usability.

By achieving these objectives, the contributions of this study are threefold:

Conceptual and methodological contribution

The conceptual and methodological contribution emerges from the investigation of the person-environment relationship from the perspective of Universal Design, focusing on the performative character of this relation. For doing so, the study developed an analytical model that combines the concepts of usability and affordances to investigate and analyse spatial experiences. The model relates the dimension of the person to that of the environment, includes the domain of activity, and addresses the compatibility, namely the usability, of space with differences in abilities and activities. To operationalise and articulate the investigation of the variables influencing the performative character of the person-environment relation, the study employed the theory of affordances.

This study provided a conceptual contribution by deepening the understanding of the concepts of usability and affordances. This allowed for a deeper understanding of these concepts and for their use in the investigation and evaluation of the experiences of users in real-world settings. By developing the new analytical model and anchoring the investigation on the enabling mechanisms, the research was also able to provide an alternative perspective to the investigation on person-environment relation which focuses on the enabling mechanisms of this relation.

Knowledge contribution

The knowledge contribution emerges from the collected information about user's experience, which provides research-based knowledge for inspiration, reflection, and decision making for architects. This information came from the conducted interviews and observations that focused on how users interacted with and experienced the built environment. This knowledge subsequently informed the synthesis of users' experience of the built environment in design strategies that can inform architects' decision about the design of materiality, dimensions, organisation, lighting and acoustic.

Practical contribution

The practical contribution emerges from the provision of performance-oriented design strategies which can inform the practice on the enabling role of architecture design. These strategies synthesise the knowledge developed on the investigation of the enabling mechanisms offered by architects' design and those perceived and experienced by users. The identified potentials of design to enable users' performances have been then framed around cognitive, physical, and social categories of usability, allowing for the synthesis and organization of knowledge according to the same categories. These strategies allow architects to better understand how the designed characteristics of materiality, dimension, organisation, lighting, and acoustics of spaces enable and support the experiences of users with impairments. Such strategies, by building on the performative aspects of the person-environment relationship, also have the potential to better consider human differencies in perceiving and interacting with the built environment for more accessible, usable and inclusive design.

9.2 Limitations of this study

The limitations of this PhD lie mainly in the complex nature of the object of study and the methodological choices for its investigation.

Spatial experiences occur in unique and non-repeatable contextual situations characterised by a combination of specific physical, mental, environmental and social factors. These factors influence the dynamics between the person and the environment, which may vary further due to the users' physical or sensory impairments. Despite these challenges, the complexity of the subject matter is also what makes it valuable to study, as it offers the opportunity to gain a deeper understanding of person-environment dynamics. This study recognises the complex nature of the disability condition and the multiple factors that influence it. For this reason, a further limitation lies in the impossibility of simplifying spatial experiences and disability conditions through a set of parameters and the analysis of their mutual relationship. The methods and parameters of investigation and analysis employed in this study are proposed with the intention of offering keys to understanding spatial experiences and thus contributions to knowledge of person-environment dynamics.

The investigation was conducted through case study research. The choice of this method was motivated by the need to investigate spatial experiences in their contextuality, while also engaging the personal perspective of impaired users. Although the case study appears to be the appropriate method for such investigation, this choice imposes limitations on its repeatability. The unique character of the spatial experience would not allow the study to be repeated with the same data and results. However, the generalisation of these might lead to the same findings.

Another limitation of case study research is the involvement of the user. While this approach is essential for understanding the lived experience of the individual, it can present challenges in data collection and interpretation. For the interviewed users, reflecting on the dynamics happening between them and the built environment can be difficult, and some complex phenomena of experience may be hard to process and describe in words. This can result in limitations for both the users in providing information and the researcher in collecting data and reporting results. Furthermore, the embodied nature of spatial experiences means that the researcher must base the study on the description of another person's experience, which is therefore not direct but mediated by communication between interviewee and researcher. This can introduce bias and limit the researcher's understanding of the phenomenon.

Another limitation of this study lies in the characteristics and number of users involved in the investigation. Despite recognizing that impairments are complex and cannot be easily categorized, the study chose to focus on three specific types of impairments: mobility impairments, visual impairments, and hearing impairments. This decision was made in order to have a more in-depth understanding of the specific challenges and needs of these groups. While the case study involved a sufficient number of users to cover the three types of impairments considered, the limited number of users made it possible to explore a corresponding limited variability of mobility, visual and hearing impairments. This means that the findings of this study may not be generalizable to other types of impairments or users.

A final limitation of this study is the small number of users involved. A greater number of users would have allowed for more robust and generalizable findings, and could have revealed more about the enabling mechanisms and influences of the built environment. However, it is important to note that the single user in a case study represents one of the infinite, unique keys to exploring the enabling potentials of the built environment. Thus, even a limited number of involved users can make an important contribution to the revelation of significant person-environment dynamics.

9.3 Future research

The study presented in this thesis is placed within the research on Universal Design and the practice of architecture for inclusion. The study contributed to provide further insights into the dynamics between people and the built environment by developing research-based knowledge for architects to implement in their practice. However, this contribution is specific to the focus of this study and therefore related to the dynamics between users with mobility, visual and hearing impairments and the built environments of sports and leisure buildings.

The trend towards the development of performative requirements that can complement existing prescriptive regulatory requirements implies the need to further study the ways in which buildings and spaces are actually used and experienced by users, particularly users with impairments. To achieve this, future research should thus aim to develop a deeper understanding of how the built environment can support and enable the inclusion of users with impairments by focusing the research on other types of buildings and impairments, hence other types of spatial experiences.

To further enhance our understanding of the role of the built environment in enabling user performances, future research should narrow its focus to unfold the potential contributions of a single design characteristic. For example, an in-depth examination of the design of materials, including factors such as color, texture, temperature, and softness, could reveal new insights into how the materiality of space can enhance user experiences in different contexts and for users with different abilities.

For future research, this study highlights the importance of human-centred investigations that take into account the uniqueness and variety of individuals. Indeed, this approach can lead to informing the design of built environments that cater to a wider range of individuals, thus being more inclusive.

Overall, this study encourages future research to embrace human differences as a driver to discover new potentials of design to support and empower individuals.

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LIST OF ABBREVIATIONS

BR: Building regulation

CRPD: Convention on the Rights of Persons with Disabilities

DCP: Disability Creation Process

ICF: International Classification of Functioning

ICIDH:The International Classification of Impairments Disabilities and Handicaps

PEO: Person-Environment-Occupation

UD: Universal Design

WHO: World Health Organization

APPENDIX I

APPENDIX (accompanying material)

APPENDIX A

BR18 and SBi's provisions for improved cognitive usability of the built environment

CHAPTER 2 - ACCESS

BR18	SBi
ACCESS AREA	
Lighting	
Access areas and access roads must be lit. Stairs and ramps must be furnished with stronger lighting.	For the users, lighting fixtures set up at a relatively small distance can act as directional orientation towards the entrance, especially for people with impaired vision. Shielded light sources can help to ensure that the light does not dazzle. To increase safety, stairs and ramps must be illuminated more brightly. Suggested values can be found in DS/ISO 21542.
Perceptible separation of traffic modes	
Pedestrian access paths to the building must be established with a clear tactile partition to other traffic categories.	Walking areas for the building, i.e. entrances and outdoor areas must be separated in a clearly perceptible (tactile) way from other forms of traffic, i.e. cycle path, road and parking lot. The aim is to reduce the risk of visually and hearing impaired people being hit and to make it easier to find your way around. Shared space solutions are in principle not permitted on building registers unless there is a separate corridor that is tactilely separated from it. Curbs, walls, guardrails, grass beds and water channels are examples of tactile separations. In open spaces, a so-called guide line can be advantageously constructed, which can support people with vision loss in finding their way around the space. Architectural elements such as walls and parapets as well as special tiles and elements can act as guide lines. Guide lines should be designed so that they can be followed with a blind stick and can be clearly seen by the visually impaired. They can be used on forecourts, traffic terminals, squares and squares and, for example, indicate the direction to entrances, taxi ranks and bus stops. Guide lines should lie in a level surface. If the guide line is placed in surfaces with many joints or unevenness, it will not be able to be marked clearly enough. For the design of guide lines in pavements, refer to DS/ISO 23599, Aids for blind and partially sighted people - Tactile indicators on pedestrian areas (Danish Standard, 2012h) and DSB's standard.

Marking of stairs and front edge	
Over stairs, the paving must change in both colour and tactility 0.90 metres before the beginning of the stairs. The outermost part of steps and the edges of steps must be marked with a contrasting colour	Above a staircase, there must be a change of pavement which differs significantly both visibly and tangibly from the other pavement. Just as for guide lines, special knob tiles and elements have been developed which can be used for the purpose. Front edges of steps are marked both on the outermost of the step surfaces and the vertical part of the step, so that the edges appear clearly for people with poor vision. Reference is made to DS/ISO 21542, chapter 13.5, with regard to achieving sufficient visual contrast. It is recommended to use front edges which are non-slip.
ACCESS CONDITIONS	
Change of pavement in front of entrances	
Areas outside outer doors must have tactile markings or markings in another colour than the surrounding surface.	A change in the coating in front of the entrance doors gives the visually impaired and the blind the opportunity to find the entrance on their own. The coating should be both easy to see for the visually impaired and easy to feel for the blind, who use a white cane. A change in the coating can, for example, be established with: - A submerged scraper at the level of the surrounding pavement. The hole size of the narrow link should be no more than 10 mm, so that a marking stick does not pass through the grating. - A change to the pavement itself in the form of a so-called attention field, e.g. specially manufactured tiles with 5 mm high studs or possibly cobblestones. The surrounding flat pavement should have as few joints and unevenness as possible, e.g. as described in the instruction text for § 49, subsection 2, regarding coatings. The attention field should have a difference in light reflection value of at least 30, corresponding to approx. 0.4 in brightness. The design of attention fields and guide lines can, for example, be done as shown in DS/ISO 23599 (Danish Standard, 2012h).
COMMON ACCESS	
Marking with colors and lighting	
They must be marked using deviating materials, colours or lighting.	Common access roads must be marked by differences in materials, colors or lighting. The aim is to make the access roads easy to navigate for people with visual impairments and orientation difficulties. Colors can, for example,

	make door frames, doors and skirting boards etc. more visible if they contrast with the color of the walls . Places with danger are marked extra clearly, e.g. front edges of steps and edges of sitting steps. The width of the markings should be 40-50 mm wide, cf. DS/ISO 21542 (Danish Standard, 2012e). Lighting that emphasizes the direction of a walkway is a help for the visually impaired, e.g. lamps with a short distance between them. Marking of general access roads, lifts, stairs, changes of direction etc. can be done by illuminating these more strongly. The light sources should be glare-free, for example by shielding the light source, and abrupt transitions from strong light to darkness should be avoided. For matters relating to the marking of glass sections and doors in common access roads, refer to § 238-§ 241 in chapter 9, Building layout . Indoor guide lines Courses of direction in halls and other open spaces can advantageously be indicated with guide lines, which provide both tactile (feelable) and visible contrast to the surrounding floor. The visible contrast in relation to the floor is recommended to be at least 30 measured in light reflectance value, see table 5 . Sufficient tactile contrast can be achieved by using elongated elements which are raised up to 5 mm above the surrounding floor covering. Special guide line tiles and elements have been developed which meet these requirements, but for example a carpet runner on a wooden floor, tiles or other floor covering can also be used. Dimensions of guide lines and attention fields can, for example, be found at [www.sbi.dk/tjeklister]. Sighted people usually have difficulty assessing whether the tactile difference is sufficient. When using untested guidelines, it is recommended to contact the Danish Society for the Blind [www.dkblind.dk] or the Norwegian Building Research Institute [www.sbi.dk]. It is not always necessary to mark a walking direction in the floor covering, if walls without protrusions and obstacles can form a natural guide line, e.g. in walking areas. Guide lines are recommended in publicly accessible buildings, e.g. cultural centres, hospitals, town halls, shopping centres, railway stations and bus terminals. Here they can connect central functions, e.g. entrance and reception, information, ticket sales, toilets and access routes via stairs, lifts and doors.

STAIRS	
Marking	
They must be marked using deviating materials, colours or lighting.	Please be aware that stairs which are part of shared access routes must also be marked with light, colors or materials. For recommended lighting values and contrast markings see DS/ISO 21542, chapters 13.1 and 13.5. Marking of glass doors and glass walls is recommended designed according to DS/ISO 21542 (Danish Standard, 2012e), where, for example, bands with contrast to the background or with self-contrast are placed at several heights. See DS/ISO 21542, chapter 18.1.5, and examples at sbi.dk/tilgaengelighed.
BUILDING INFORMATION	
In building open to the public which offers citizen services, important information about the layout and use of the building must be easy to read and understand. Subsection 1 includes information at the entrance to the building and directions to important functions in the building such as lavatories, disabled lavatories, lifts, stairs, distribution routes, etc. With due consideration of the use of the building, this information must be provided in Braille, sound and pictograms, writing and graphics in relief and guiding lines.	For many, the architecture of a building can be the primary oriented element. In addition, DS/ISO 21542 in chapters 39 and 40 provides guidance on how easy-to-read information in the form of signage can be designed. This can be done by means of, for example: - Orientation signs at entrances, reference signs for toilets, disabled toilets, lifts, stairs and important common access routes, signs at doors to selected rooms such as toilets and disabled toilets are relevant. - Signs and information at an appropriate height for sitting and standing. - Good contrast between sign and background, good contrast between fonts and signs and good lighting on signs and information. - Relatively large fonts with a size adapted to the reading distance. - Use of recognizable symbols. - Tangible writing on important signs, tactile floor information on handrails. - Possible guide lines to important points in larger halls or access roads. Digital information about orientation and use of buildings with a public function may be covered by provisions on accessibility to websites, apps and documents, cf. Act on accessibility of public bodies' websites and mobile applications (Executive order no. 692, 2018).

APPENDIX B

BR18 and SBi's provisions for improved physical usability of the built environment

CHAPTER 2 - ACCESS

BR18	SBi
ACCESS AREA	
Access roads and coatings	
The access path from road and parking areas must be minimum 1.3 metres wide and have an even and hard surface.	Access roads on properties' undeveloped areas are recommended to be carried out in accordance with the road rules in Traffic areas for all - Handbook in Accessibility (Vejdirektoratet, 2013). A clearance of at least 2.6 meters should be ensured on access and exit roads as well as in the disabled parking spaces themselves, as many vans are made with a raised roof. Please note that according to the building regulations, access areas must always be without steps. Steps and stairs can supplement, but not replace, ramps and equalizations. Flat, fixed and non-slip surfaces on the access area help to reduce the risk of falling accidents, and the properties are also important for people with walking difficulties, visual impairments or wheelchairs. A covering laid according to, for example, DS/EN 1136, *Paving and paving* works, and the section on tiled coverings (Danish Standard, 2013h) can be used. Here, measures are specified for, among other things, evenness and maximum joint width. To ensure that coatings have a sufficient anti-slip effect in both wet and greasy conditions, values R10 to 12 can be recommended measured according to DIN 51130 (Deutsches Institut für Normung, 2014) and DIN 51097 (Deutsches Institut für Normung, 1992). A free aisle width of at least 1.5 meters is generally recommended, so that you can turn around with most wheelchairs (quality level B). For buildings with many users, a minimum of 1.8 meters is recommended (quality level A).
Equalization of level differences	
Differences in levels in the access area must be levelled at ground level or by means of a ramp with a maximum rise of 0.15 metres and an area	If differences in level are compensated with ramps that slope more than 1:25 (40 mm per

of minimum 0.3 metres. A horizontal area of minimum 1.3 x 1.3 metres must be established at both ends of the ramp. The gradient of ramps may not exceed 1:20 (5 centimetres per metre). Ramps with a gradient exceeding 1:25 (4 centimetres per metre) should have landings for every 12 metres.	meter), these must be made with horizontal rest stops of at least 1.3 × 1.3 meters and handrails. However, it is recommended to make the landings larger if self-propelled pallet lifters must be able to turn 180 degrees, e.g. for ramps with several parallel runs. Ramps and leveling in the ground that come in connection with the plinth should be finished in a way so that facade and surface water is directed away from the building and is not led down to, for example, volume drains. *Small level jumps* According to the road rules (Vejdirektoratet, 2013), ramps at curbs can be made with a slope of 1:10, which is the maximum for which many wheelchairs are approved. An existing, single step will often be acceptable offset with a ramp of 1:12 (83 mm per meter) made in accordance with DS/ISO 21542 (Danish Standard, 2012e), but this requires a relaxation from the municipality on the grounds that the slope 1:20 (50 mm per meter) otherwise would mean radical changes. *The slope of the stairs* Stairs in access and approach areas can have a rise (step height) of no more than 150 mm and a ground (tread depth measured horizontally from front edge to front edge) of at least 300 mm. A rule of thumb is that a comfortable outdoor staircase is achieved in the following context: 1 ground + 2 rise = 650 - 700 mm It is recommended that stairs are made with a low slope if there are many users, e.g. in public buildings, institutions and businesses. Here, for example, the increase can be approx. 160 mm and the ground approx. 355 mm. Stairs should have the same ground and rise over the entire course. Varying sizes can mean a greater risk of users falling. Stairs should also have few runs, as each transition from landing to step or vice versa increases the likelihood of a user tripping. Treads should be horizontal, but closed stairs and stairs in the ground should have a slight outward slope of no more than 1:40 (25 mm per meter) for reasons of drainage. It can reduce the risk of ice formation in winter.

	The terms tread, rise and ground refer to ISO 3880-1 on Terminology for Stairs (ISO, 1977).
Handrails	
Grip-friendly hand rails must be installed at a height of approx. 0.8 metres on both sides of ramps and stairs.	An example of cross-section of handrail is given. The drawing reports a distance between the handrail and the wall of 50 mm and a diameter of the handrail between 40 and 50 mm.
ACCESS CONDITIONS	
Level free access	
At all outer doors, access to the building must be on the same level. Any differences in levels must be adjusted in the access area outside the building. This includes access to lifts at the access floor of the building. Any differences in levels must be adjusted in the access area outside the building. Ramps may be used. A horizontal, hard and even area of 1.5 x 1.5 metres outside outer doors measured from the hinged side of the door. When the door opens outwards, further 20 centimetres must be added along the front of the building. Door steps may not be higher than 2.5 centimetres. Areas outside outer doors must be level with the indoor floor.	A local elevation or ramp is the recommended way to achieve level-free access, in both cases combined with a horizontal area in front of the entrance doors. The area must be large enough that people in wheelchairs have room to open the door, and this is usually achieved by an area of 1.5 × 1.5 meters in front of inward-facing doors. The area is measured from the side where the hinges are. An outward-facing door requires a larger area so that the person can pull the door past them when it is opened. Here, the width must be 1.7 meters along the building's facade. Double doors and very wide doors require an expansion of the area along the facade, corresponding to the extra door width. *Protection against frost heave* If it is a question of outward-facing doors, e.g. escape route doors, garden, terrace or front doors, frost heave, ice, snow or small objects can block the door from being opened. Therefore, a suitable distance between the door leaf and the area outside the door should be ensured. For example, use a short, slanted grating from the raised area to the door step, so that the users of the building still only have to overcome a maximum of 2.5 cm. The area outside will be slightly below the floor level inside and is therefore in principle contrary to BR18, but is recommended for reasons of practical functionality. See example at sbi.dk/tilgaengelighed. *Local terrain elevations* If it is to be ensured against more extreme amounts of precipitation, buildings should not be sunk into the terrain. There should be min. 150 mm free plinth height, and gutters between the plinth and locally raised areas

should have drainage beyond the surrounding terrain. It provides the best built-in security against water ingress at the plinth, e.g. when congestion occurs in the sewer network. Solutions based solely on seepage to drains do not always have sufficient capacity and are often not in accordance with norms for drainage installations and drainage of buildings (Danish Standard, 2009 &1993).

Buildings with ground decks and existing buildings that have level-free access added, it is particularly important to secure against the ingress of water at the plinth. Gutters can be covered at entrances with a grate in a width of 1.5 or 1.7 metres, which can also function as a tactile (feelable) covering and for adjusting the door step height. If, for special reasons, the terrain is chosen to be raised along the entire plinth, the gutter should be connected directly to the drainage system. Remember to ensure access to maintain joints under door steps and low-lying windows in order to maintain the tightness of the climate screen.

An appropriate construction is shown, for example, in **SBi instruction 224, *Moisture in buildings, 7.4.1 Level-free access*** (Brandt, 2013). Other solutions can be found, for example, in **SBi instruction 267, *Small houses – the climate screen*** (Møller, Brandt & Pedersen, 2016).

Doorstep

Door steps should allow users to force their way through the entrance. At the same time, access should be ensured for regular replacement of the joints under the bottom piece.

Availability	Door step height
Quality level C	Max. 2.5 cm
Quality level B	1.5 cm, used e.g. at entrance doors in accessible residential buildings, which must be suitable for people with wal-king difficulties, in wheelchairs or with walkers
Quality level A	0 cm, used for example indoors in ac-cessible homes and at all doors in care-oriented construction

Free passage width

Outer doors must have a free width for passage of minimum 0.77 metres. On the side of the door that opens towards the person, there should be minimum 0.50 metres of free space next to the door opposite the hinged side.

The free passage width is measured with the door opened 90 degrees and is the smallest distance between the door and the opposite frame. A clear width of 0.77 meters allows the passage of most people in wheelchairs, but a clear width of 0.87 meters is recommended, as, for example, people in manual wheelchairs may need extra space to operate drive rings.

The door's construction and thickness often mean that 9M and 10M doors provide a smaller passage width than 0.77 and 0.87 metres, especially for external doors, sound-absorbing doors and fire doors. This is why you must be aware of this when designing, and possibly go up a module measure. In the case of sliding doors, in the same way, a wall hole of 10M must be calculated in order to achieve 0.77 meters of free passage width.

Doors which must be able to be passed by ordinary care beds should have a clear passage width of at least 1.07 metres. In some buildings, clear passage widths of up to 1.5 meters should be considered, e.g. in health and care-oriented buildings for severely overweight people. To prevent very wide doors from becoming too heavy to handle, they can be divided into asymmetrical, two-leaf doors, where opening one door leaf meets the requirement of 0.77 or 0.87 meters of free passage width.

Availability	Free passage width
Quality level C	Mine. 0.77 meters
Quality level B	Mine. 0.87 meters. Allows i.a. that drive rings on manual wheelchairs can be used in the doorway.
Quality level A	Mine. 1.07 meters. Used where ordi-nary nursing beds and wider aids must be able to pass. Very wide door may be shared. up to an asymmetri-cal, double-winged door, where one door leaf meets the requirements of 0.77 or 0.87 meters clear passage width Min 1.5 meters. Used in health and care-oriented construction for severe-ly obese (bariatric) people.

Place next to door

In order for a wheelchair user to be able to open a door towards him and pull it past the wheelchair, there must be at least 0.5 meters next to the door opposite its hinge side.

COMMON ACCESS

Width

Its width must be sufficient for its use, and unhindered passage in its full width must be possible. The free width must be minimum 1.30 metres.
Any differences in level or height must be eliminated with ramps. Ramps may not be installed with a gradient over 1:20 (5 centimetres

Common access roads with a width greater than 1.3 meters increase user-friendliness, and they can be made wider where many people are expected to pass. Most shared access roads also constitute escape routes that must meet special requirements, including

per metre) , and there must be a horizontal area of minimum 1.30 metres x 1.30 metres before and after the ramp. Ramps levelling differences in height of over 0.60 metres must also have a horizontal landing for each 0.60 metres rise. Ramps must be equipped with hand rails. For ramps with a gradient of 1:25 (4 centimetres per metre) or less, hand rails can be omitted. Door in shared access routes must have a free width for passage of minimum 0.77 metres. On the side of the door that opens towards the person, there should be minimum 0.50 metres of free space next to the door opposite the hinged side. Door steps may not be higher than 2.50 centimetres	width. Requirements for escape routes are mentioned in § 94-96 in chapter 5, *Fire* . Common access roads in front of lifts should be at least 1.5 meters wide. If there are descending stairs in front of the lift door, the distance to the stairs should be at least 2.0 metres. However, these dimensions must be larger if it is to be possible to maneuver with beds, personal lifts, trucks or the like, i.a. in commercial buildings or where there are special requirements according to the working environment legislation.

Availability	Width of common access roads
Quality level C	Mine. 1.3 meters
Quality level B	Mine. 1.5 meters, allows a pedestrian and a wheelchair user to pass each other. Allows about 80% of all wheel-chair users to turn on the access road
Quality level A	Mine. 1.8 meters. Accommodates more frequent pedestrian traffic in both directions Furthermore, two whe-elchair users can easily pass each other

STAIRS

Stairs in shared access ways must be designed with sufficient width and free ceiling height in relation to the intended use, and have a slope that makes them easy and safe to walk on. The provision is considered fulfilled when: 1) The clear width of the stairs is at least 1.0 m, and the clear height measured in the stair tread line is at least 2.10 m. 2) The rise of the stairs (vertical height of the step) must not be greater than 0.18 m. 3) The base (horizontal depth of the step) on straight, quarter and half-turn stairs is not less than 0.28 m. In residential buildings, however, at least 0.25 m. 4) On spindle and spiral staircases, the ground must not be less than 0.20 m	A free width of min. 1.5 meters can provide space for evacuating persons and firefighters to move in different directions at the same time on a staircase. An increased width can also make room for using the stairs with an ambulance stretcher. See chapter 13 in DS/ISO 21542 (Danish Standard, 2012e). It is important that the ground is measured horizontally from step front edge to step front edge and not under them. A plot on mine. 0.3 meters is recommended so that more of the foot can rest on the tread when people move down stairs. This can reduce the number of falls. For construction with many users, a lower rise can also be recommended. As a guide to a walk-friendly staircase, refer to the stair formula for indoor stairs. Varying grounds and inclines usually reduce safety when walking on stairs. See DS/ISO 21542, chapter 13.1. The choice of staircase type can have an impact on how safe it is perceived by users. Spiral staircases, for example, are not recommended, as they have highly variable ground and can be difficult to use, e.g. when two people have to pass each other. Straight stairs are considered safer, as they can be done with the same ground and rise throughout the course. If it is desired to use curved stairs, it is recommended to make these with a very large diameter, so that the

	differences in the base of the steps are reduced. Please be aware that stairs which are part of shared access routes must also be marked with light, colors or materials. For recommended lighting values and contrast markings see DS/ISO 21542, chapters 13.1 and 13.5. In larger rooms, it is recommended that an area with a coating change in color and feel is carried out above the stairs, starting 0.9 meters before the start of the stairs and extending the entire width of the stairs in the same way as for outdoor stairs, see § 49. If people can pass under free-standing stairs, it is recommended to shield the underside of these so that a suitable clearance is ensured. See DS/ISO 21542, chapter 13.6. See more staircase details at sbi.dk/tilgaengelighed.

PROTECTIONS

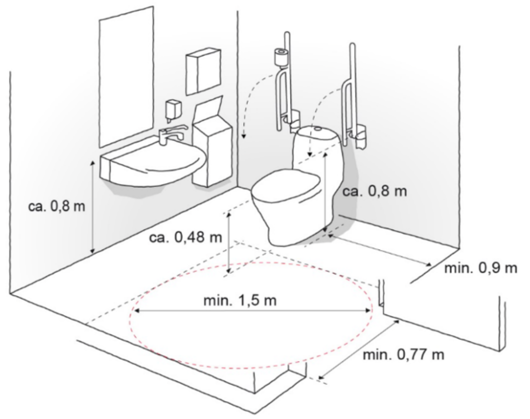
Corridors, staircases and ramps in shared access routes and balconies, French windows, balcony corridors, air locks, roof terraces, outside staircases and other elevated residential areas must be protected with fencing and equipped with hand rails with due consideration of the use of the building. With due consideration of the use of the building, all types of fencing or railings must be designed in to ensure that their height and design, openings in the fencing, etc. protect persons from falling over or through them. This provision is considered to be fulfilled when: 1) The height of fencing or railings is minimum 1.0 metre. 2) The height of fencing at staircases and ramps is minimum 0.80 metres and 0.90 metres over landings. 3) The height of fencing at staircases with a clearance over 0.30 metres, balcony corridors and air locks is minimum 1.20 metres. 4) The height of fencing must be measured over the front edge of the steps and from the top edge of the floor/deck. 5) Hand rails must be easy to grasp and hold on to. Fencing must be designed with a distance between all types of baluster, vertical as well as horizontal, which does not cause personal injuries. In that connection, particular focus should be on	Height of protection As the center of gravity of the 95% fractile of tall male persons is around 1.2 metres, protective heights in general of the same order of magnitude can be recommended, also for balconies. Please note that stairs with more than 0.3 meters of free clearance to one side must have protection at a height of at least 1.2 meters, whereas handrails must be placed at a height of approx. 0.8 meters above the step front edges. Shielding of free-standing stairs For safety reasons, the underside of free-standing stairs should be shielded with some form of protection so that inattentive people and the visually impaired do not bump their heads against the stairs. See DS/ISO 21542 (Danish Standard, 2012e) To protect children from getting trapped, openings in guards and railings should be sized so that a small child's body cannot be squeezed through. This can be tested as in DS/EN 1176 (Danish Standard, 2008-2014), where a mandrel of 89 × 157 mm is tried to be pressed through the openings. At a pressure of up to 222 N, the mandrel must not pass completely through. For example, vertical balusters should be spaced less than

ensuring that children cannot climb onto the guard or get pinched between balusters. Fencing made from glass must be constructed in accordance with ss. 238-241	89mm apart and be stiff enough to pass the above test. Openings between steps should be secured in the same way. See examples at sbi.dk/tilgaengelighed. The design of the guards must also make it difficult for children to climb onto them, and this may require the use of vertical elements, fully or partially closed guards
HANDRAILS	
Corridors, stairs and ramps in shared access routes must be equipped with grip-friendly hand rails which are easy to grip and hold on to in the sides not equipped with fencing. Hand rails must be installed without interruption over landings and must be terminated horizontally. (2) Hand rails must be installed at a height of approx. 0.80 metres.	If there is protection on both sides of a staircase, there are also handrails, unless it is assessed that they can be dispensed with on one side. This may be the case in commercial buildings or residential buildings. This appears from the section 'Questions and answers about access conditions', as part of the instructions for chapter 2, *Access conditions,* at www.bygnsreglementet.dk. Handrails on both sides provide something to hold on to for people who have to pass each other on stairs, also in situations where, for example, responders move against the flow of evacuees. For partially paralyzed people, handrails on both sides can mean that the person does not have to walk backwards down a flight of stairs. Handrails carried unbroken across landings can make evacuation safer for anyone who has to find their way in dark or smoky rooms, especially stairs. In daily use, unbroken handrails and horizontal ends also show the way for the blind and partially sighted, just as handrails extended beyond the first and last step can help those with walking difficulties to overcome the steps. Handrails with a circular or rounded cross-section, which both children's and adults' hands can fully grasp, offer better opportunities to hold on and prevent a fall. See DS/ISO 21542, chapter 14, and examples at sbi.dk/tilgaengelighed. Please be aware that there are now requirements for the height at which handrails are placed, and that they cannot therefore be placed on top of high guards. In these cases, around 0.1 meter more space must be set aside in the width of each flight of stairs. If you follow DS/ISO 21542 with regard to the end of handrails horizontally and unbroken guidance across landings, extra

	space must also be set aside for this on the landings
BUILDING INFORMATION	
-	Signs and information should be placed at an appropriate height for sitting and standing

CHAPTER 9 – BUILDING LAYOUT

BR18	SBi
LAYOUT OF BUILDING WITH ACCESS FOR THE PUBLIC	
Toilets	
In storeys where public toilet facilities are established, minimum one room must be established which fulfils the following requirements: 1) Level access to the toilet room. 2) Free passage through the door to the toilet rooms must be minimum 0.77 metres. 3) Washbasin and toilet must be located across a corner on adjacent walls to enable hand wash by a person sitting on the toilet. 4) Free distance of minimum 0.90 metres on the side of the toilet facing away from the washbasin. The wall next to the toilet which faces away from the washbasin must be free of permanent fixtures. 5) A free area with a diameter of 1.5 metres in front of the toilet and free of the door opening range must be available for manoeuvring. 6) The toilet seat must be placed at a height of approx. 0.48 metres. 7)Foldable armrests must be established at a height of 0.80 metres on both sides of the toilet. 8) The washbasin must be established at a height of approx. 0.80 m, and the drain behind the washbasin must be installed further back. 215. Minimum one toilet room equipped according to s. 214 must be established on the ground floor or on other storeys accessible via lift, stairlift, etc. 216. In connection with conversions, toilet rooms subject to s. 214 must be designed for use by all users of the building. Minimum one toilet room equipped according to s. 214 must be established on the ground floor or on other storeys accessible via lift, stairlift, etc.	*Space* A free turning area of 1.5 × 1.5 meters in front of the toilet and fixtures makes it possible to place the wheelchair here when transferring to and from the toilet. With a 0.9 meter wide open area on one side of the toilet, transfer can also take place from here. If the area under the sink and in front of the toilet can be used, people in slightly larger wheelchairs will also be able to turn around in the toilet. The door to the toilet room must not swing over the free turning area. *Doors* If it is desired that people in wider wheelchairs should be able to enter the toilet, the free door opening is recommended to be increased to at least 0.87 metres. Outward-facing doors provide more space in the toilet room and are easier to open from the outside in the event of a fall accident in the toilet room. It is recommended that outward-facing doors be fitted with a horizontal pull-back handle on the inside so that the door can be easily closed by wheelchair users. *Inventory* A washbasin with a height of 0.8 meters, a depth of approx. 0.6 meters and retracted drain, allows wheelchair users to get under it with footrests and legs. Seat height of 0.48 meters on the toilet corresponds to the seat height of most wheelchairs. In addition to the eight points in § 214, subsection 2, the following arrangement will make the toilet more suitable for people with disabilities: - Soap dispensers, towel holders and hooks should be installed with an operating height of 0.9-1.2 metres. - The toilet paper holder is placed so that it can be easily reached from a

	sitting position on the toilet, e.g. at the front of the armrests. - Door and lock handles, mixer taps, flush buttons, etc., which can be operated with a closed hand and little force, make it possible for people with reduced arm and hand function to use the toilet without help. - Mirrors should be usable by both seated and standing persons, e.g. placed between 0.9 and 1.9 meters above the floor. - The front edge of the toilet is placed approx. 0.8 meters from the back wall. For example, interior design examples can be found in DS/ISO 21542 (Danish Standard, 2012e) for toilets, publicly accessible or for people other than employees. However, be aware that not all examples meet BR's legal requirements. 
Fixed seats	
In rooms and facilities with access for the public with permanently fixed seats for audiences, seats must be set aside for persons with special space requirements, e.g. wheel chair users.	People with mobility aids may need audience seats where chairs are not installed and with extra space to enter the seats. You should be able to sit with a good view, just like in other seats, and with, for example, a companion, family and friends. Some seats should allow multiple wheelchair users to sit together. Demountable seats can be an option here. See DS/ISO 21542 (Danish Standard, 2012e) for example on spectator seats in assembly areas

CHAPTER 18 – LIGHT AND VISIBILITY

BR18	SBi
VISBILITY	
Windows	
-	For the sake of the view, including the relationship between foreground and sky, the lower edge of the window should not be higher than 0.8-1.0 meters above the floor level

APPENDIX C

CASE STUDY 1: Vandhalla
Vandhalla - Egmont Højskolen
Villavej 25 - 8300 Odder, Denmark
Tlf. 87 81 79 00
https://vandhalla.dk/
Area: 4000 m²
Built in: 2013

Architects:

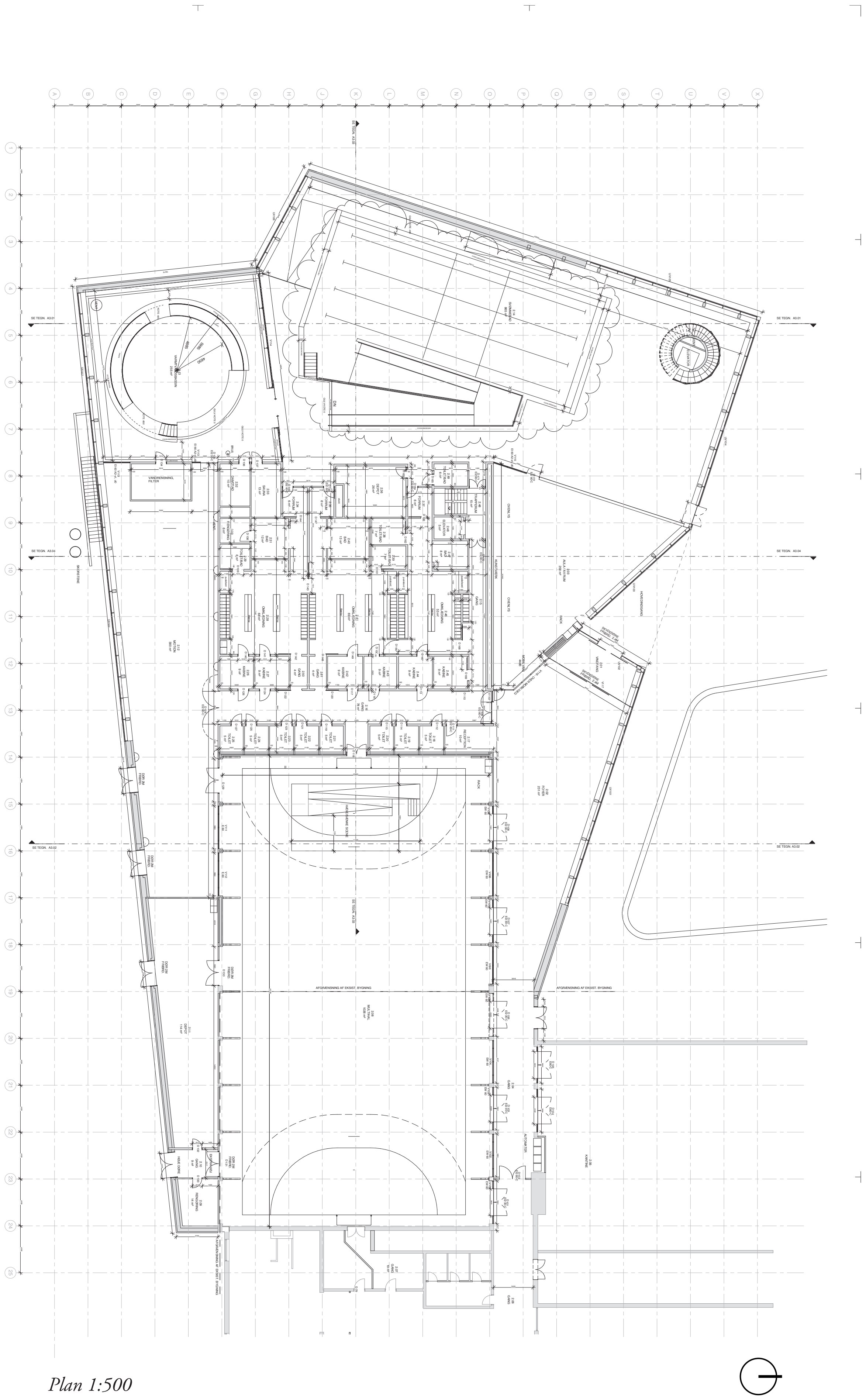
- Cubo Arkitekter
  Frederiksgade 72 B
  8000 Aarhus C, Danmark
  Telephone: +45 86 93 94 00
  Email: cubo@cubo.dk
- FORCE4 Architects
  Ryesgade 19A, 3. Sal
  2200 København N, Denmark
  Telephone: +45 3943 3131
  Email: mail@force4.dk

General sources:
- http://force4.dk/projects/egmont/
- https://cubo.dk/projekt/vandhalla-egmont-hoejskolen/
- https://www.archdaily.com/474130/vandhalla-egmont-rehabilitation-centre-cubo-arkitekter-force4-architects

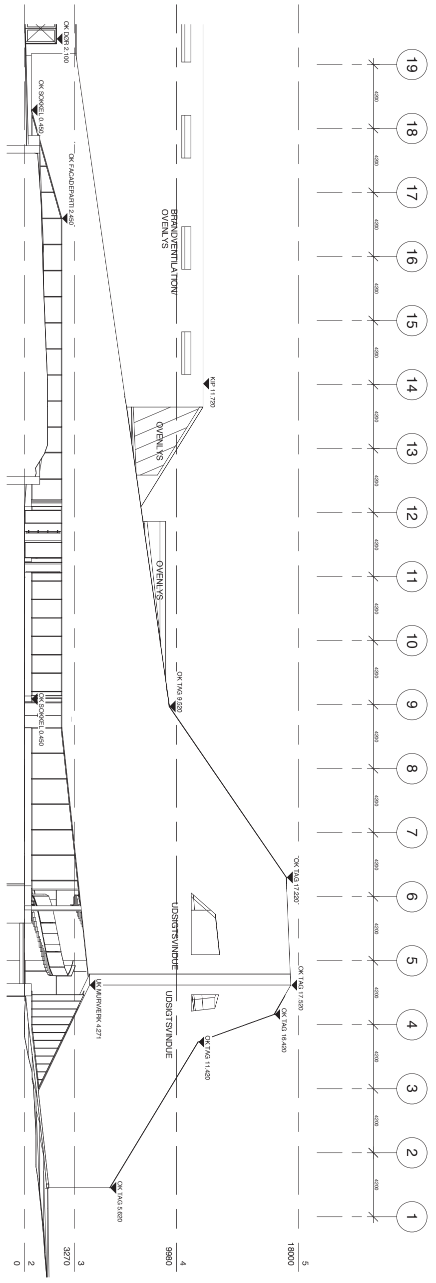
Main references on Vandhalla:
- Grangaard, S., & Ryhl, C. (2016). Vandhalla-A Sport Centre and a Successful Example of First-Generation Universal Design. Universal Design, 243-245.
- Grangaard, S., & Ryhl, C. (2016). Vandhalla: evaluering af tilgængeligheden af Egmont Højskolens Vandhalla. SBi Forlag.
- Grangaard, S., & Ryhl, C. (2017, April). The Architectural Question of Vandhalla–to Compensate or to Stimulate?. In ARCH17-The 3rd International Conference on Architecture, Research, Care and Health (pp. 316-330). Polyteknisk Boghandel og Forlag.

Interviewees:

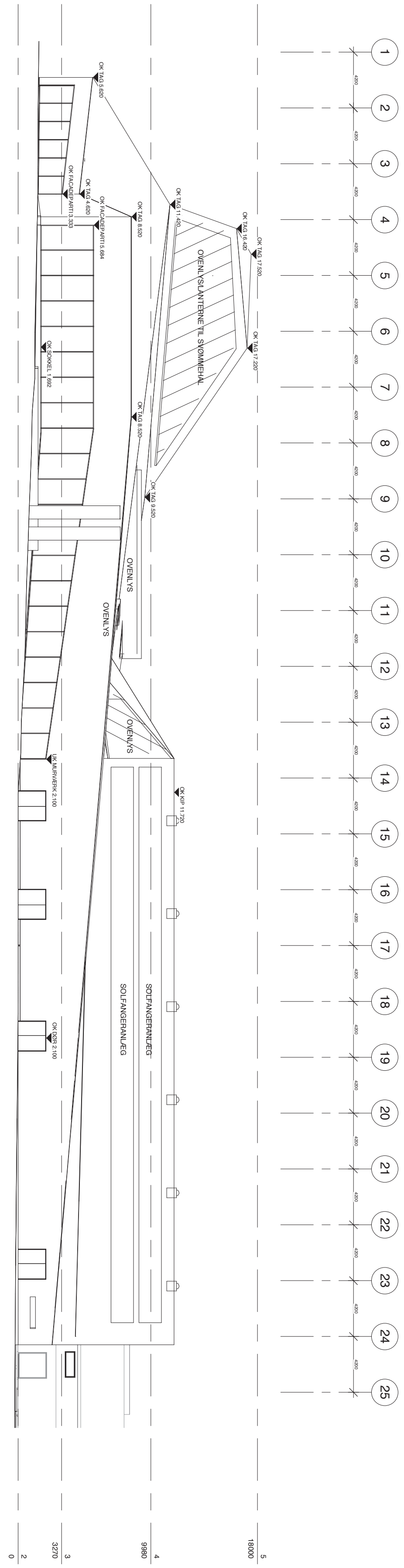
Andreas Lauesen	Head architect of Force4	Appendix 04
Per Ravn	Architect at CUBO	Appendix 05
User 1	Egmont student	Appendix 08
User 2	External user	Appendix 09
User 3	Egmont student	Appendix 10
User 4	Egmont student	Appendix 11
User 5	Egmont student	Appendix 12
User 6	External user	Appendix 13
User 7	External user	Appendix 14
User 8	External user	Appendix 15
User 9	Blind	Appendix 16
User 10	Deaf from one ear	Appendix 17



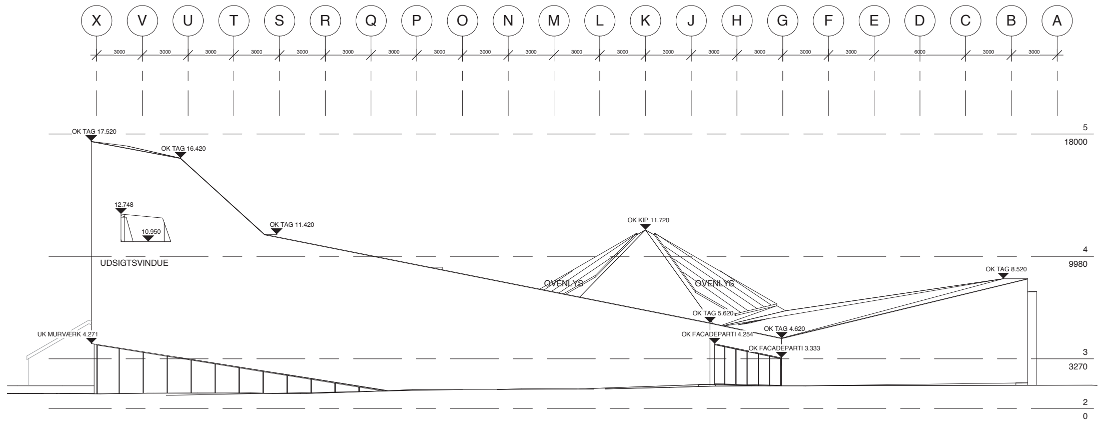
Plan 1:500



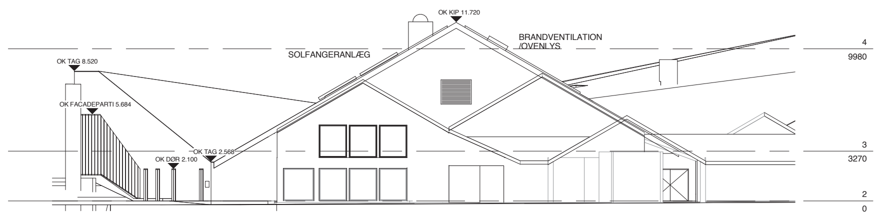
Facade North 1:500



Facade South 1:500



Facade Weast 1:500



Facade East 1:500

APPENDIX D

CASE STUDY 2: Musholm
Musholm – Ferie – Sport - Konference
Musholmvej 100
4220 Korsør
Tlf: +45 70 13 77 00
https://musholm.dk/
Area: 3200 m²
Built in: 2015

Architects:

AART Architects

Mariane Thomsens Gade 1c,

8000 Aarhus C, Denmark

Telephone: +45 87 30 32 86

Email: aart@aart.dk

General sources:

[- https://aart.dk/en/projects/musholm](https://aart.dk/en/projects/musholm)

[- https://realdania.dk/videoer/musholm/musholm](https://realdania.dk/videoer/musholm/musholm)

[- https://www.archdaily.com/776148/musholm-extension-aart-architects](https://www.archdaily.com/776148/musholm-extension-aart-architects)

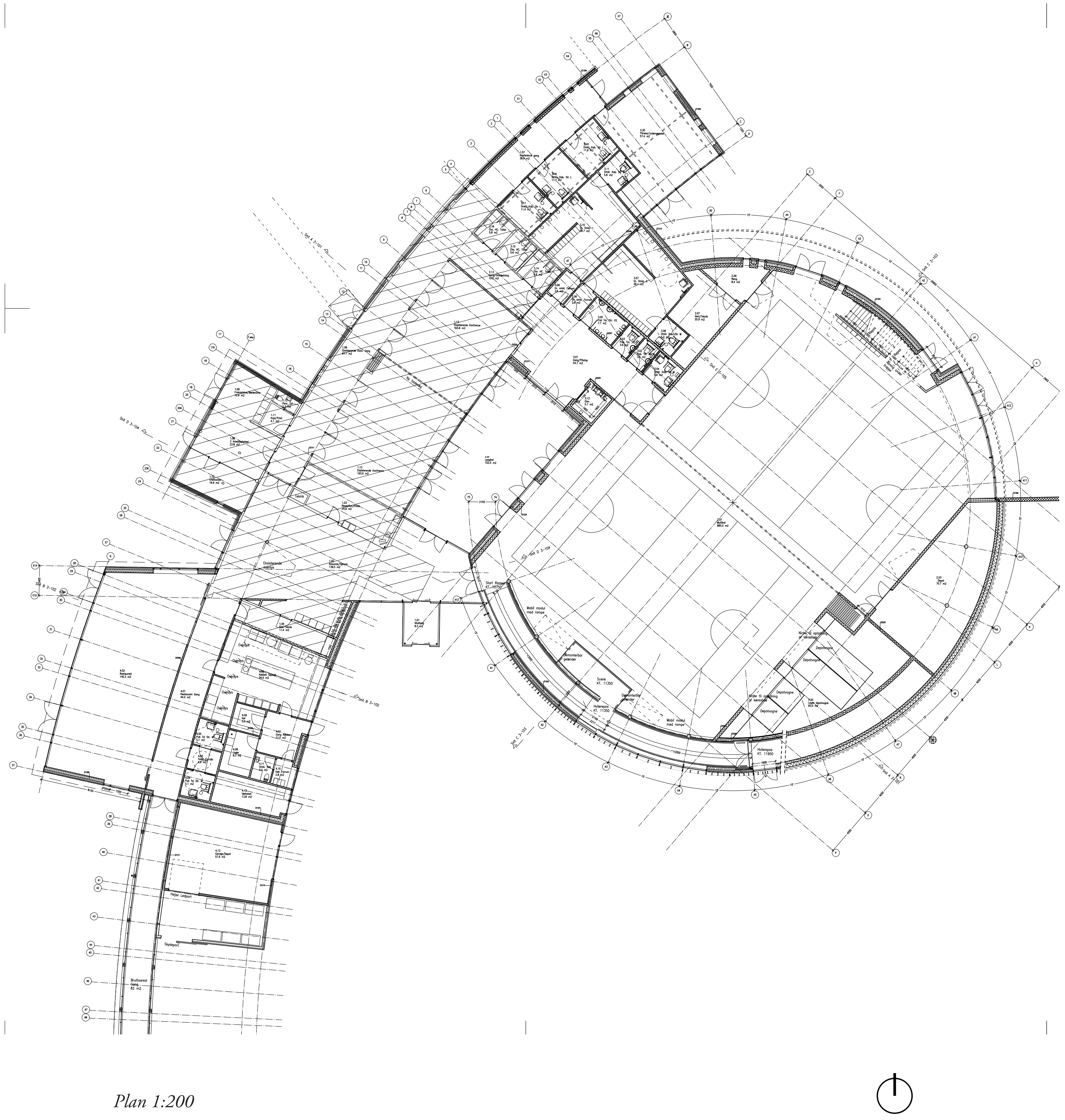
Main references on Musholm:

- Grangaard, S. (2019). Musholm ferie-, sport-og konferencecenter.
- Jensen, L. B. (2002). Dansk Arkitektur-årgang 2000: Musholm Bugt Ferie-og fritidscenter. In Dansk Arkitektur-årgang 2000: Musholm Bugt Ferie-og Fritidscenter (Naturlyrik som anti-institution) (pp. 180-198). Fonden til udgivelse af B+ Statens Kunstfond.

Interviewees:

Kathrine H. Stær-mose	Architect at AART	Appendix 06
Simon Philip	Former architect at AART	Appendix 07
User 11	Member of Danish Muscular Dystrohy Founndation	Appendix 18
User 12	Member of Danish Muscular Dystrohy Founndation	Appendix 19
User 13	Athlete of Danish Rugby in wheelchair	Appendix 20
User 14	External user	Appendix 21
User 15	External user	Appendix 22
User 16	Blind user recruited from Dansk Blindesamfund (Danish Blind Association)	Appendix 23
User 17	Deaf user from Danske Døves Landsforbund (National Federation of the Deaf)	Appendix 24

Plan 1:500



Plan 1:200

APPENDIX E

Interview guide for semi-structured interviews with architects

- **Setting goals - general**

- What was your general target in relation to the accessibility and the usability of the building?
    - Do you for example have a sort of MUST HAVE/requirements of your projects that you always consider in the design process/accessible consultancy? (e.g. values that you would like to transmit and/or specific/technical elements).
    - Do they mainly refer to Building Regulation, guidelines, personal experience or value that you want to transmit?
- If you consider to deal with users with mobility, visual and hearing impairments, on which requirements would be your main focus?
- Which features of the building do you consider more?
- Fit between building program and actual user needs?

Determining actions to achieve the goals and mobilizing resources to execute the actions
How do you develop the design solutions?

- Your decisions are mainly based on: (pool of knowledge that contribute for addressing design task/problems)
    Previous experiences/personal knowledge
    Clients/user information
    Regulations and guidelines
    Research
    Other architectural references

- Do you integrate any scientific research in the design process? Are they usable tools? Do they lack of something?
- What are the main challenges that you encountered in integrating those solutions in the final project? How did you overcome those challenges?
- Do you involve the end-user in the design process? Is there a precise timing that you prefer for involving the user? - What kind of user involvement experiences did you have? Which one worked well and which one did not?
- Usually, what is the outcome that you get from the user involvement? A sort of checklist, a generic inspiration or general/specific recommendations?
- How did you work creatively with these information (beyond regulation)?

How do you evaluate the success of your actions/solutions?

- Did you test some of the solutions in your projects? There something that didn´t work as you expected? In which project? Why?
- Do you think something is missing in your strategy? Do you think that you lack insight into how disabled people experienced space? Why?

APPENDIX 01

Interview Andreas Lauesen (A)– Head architect Force4

R When you started to design, what were the general target that you had in mind in relation to the accessibility and usability of the building (e.g. values, specific requirements)?

A The goal was to design something meaningful. It is the DNA of our architecture, meaningful sensory architecture. And this meaning should come through the architecture. We used our working method. Normally you have some requirements, you start designing and sketching and then you develop the project. What we do instead is that we step back with research about the specific project that could be, if it is a home for blind people, the research is about "How is to be blind". Also, we are very interested in telling the same story to different users. The way you understand the building should be the same for all the senses. Architecture usually tells one story and that is for the eyes, but we would like to tell the same story for the nose, the hands, you should be able to even to taste.

R What are the tools that you use in this part of the process?

A The first tool is broad research to find out what has been written about we are designing, so the literature, then we talk with experts. Normally we would have experts in this phase, and we also try ourselves, like blindfolds, so that we test and then we look for references, whatever we can find. Then we start getting an overview of what the project really is, then we line up all the information. What is relevant? So, then we have the building program plus our own research. And this is our new assignment. We add an extra layer of knowledge to the one from the layer.
Then we start designing we can make a square building, we can make a round or a triangular building, etc. We can make something funny. And here we are very systematic, where we test the sketches

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R How do you evaluate each sketch/concept?

A We take each one and then we put them up against each other. We make plan, diagram, etc and then we compare. We know the competition and then we know which are the possibilities that answer to the question. The wrong model doesn´t work for the blind… so we come up with the right answer and then we develop and finalized the chosen one

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R When do you start considering the BR?

A We look a little bit to the BR when we come up with the concept, and then we start digging in and challenging with the BR. For example, we have problems with the sqm so we need to challenge the BR. The typical one is with the hallway.

R Did you experience any discrepancies between the BR and the design solution that you want to integrate?

A No we don´t look so much at the BR. We just look at the BR only to be sure that we fulfill the minimum requirements and then we do better. So, we don´t look at the BR for making the house accessible.

R Did you never involve the end user?

A Sometimes we can ask the user, if it is an existing home that needs to move to a new one. Sometimes there are not end-user because is a completely new home and sometimes we are not allowed either for the competition or because they are too weak. For example, for Ebberød project we were not allowed to talk to end-user because they were too weak, instead we got some descriptions from the client. They tried to describe the people and their needs with an A4 page description for each person. Like this person is blind and deaf and can´t talk he bits the walls and he uses his hands to find the way to the kitchen.

R How do you translate these descriptions in design solutions?

A We say: How can you find the kitchen with your hands from your apartment to the kitchen? How can we make a tactile guideline that he can follow?

R How do you evaluate if it works?

A No, we don´t. You will evaluate. Normally we make the project that is 100%, then we get 80% in. The clients are not willing to pay a little bit extra to get 100%. They say 80% is fine for us. Then we build it and we leave it with them. Some might work and some might not. We don´t get back. But we have Realdania and SBi that evaluated some of the project, like DH.

R Did you never experience something that you really thought that was the right solution but that at end was not usable at all by the users?

A No. Sometimes we have a little bit too much. That you don´t really need, like an over layer.

R Is sensory architecture based on low tech solutions?

A It is based on what you build. Solutions should also work if you don´t have money to buy a computer that do something. So, we try to integrate as many as this idea into the shape, into the physical part of the building as much as possible. Because then you cannot take it out. It is part of the concept.

R How do you prioritize when you need to make some cuts in the project?

A We know that all the soft stuff that you put afterwards, they will not come up. They are very cheap buildings, so for example if we suggest artificial daylight system, it will be normal lighting. So we cannot win the competition. We can win on the concept that is integrate in the idea. So, the high tech we work with is kind of different layer. I´m most interested in things that are integrated and you cannot take out afterwards.

R How much you use the research "intuitive accessibility" in the design? Is it a useful tool?

A Yes, I think so. It is very important because we have done research about blind, deaf-blind and different sensory impairments, and it gives us idea about how it is to have an impairment.

R Do you use it through the entire project or mainly at the beginning?

A We use it through the all project. From the concept to the detail. Because it is important how the detail is. It is different if it is a square house or a round one, and if there is a dot on the handrail, whit which you can feel there is a room there. So, it is about the all scales and everything in between.

APPENDIX 02

Interview Per Ravn (P) – Architect CUBO

R What was the approach you had for this project?

P For us, I think the approach was a Universal Design approach. Was important for this project as the other we work on to use a Universal Design approach so that it is a part of the basis or the DNA of the building. Our process is different from project to project. So it is not like a scheme, it depends. We always need to get some knowledge about the project, the client, the users about the different ways of making universal design. And every project gives you something different. Because you learn something more and you change your mind. It's a kind of philosophy.

R What about Vandhalla, how did you developed the design of this building? what kind of knowledge you used?

P It is something we developed on the way, about the difficulties of different users and every solution was thought so to include them in a natural way. We had to take care of everyone and include them.

R How did you do that?

P The first sketch was about making one solution for everybody. Then we became aware that sometimes we had to give different solutions to include everybody and that made the difference, like in for the swimming pool. We realized, by knowing a bit more about how different users are that treating everybody equal, you sometimes have to treat them in different ways. So it is all about giving them the offer of experiencing the space even if in a different way. There was the difference in level for entering the swimming-pool and we thought the ramp was the solution that fit for everyone, but someone else preferred the stairs.

R How much did you think about wayfinding?

P First, it was important that everything was in the right position so that everybody can find the way. And that you can go everywhere without having to ask and that needed to be somehow integrated in the architecture. We worked with lights and materials as much as possible as architectural parameters. We wanted that the swimming pool was visible, as a landmark, and then we started thinking about the flow, and that is how we came up with the central disposition of the changing rooms. It was important to have short and easy ways, where you do not have to turn many times, both for wheelchairs and wayfinding.

R How did you use these parameters to improve the accessibility and usability of the building?

P We started working designing what we thought was the best solution based on our knowledge and experience. At that time we were working on the DH project and we used kind of the same knowledge we were developing in that project. At that time we met with different users, different people humans, with a lot of different handicaps. We learnt a lot from them. We met with professors and handicap organizations. We talked with Camilla, and SBi. All of this contributed to the project. We had panels with different users and we talked about different solutions, but we didn't call it Universal Design. We just worked with humans and we try to understand them so that everyone can use this building. A lot of elements that we work with in Egmont highschool was based on this philosophy of Universal Design. But we didn't call this. We just did it without knowing we were doing it. I also think was an early project that influenced a lot what we did after and the other projects.

R How this process influenced the use of the parameters you mentioned before?

P Talking about the space at Egmont, we started thinking differently about for example different perception of wheelchair users, so how can we managed to make them see or reach something from the sitting position. How to place a window as well. And for people who has difficulties in hearing we knew we had to provide a good daylight so that they can see the faces and the mimics. But not a flat light, because it is important for them to have some shadow. So in this process every parameter was important.

R How did you consider sensory impairments like people with visually impairments?

P During DH project we did what was called "Try yourself". We had a kind of workshop where we tried to have different disabilities. We tried to bee blindfolded and this opened our minds in relation to the design ass well. Because sitting on a wheelchair is really difficult, very very hard, but also it´s very difficult to navigate when all is dark. And also we were not trained, everything was really new for us, so it was even more difficult I think. Anyway, it really opened our minds, for example the importance of not having carousel doors or the fact that solutions which are good for someone are a problem for someone else.

R How did you implement all of this in the project?

P It was sometime hard to integrate all of this in the project. Because there were many little solutions that didn't have to be such as visible. We knew when something was a good solution when it is not so visible because it is integrated but then it is difficult to sell because the client thinks to get nothing. But we know that there are small details that can save the day to many people. In Vandhalla there are great small solutions. The way you enter the water, the water slides with the lift, the changing rooms. Did you see the picture of the swimming pool with the woman in a wheelchair entering with the baby in the swimming-pool?

R Yes, sure, I saw it

P This was from good thoughts about humans and a wide range of different users. And that´s just THE picture for me. A mother, his son, entering the water together, that's it.

R What about the changing room?

P There we wanted to reach a good level of flexibility. There are doors in between the changing room so that you can use them differently depending on the events. So it was made really flexible in that way. And we made these cabins so that everybody can have a private dressing room and you can also have the shower without being exposed. Everyone has different things about their body. But you can decide to stay private, then you meet again with your friend or whatever in the changing room and you enter together in the swimming-pool. We did these cabins that you can access from the corridor. We divided them in three blocks, they are mixed for men and female and one which is uni-sex in case you have some helper going with you.

R What about the openings and the transparencies between the spaces?

P We wanted to create visual connection. A visual contact. But that also is very individual. Some people are very private, even if it is a public space. But we knew was good to have some visual connection because it could be something that challenge you, when you see others moving. I think again, the best solution is flexibility because if you are disabled, if you have been in a car crush and suddenly you cannot move you have to learn to move your body again and you have to understand in your mind how the to approach the world differently and you see yourself differently. But that´s is also gradual. Maybe you need smaller space at the beginning, more private, come back to a sort of normal life, and after you are ready to do something different. But it is here that you need to have different spaces for different functions. For example we decided to put the fitness room where you do rehabilitation not directly at the entrance. Instead we put the big gym in the front because when you play basketball you probably don´t care about being exposed. We did the same for the two swimming-pools, but we put filters in between. So you can have the feeling of being together but still you are in a private position.

APPENDIX 03

Interview Kathrine H. Stærmose (K)– Architect AART

R When you design a project what is the strategy that you implement for the accessibility and usability?

K Our approach is very holistic, and we talk a lot about universal design. It is of course about disability, but it is also about all of us. Making the world accessible for all of us. It also includes your stroller when you have a child. It includes the two weeks when you have a leg broken after a sky holiday, or when you have high heels. And we need to make the world accessible for everyone in every situation. We do know that everyone of us at some point in our life experience the need for people to take better care of us. And that approach is very important when we talk about disability and design for disability whatever we call it, that we think as universal and important for all of us in our life.
So that was the main thing about Musholm, because we need to understand that this is not only for wheelchairs, it is about everyone of us and we need to treat people with respect. I would say Musholm has two big strategies that we aim for.
The first one is : "we should be able to follow each other" . That was the main thing we started and then we developed the project.
Musholm is a holyday centre which is built in different phases and the first phase before we came it was very much about wheelchair and how people in wheelchair wanted to be met. What we did with our extension was way more universal, we would also think about other categories of disability, the vision, the hearing, people that has difficulties in walking, much wider than it was before. But the one thing was that everyone was supposed to follow each other. The important thing we considered for this large sports facility is that when people come to this place they should feel safe, they can feel comfortable while challenging their limits.

R Yes, I saw that Musholm was not supposed to be only a supportive environment, but it is a challenging one, that push people to exceed their limits.

K Exactly, but the important thing was that we had to create the basis for everyone to feel safe and welcome. Then we worked with a strategy where we didn't think everyone could do everything, but everyone had to have their own space and be challenged differently on their skills. it became our goal in the process of designing it. Because we realized if we were supposed to kind of hit the lowest bar in all the stuff that we did it would be a quite boring place and this was not what we wanted to do. We wanted to challenge everyone in different ways. There is a ramp, for those on wheels, there is also stairs for those who like it even better and there is also elevator. And then all these three stuff are also combined with different activities. We have for example the line in the ceiling, inside the sport facility and this is not only challenging. And if you are on a wheelchair you can go on this fabric stuff and you can actually try this but if are not disable in any way it would also be a challenge to try that, it is quite intimidating. There also a climbing wall that is intimidating for everyone I would say. It also has this system that work with the body weight, so if even you do not have force in the muscles you are able to climb, and also for blinds, blind people are usually really good climbers because they feel the right way to go.

R You talked about the old and the new building. Where the first one was much more focus on wheelchair and the other had a wider focus. Can you tell me more about it?

K There was an existing building and that building had the focus on wheelchairs. So it was important for us when we started with this project, that it was for everyone. They also had very few people coming to visit Musholm at that point and they really wanted to make it more open for everyone and they also wanted to make it as neutral as possible that it was also for not disable people. They wanted to have conferences for business men and women, so they wanted to be wider.
But if you ask about the design process, this is actually an interesting project because it was a competition in two phases and this was the first time that we felt the need to invite users in, already in the competition. Because we really understood that we needed to talk to people to understand their specific needs and how far we were allowed to go.

R What kind of user involvement you had?

K We had a really good consult on this project, she calls Karin Bexcom. She had really good connections with a lot of different people with different kind of handicaps, she kind of made this specific choice so that we were covered with different kind of people. So we invited them in and we showed them four different concepts and one of them was with this ramp going around. It was even more crazy when we did it the first time and we thought it was a little bit too crazy and that it was too challenging, so even though we are huge speakers for users shouldn´t decide anything. Expert should decide. It was actually the users that convinced us it was ok to challenge them and they were actually seeking the challenge, they wanted to be challenged in a good way.

R So you thought that the ramp was too much?

K We thought that the ramp and the activities going around we thought "well, there are so many people that cannot do that"… because of this, this and this. But then the users said they wanted to be challenged, they wanted to do crazy stuff and they actually convinced us.

R How did the users involvement work?

K It was really complex. We had users involvement in the whole process. We had this really specific toilette strategy. It is really unsexy but the toilette is kind of the biggest issue of every handicap. Because there are so many needs in a very small space so that you can really see the different needs. So this was the first time we involved the users in the competition, then we just showed the concepts, no solutions, just concepts and ideas. We just listened to them and then we went home to decide with our expert what was the way to do it. But later on when we were in the project phase we invited, some of the same users but also new ones, also from the clients. We invited them in and we built a small, medium and large toilette and we invited the different users with kind of disabilities and we tested them. It was so interesting seeing this test. You can kind of see we had this blind man coming in and of course he was interested in the very small toilette because he can kind of feel all the walls. And it was so interesting to see him and his dog trying this toilette, like we could see 1:1, where is the issue, where he putted his stick, where he was supposed to put that and we could also see people in the wheelchair that was very helpful themselves, but we also saw people in a wheelchair with one helper or two helpers and we kind of really understood the need of anyone of those and we adjusted. And of course toilette is the topic that you will get a new answer from every person you ask, so we really needed to analyse the situation and the results that we got from the users and then make the right decision or the decision that wasn´t worst. I mean is always a compromise.

R How did you ended up with the final solution?

K At Musholm today we have small, medium, large and actually even extra-large toilettes. The conclusion is that the needs are so different. Like the blind man would have the small toilette and the guy with two helpers would need the big one.

R Did you received any feedback in relation to the building?

K We are just now making the report on Musholm. Because at AART we really do make a big force about going back to our buildings and evaluating them. We do qualitative wises and also quantitative wises: We have a collaboration with Alexandra Institute, here in Aarhus. They have anthropologists going out and research doing interview with people, observing and then we gather information ourselves, like numbers, visitors before, visitors now and all of that and then we have a big report on that from which can learn for the next time. And one of the thing in Musholm, that is quite surprising for us but also for Alexandra Institute, it was so touching, because people said that when they came in they felt free. They felt this was the place where disabled children felt free and felt at the same level as everyone else and sometimes they even felt even better, because of their disability and because of being in this place. I think I can make this evaluation public for you.

APPENDIX 04

Interview Simon Philbert (S)– Former architect AART

R What about the choice of the materials at the entrance. there are different materials here.

S We thought to use bigger stones so that blind people can recognize the traditional stones, but they decided for another stone. So then you can follow the stones with your plan stick to get into the building.

R How did you come up with the organization of the entrance?

S The problem is that actually, sometimes when you're blind the entrance should be right in front of you. But we made the choice that the people working here could see if they're coming this if they're blind, so they can reach out. Yeah, yeah. Because you can actually go outside again if you're walking straight. But we did of course the reception is in two heights. I would say that it's a problem that they put all the candies up there. This should be the area for the ones that cannot walk sitting in a wheelchair.

R Can you tell me something about the big hall?

S Yes, it is quite smart here because one of the things that you could do is that you can have two conferences at the same time. They use them a lot for different events and the light up here makes the difference, I think. Because the light is really good in here. Together with the wood sticks it makes a nice effect. In the project we thought to use the same distance used on the walls on the ceiling too, but it was really expensive, so they had to make it wider. But it is really good how it came up. And the ceiling has different heights with skylights of different size. That´s also one of the things that made the construction. Small details. As a regular user you maybe doesn't notice it, but it's the whole thing about experience. It is not just a square.

R This ramp is the symbol of the project isn't it?

S Yes, even if there are two levels there are no steps and no gaps between inside and outside. I know that if you are not walking that good. It is a long way but there is the elevator as well. It is about giving different choices. What is nice here are also the activities you can do here. This is the video room for movies or games, but you can also open the wall and watch the game from here. It took some time to figure out what to put on the different levels of the ramp. It was a long discussion. That´s the funny thing. You can have the best idea, but clients maybe want something different and you also have to consider how users will use it now.

R What about these benches along the ramp? do you think someone use them?

S I don't know. Actually I don't think so, they are too low. Or if you sit down, then you cannot stand anymore. They have to be higher, I think. And it would be nice if they had a backrest as well. Also the handrail, I remember that we thought to have it in double heights for children as well, but then they do only one, I think for economical reasons. But all the rest is more or less how we planned it. The windows give light without making the room too warm, the lights give a sort of wayfinding and the line as well. And all the time you have the view on the surrounding while you walk up.

R How did you decide about the materials and colors?

S Yeah, this place would be a place for entertainment. So we wanted to use some colors and at the same time makes it homely and chill. We used concrete and wood for the rest of the building because this is a sort of tradition in Denmark. And here, because is for activities we used colour but we didn't want to use so many colors. At the beginning the ramp was supposed to be green, but it was too shiny, so at the end it came up to be this red which works better with the other materials.

R Here there are all these different bathrooms

S They used a lot of money for this kind of toilets. In these ones you can have the toilet that goes up and down and I think this is the biggest size, there are the other which are probably bigger though, with the shower and the lift. Those are on the other side, but these are the closest to the conference room. And this is the kind of normal size. I think it was a good idea to have many different bathrooms, but on the other side it seems a bit overwhelming, also for the staff that has to clean, maybe are too many. I wonder if architects can do something better about bathrooms for disabled. For the tubes as well. Make it a little bit nicer. We tried to keep them simple by using nice grey tiles.

R What about the changing rooms, the layout and the furniture?

S You can see on the wall there is a problem of people turning with the wheelchairs. They smashed the wall. Maybe because it is not the best layout. The benches can go up and down, so that you can sit and get support when you are standing or still for doing transfers at different heights. There are two changing room, but one is only used as storage now. That makes me think that maybe having two changing room was too much. I do not know. But it has to be there anyway. We tried to make it as anonymous as possible. The whole thing so if you're using this one you don't get that afraid of all the handles, etc.

APPENDIX 05

(XX is a Danish girl who does not speak English. Her assistant provided a translation of the researcher's question and what XX said during the interview)

R Why does she come to Vandhalla? What kind of activities she does when she is here?

U(translation) XX is a day student here. So she's one of the few who doesn't live here in the school. But she uses this facilities one or two times a week because we have this class called water sport. So we are in here doing this activity which is mostly for using the body, but in the water, which for her is the only way. One or two times a week.

R Could you tell me how is your typical day when you come here?

U(translation) She said she is usually accompanied by her parents, or her brother. They bring her at the entrance and sometimes they spend some time at the entrance, talking with me, about her week, her day or other general things.

R Where do you stay while you have this little chat?

U(translation) We stay here at the entrance. At these tables. Or outside if the weather is good. There are tables also out there. But most of the times we stay here.

R What does she think about the entrance? Is that confortable?

U(translation) Yes, she said that it is always a good feeling to come and enter in here. There is good space and she doesn'´t feel restrained at all in her movements when she is here. Also, she said that she feels a bit like at home. Even she is not living here, when she comes here, she always meets someone she knows, so sometimes we start talking all together here at the entrance, her, me, her parents and some other people.

R Is there something she really likes of the entrance?

U(translation) She said, she likes that there is a lot of space. The ceiling is high, she feels like there is always fresh air even if there are many people in here. She said she likes the lights as well; they are different from the usual kind of lights.

R Could we now move towards the changing room? So that she can tell me about how she gets ready and what she usually does before getting into the swimming-pool?

U(translation) yes sure

R Which changing room does she use?

U(translation) she uses the woman's one because she is not that comfortable using the other one if there are men. But she said that in case she will get a male assistant it would be okay to use the other one anyway. Now I am her assistant, so we go in the one for women.

R When you are here, and you need to get ready. How do you do?

U(translation) well, XX doesn't have any muscles that is useful in her legs so she cannot stand. So in the changing room we use the lift to lift over in the chair.

R How does she feels about being lifted and getting dressed in this changing room? What about the privacy?

U(translation) XX says that she doesn't care about the other woman because it's fine. She dresses in front of others. But when she is getting lifted, you know, she prefers to have a little more privacy, because that's more personal than changing because everyone is naked, but most of the times she is the only one that need to be lifted. So she prefers to use one of the free rooms that's in there as more private rooms.

R How are those cabins? Is that easy to use those?

U(translation) She says that she always needs something to grab, it really helps to have all those handles. Otherwise, she would need two assistants not just one. But sometimes, especially when we use the lift, we would need handles where there are none. It would be great to have some more, but she also said that in that case the wall would be full of handles, which would be strange.

R Is there something she really likes of the changing rooms?

U(translation) Again, she said she likes that there is a lot of space to move, and the light. She likes the light from the skylight. The other changing rooms she used in other places have a really cold light. She cannot really say why, but she likes it.

R After you got ready, how do you get into the swimming-pool?

U(translation) when we get in here she uses the ramp because it's not possible for her to walk down the stairs. Even though it's in water, her body gets easier but we have to use the ramp.

R Did she used other swimming-pool before this one? How did she get into the water in the other places?

U(translation) Yes, before she came here she has been using other pools and other swimming halls. But she says it was hard because there were a lot of stairs and I asked her how she got in the water and she said she was being lifted by her family, the father. So the different from here is that she is feeling more like a human is is she's feeling more free because she doesn't need anyone to carry her down the stairs and she doesn't feel so much into trouble as well, because it was so easy to fall down.

R Does she use the main gym hall?

U(translation) because XX is a day student, she doesn't use that much. She just started this year this summer. So it's quite new for her. Yeah, but yeah, she is probably going to stay here and live as well in few months. So when she will do that, she will use that more.

R Did she ever had really bad or really good experiences in this or other swimming-pools?

U(translation) Yeah, okay so she said she cannot remember any bad experience. But she has a lot of experience from a different kind of swimming halls so before she started here, she wasn't that fan of the water. But because she knows that Egmont has all of these facilities to go in and out of the water without complications, this makes her more calm and now she likes swimming more and more.

APPENDIX 06

R Why do you come to Vandhalla? What kind of activities do you do when you are here?

U I come here once a week for doing water activities, I live one hour far from here, but I come till here because there are no other swimming-pool like this one. I started coming here with a friend of mine from the school, but he had to stop. I kept coming here. Yes, once a week, but sometimes I do it in a weekend also, but it's mostly one day a week.

R So you were used to do water activities in other places?

U Yes, I did it before, but where I did it was not really for disability, because it was difficult.

R Why you say that it was difficult? What was different from this one?

U The changing rooms were way different. It was difficult. All the rest was fine, because since I am in the water, then I don't feel I am disable anymore, but the changing rooms, I love these ones.

R Which changing room do you usually use here?

U I always use the changing room for women. I am practicing to dress in the public because there are these small locker rooms, but I'm practicing to do it in the big room. But I like it much better in these small changing rooms.

R You like better the small cabins? Why?

U It's because I had many surgeries, and my body is full of scars. I don't mind anymore, but I don´t feel good to undress in front of others. And if I don't know the person's I'm showing with then I am a little bit more comfortable to not show my scars. It's not totally terrible. it's, you know, okay. But, I still do prefer. And there is also a unisex changing room but no way. Because I cannot do with seeing, the other changing and get naked. Yeah, I don't like that much. So if I change in the big changing room then I use the one where there are only women

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R What about the cabins? do you go there alone or with the assistant?

U I go with YY, my assistant. Or in the weekend with my mum.

R How are they?

U They are good, because they are big. That's what I like here. Yes, in the other place where I was used to go there were some small cabins, more private, but they were really small. It was not possible to enter and move, especially if we were two persons. Also, the chair takes place. Sometimes we remained stuck. It was difficult.

R So what do you especially like of these ones?

U I like that they are big, you have everything, the shower, the toilet, the sink. There is also the lift, but we do not use it. I can do everything by clinging to my mum or to XX. I know that it is not really easy for my mum though. But better than the other ones.

R Do you use the handles on the walls?

U Yeah yeah, sure. It is the only way, but I do not have so much strength, I grab them just so to not fall down or to avoid hitting on the wall, but I cannot really use them to support myself. Sometimes, when I am with my mum, we use them to hang stuff as well. We have a bag with a belt that can be opened and closed. My mum, when she needs her hands free, hangs the bag on the handles, so she doesn't have to put it on the ground, which is wet or sometimes a little dirty.

R Is there something that you do not like of the changing rooms or of the cabins?

U Mh, no. Not really. They are good. Maybe the colors. I do not like the green one. It is too much green. But, yeah, it is just the color. Like here (indicating the common shower space) it would be nice to have some more handles where to hang or keep my stuff while I shower, but they would get wet, so I don't know.

R After you got dressed and you are ready what do you do?

U I go straight here to the swimming-pool.

R What do you think of the swimming-pool area?

U I like it. Sometimes is a bit noisy, like now. But all the swimming-pools are noisy, I think. We are a lot of people here and they put the music.

R How do you get into the water?

U I use the ramp, but not necessarily, sometimes they put me on the second or third step of the stairs and I crawl down.

R Do you feel safe when you enter in the swimming pool?

U Yeah, I would definitely say this. And then I think it's amazing that there is an elevator to the slope. I don't know what is called in english but...Because otherwise I couldn't use it. Yeah, I would say that it is really quite wonderful

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R What do you like when you are into the water?

U I really like when I use the floats, the circular ones, so I keep myself up and look at the ceiling.

R Why do you like that?

U Because I feel like flying, and I look at the reflections of the water or the lights from the outside on the ceiling. You cannot see them now, but there are days where it seems there are little bubbles dancing on the ceiling. I like to steer at those, and I float. I really enjoy the fact that I can move easily, but that's the same in every swimming place. Yeah, but I can walk in the water. Yeah. Without having difficulty. because when I'm on land, then it's difficult for me use my upper body a lot. But in the water I can use both my upper body and my lower body. Then it is amazing. Because I kind of forget that I have... at the hours in the swimming pool I don't think about my disability.

APPENDIX 07

R Why do you come to Vandhalla? What kind of activities do you do when you are here?

U I am a student here, I come here for doing water sports but not today because I have a problem with my ear, and I don't feel to get into the water. But usually I do the activities two-three times per week.

R What is the thing that you like the most of this building?

U I like here because there are a lot of people I know, I live here. It is like a home, and I am never alone.

R Why do you live here?

U It is easier to stay here. My parents don't live far from here, twenty minutes by car, but our place it is not good for me. Yeah, it easier for me to stay here after school, because I can do the other activities after school, and I sometimes come back home in the weekend.

R How long have you been here?

U One year and half more or less.

R So the swimming pool was already built when you come here?

U Yes

R How do you like it?

U I really like it, and I think it is special.

R Why you say it is special?

U For the ramp. It is good for me, but also for many other people. I have a friend here that has a special electronic wheelchair and when he comes here, he must be brought in with the bed.

R With the ramp?

U Yes, his brother put him on the bad and they enter in the water with it.

R How do you get ready before going into the swimming-pool, do you have an assistant?

U No, I am independent. It takes me some time, I am pretty slow, but I can do almost everything on myself. But there are the instructors that sometimes help me or other students.

R Which dressing room do you usually use?

U The green one

R Do you never use the uni-sex changing room?

U No, I'm not using it myself. So I cannot speak

R How is the changing room? what do you like?

U There is a lot of space. When we have water classes, we can be 8-10 people in there, some with the wheelchairs. They take spaces and other stuff as well, but we fit.

R Do you use the small cabins to get dressed?

U Sometimes, when I need to go to the toilet then I get dressed in there. But it is rare. I come from my room, almost ready to get into the water, I just need to shower before and then I get in.

R Do you think is something missing in the changing room that would help you better?

U No, not really, I think they work well. It would be great to have more handles on the walls and in the water as well. I like to float but it would be nice to have something to grab. Often, the instructors put the music and we do exercises or games with the floating mats, maybe because you need to make some movements and you need to hold on to a handrail sometimes.

R How is staying here in the swimming-pool for you? There is a big window there, do you like the light inside here?

U Yes, I do not have any issue with it. Sometimes can become really bright though.

R Do you want to move to the gym?

U Yes, sure

R What do you think about the corridors and how the spaces are connected to each other?

U It is good. It is easy. It is not a long way, and it is good to have the changing rooms here that work for both the swimming-pool and the gym.

R Do you use the gym often?

U Yes, we do many different things in here. Especially when we are a lot of people, we stay here. Maybe we use only half of it and other people do other stuff in the other side. We come here also for the big meetings or when there are events, something like that

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R Is there something you particularly like here?

U I do not know. It works well, sometimes is a bit dark, but there are many doors and light come from those too. We have a lot of sports equipment behind that door, for different activities. It works.

R When you are not in the swimming-pool or in the gym where do you usually stay?

U Either in my room or around here. I often stay in the canteen. We have tables there and board games. I like to play board games when I don´t have anything else to do. Or outside if is good weather. Then we stay outside at those tables or in the garden behind the building. It depends.

APPENDIX 08

R Why do you come to Vandhalla?

U I started to come here four years ago when I had an accident and lost my right leg.

R Did you already know this place before your accident?

U No, I didn't know but it happened that I was talking with another guy at the hospital who told me that he was used to bring his son here. I didn't want to think about anything at that time, but after some days I mentioned it to my doctor who knew this place and recommended it as well. I knew I had to do some rehabilitation and other activities and this place it is not far from my place. Yeah, it is pretty good now.

R How often do you come here?

U I come two-three times per week. Two times for rehabilitation with the staff and sometime to play badminton. I would like to come more often, I think it would be good for me but I have a family and in the weekend I am pretty busy with my boys.

R How do you like this place?

U Oh, I like it. I feel lucky that there is a place like this one close to where I live. I remember it was good since the beginning. And it was easy to meet people and get along with them. Before I had another assistant, after few month he had to leave so I changed to a another one, who is really good as well. I'm happy Yeah.

R What about the building? Is there something you particularly like in here?

U I spend most of my time in the gym. The big one and the fitness room. I think that all is really functional. There is space, there is the equipment, it is comfortable. I like that it is all new, I see the quality of this place.

R What do you like for example here at the entrance?

U I like that it is fresh, the high roof and the lights.

R Why do you like the ceiling and the lights?

U I like the ceiling because is high and it makes me feel I'm inside, but still outside. I mean there is a lot of air. And I like the two lights. They are modern lights and different than usual, so they are not boring.

R Do you use the changing rooms?

U Yes, but not so much, because I come here almost ready and I take the shower at home. I just put my bag sometime, but most of the time I bring the bag with me here in the gym, but yes I do use the changing-room sometime.

R Which one do you use?

U What do you mean?

R There are three types of changing room here, for women, for men and a uni-sex one.

U Ah, I see, no I use the changing room for men.

R How is it?

U Simple and practical. Could be a problem for me when it is wet on the floor, you know when other guy from the swimming pool use it and take the shower, it can be pretty wet the floor. But was never a big problem.

R What do you think about the big gym instead?

U Good, I like it. Maybe the only thing is missing is a place where to sit. You know, while I wait for someone inside or I want to the take a break or I don't know, it would be nice to have some places where to sit. There is plenty of space where to leave the bags and other staff but not so much where you can sit. But the rest is really nice.

R Is it here where you do rehabilitation?

U It depends by the exercises. I do some here and some others in the small fitness room.

R Where do you prefer to stay?

U When I play badminton it's fine to be in the main gym, but for rehabilitation exercise, I prefer to do it here. I feel less exposed. Also the exercises that I do here are the most difficult ones for me, so I prefer to be focused in what I am doing. Usually in the big gym there are other people or you need to be aware so not to get ball on your head or whatever.

APPENDIX 09

R Why do you come to Vandhalla?

U I come here for my child. He has a cerebral palsy. I come here so that he can stay in the water.

R How long have you been coming here?

U It is almost one year. We started last year, but after few weeks we were coming here we left and we stayed at my parents place for two months, the we started to come here when we came back.

R Have you been in other swimming-pools than this one?

U Yes, three years ago we went to another one in Horsens. It was ok, but then we moved to Odder, and I knew there was this swimming-pool, so we started to come here.

R Is there something that you particularly like of this place?

U Mmh, well it is close to our place, and it is easy to drive in. I think it is a really good place. Nice people. It is always a bit difficult for me when I bring XX out from home. Well, it is always difficult. Here there is good help. I met the parents of the other children and it is easy when we are more here because we help each other and the kids can stay together. I think it is good for XX.

R You come here only for the water activities?

U Yes, he does water classes

R How often do you come here?

U Two times per week

R What do you do when you come here? Do you stay here at the entrance, or you go straight to the changing room?

U We go straight into the changing-room. We are always late. If we can we stay a little bit here after the class if the other parents and kids, but it really depends. Sometimes we have something to eat here and some other times we come back for lunch so as soon as we are ready, we leave.

R Where do you stay when you have lunch here?

U I most of the times bring some sandwiches and we eat them here. Last week we were here and it was sunny outside, so we stayed at the tables out there. It also depends what time is it and if they are available because sometimes, they are full of students and there is not so much room for us.

R Could you move to changing room? Which one do you usually use?

U Yes sure. Well we go to the women. We are mostly mum bringing our kids.

R Did it happen there was a father as well?

U No, it happened only once that a mum couldn´t bring her daughter and that time the father came. And he used the other locker-room.

R What do you like of this changing room?

U I like the light. This is not common. It is a special light and makes the space more comfortable as well. It helps to relax both before and after the class.

R When you prepare XX for getting ready, do you stay here, or you go in the small cabins?

U We stay here with the others, I go there only if he needs to go to the toilet

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R What about the space and the organization of it? does it work well with you?

U Yes, yes, there is good space.

R Is there something here that makes the thing easier for XX?

U XX depends a lot on me. Because of his handicap, he cannot do anything on his own. Also because he is young. For me it's like having three children instead of one. It's a bit easier here than at home because there's so much help. I don't use the lift because I don't need it, but for me it's very good here because there's a lot of space and above all it's very good because there are a lot of other people and we try to help each other.

R Let's move to the swimming-pool. Do you keep this wheelchair for the swimming-pool?

U Yes, we keep this one and we leave it at the entrance in the corner. It is small so it doesn´t take so much space

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R Do you enter in the water with XX? How do you enter? Do you use the ramp?

U Not always. It depends on the activities and it depends on XX. Sometimes he is ok to go alone, sometimes he wants to have me with me. I put him on the edge, I jump in the water and then I catch him

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R Do you use the round swimming-pool as well?

U Yes, after classes we go in the other pool. It is really relaxing. I like the temperature in there and XX lies on the surface. Once he even fell asleep.

APPENDIX 10

R How many times you use this facility and for which kind of activities?

U I use it a lot. Every week, both Thursday and Tuesday. I try to come by two times a week, when I have swimming courses.

R Do you or did you use other sport facilities?

U Now, only this one, but I've been to a lot of. Yeah, yeah.

R Do you see any big difference between this one and the other where you have been?

U I really do and I've been here many times. It's just so easy, especially with my mobility problems

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R Why you say that it is easy?

U It's just really easy for me to get into the water and into the changing room, there is a lot of space so it's easy to get around. I think it's very ideal for handicapped people sometimes here. And when I am in the swimming pool I usually stay on the ramp where the level is not too high and I can walk a bit there, but it is also good for swimming.

R What do you think about changing rooms?

U I like the space, there is plenty of space for us, for the wheelchairs, the lockers, some are lower and easier for me to use. And there are no gaps before the swimming-pool.

R What do you think about the three different changing rooms, the one for women, men and the uni-sex? which one do you use?

U I think it's great that there is this unisex locker room because I go together with my team, me another girl and two boys. So it's great that we can help each other and we don't have to be divided. Yeah. But when I get naked I use the small bathrooms.

R What do you like of the small cabins in the changing room?

U They are easy to use. I prefer to shower in those bathrooms because you can move the shower up and down, while in the shower area they are fixed at the wall. But anyway. Yeah, it's great.

R What about the swimming-pool? do you use both the big and the small one?

U Yes, both. First I use the big one for classes and then I go in the small one for relaxing.

R Is there something that you particularly like or dislike of the space of the swimming-pool?

U I think it's great that the space is so big because then there's lots of space around when you move with the wheelchair, and when we need space, we just asked people to move down. They are all really kind here. But I have one bad thing I don't like in here. When I swim on my back I of course look at the ceiling. Yeah, there are these lines in it, but it's not parallel with the swimming pool, so I always follow the lines and go in the wrong direction.

APPENDIX 11

R Why do you come here in Vandhalla?

U I have a disease. It is something called Guillain Barre syndrome is something where your nerves are paralyzed. I was completely paralyzed for two and a half months. I was hospitalized for a year and a half and I have never heard about this illness so I wrote on Facebook: does anyone know anyone that has had this? and someone wrote to me there was a guy his girlfriend had the same and she had the contact with a project for rehabilitation in Aalborg. So then I wrote them on Facebook. And everything started from Aalborg once a week half hour every day. When I got a little bit better, then we have talked about that I could go three days a week. And it's been so ever since. Fortunately, I can now come here. I do the same things I did in Aalborg but closer to home.

R What's the difference in your opinion between this building and the other ones that you experienced?

U The accessibility in here is great. Even when you get in here, all the windows, you don't feel like you're driving into a box, that is dark you know, you can breath in here, that's nice. And even the toilets, where I trained in Aalborg the toilets, the handles. They were too high, the mirror was too low.

R When you have your activities here, do you also use the changing rooms?

U yes when we go in the water

R I know that there are three changing rooms, the women, the men and the unisex changing rooms. Do you usually use the women or to the unisex?

U No the women

R What do you think about the bathrooms and they changing rooms? Do you think in terms also of privacy, and the use of the lockers, the space for the wheelchair

U I think it's nice and I think it's nice that I can change with all the other ones if I want to. But if I want there are also the individual changing rooms. The bathrooms are ok. I think, to me the toilets are a bit high. I think it would be easier if they're a bit lower for me. For tall people they could use them tall or low but, but when I have to get over there and I can't reach the floor, then it makes it hard for me to take my cloth on again. I use the green one. When I changed my assistant, the first time we were here, she asked me which cabin I preferred to use, and I just told her: the yellow one.

R What do you think about the bathrooms and they changing rooms? Do you think in terms also of privacy, and the use of the lockers, the space for the wheelchair

U At my home, it's not that nice because it's an old bathroom. Here are better but, there are handles and a big mirror. That's just fine. Yeah. And I can use the mirror. It's almost like that when you are disable you don't have to look yourself in the mirror? Of course I need to.

R Do you use both the swimming-pool and the gym?

U Yes, the pool, the big gym and the fitness room.

R How do you enter into the water?

U I use the ramp it´s great, really great. I have never seen anything like it. It's really fantastic.

R How did it work in the other swimming pools? What did you use?

U Sometimes they simply threw me into the pool, while in other places there were stairs and they had to carry the chair up to the stairs.

R Was that ok for you?

U No no. No. And for the girls who assisted me was a lot of work too. Especially when they had to pull me up again.

R When you are inside the swimming pool, do you think that you need something more like more handles? in case you want to move around the swimming pool

U No, as soon as I get into water I can walk

R How is to stay in here? (the big gym)

U It is great as well, really.

R What do you like the most?

U Mostly other people. Here, well, half of us at least are disabled. In other places when I was swimming, I was slow and there were people shouting at me "swim to the other side" and stuff like that. Here no.

R Is there a place around here that you think is your favorite place where you just like to stay?

U Everywhere it is fine. I like both the swimming-pool and the gyms. I think when you move around here, you could almost sense that people like being here. It's like, you know, a good karma. Yeah.

R I see, but why do you think you have this feeling? It's mostly because of the other people?

U Yeah, but also the building as well. If it was, you know, just a little concrete box, that would have affect me badly, I'm sure. I think it is a very high level place. And I really think it's great. It's nice being here.

APPENDIX 12

R May I ask you tell me a bit about you and the reasons why you come here?

U I had an ischaemia ten years ago. This caused me a hemiparesis. I have been coming here for four years to do rehabilitation and water exercises.

R What do you think about this place?

U I like it, since I started coming here I can see that there have been improvements. Before I couldn't move this side at all, now I can do a little bit. It is tiring but the first years were more difficult.

R You said you had the ischaemia ten years ago and you came here only four years ago. Have you been in other places before?

U No. I mean I did some rehabilitation in a place close where I live. But I got a deep depression and the times I did not go were more than the times I went.

R Are you feeling better now? May I ask you how you decided to come here?

U Yes, now is way way better. But it was a slow long process. I went to the psychologist, my husband helped me a lot. He was the one suggesting me to come here. He came with me at the beginning and while I was doing rehabilitation he went to swim. But now I also go to swim and I do rehabilitation so when I come here I stay a lot of time and for him it is too much time. I slowly started to see some results and of course this was good for me. Now I am fine. I am happy.Yeah, but you know, my life changed.

R I can only imagine, but I am happy to know that now you are feeling better.

What do you do usually when you enter here? What do you do first? you to the swimming-pool?

U No, I do first some fitness and after I go to swim.

R So you go to the changing room and leave all you stuff there?

U Yes, I have my bag here. Sometimes I bring it inside at the gym and after rehabilitation I go to the changing-rooms, otherwise, maybe if I need to go to the toilette, I leave the bag in the changing room and then I come back here after.

R Which changing room do you use? Do you need an assistant to get ready? Is a woman?

U This one. Yes, XX, is a woman

R Do you use one of these cabins?

U Yes, I use the yellow one.

R Do you always use that one? why?

U I've tried the other bathrooms and they could work for me, but the yellow one has everything in the right place for me.

R Maybe we can go first to the gym and then we come back in the swimming-pool after

U Yes

R Where do you have the exercises? In the big or the small gym?

U In both.

R What do you like of these two spaces?

U I do not know. I like to stay here. I think it depends on the days. Most of the times it is really difficult for me and I do not like to stay here, but XX is really good in motivating me. But when you know I cannot do what she asks me or I do not have energies I don't like it.

R Do you mind if other people look at you while you do the exercises?

U No, I do not mind. I don't think about it. No no, I think it is not a problem. I also like to see the others. While I do my exercise here, I see other people doing rehabilitation in the small gym and I feel less lonely.

R So you don't mind to do the exercises here or in the small fitness room?

U Well, when I am here I know I do more funny exercises, so I prefer here. In the fitness room, we work with the machines or you know little movements which are quite challenging as well.

(The user had rehabilitation and I met her after that in the changing room before going in the swimming-pool)

R Are you happy you finished rehabilitation?

U Yes, now is the best part. I like swimming.

R How do you get into the water? Do you use the ramp?

U Yes, It would be impossible for me to sit at the floor level for entering the pool. So, either I enter from the ramp, or I sit on the edge and then jump into the water

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R Do you use also the round swimming-pool?

U No, otherwise it takes me really a lot of time. I usually stay here four hours. if I used the other pool I would never leave.

R What do you like here

U Is a nice place. I like there are the water slides. When I am here there are no many people using it because it is mainly for children, but it is nice to see the tubes going around. In general I like to stay in the water. It helps me a lot.

APPENDIX 13

R We start here from the outside. Do you think it would be possible for you to find the way towards the entrance?

U If I just walk in here I wouldn't really know the structure of this building or find the door. I would just you know, follow straight and find out if there is something. There are these things that you do not know where they are. I have all this limited information because of the things that I cannot see. I could ask the dog to find the door and then she would go looking and find whatever she thinks is a door. Here, I can feel is another space here, the acoustic is also different, so I suppose the entrance should be somewhere here. There is something over our heads that wasn´t over there. It is a nice indication. It is of course indication that it will probably also be the entrance here somewhere.

R How do you think is organized the entrance?

U These doors are like one after the other, right? but could be that often you go in one door and then turn left or right and go in the other door. So I think I mean, these kind of double doors can be made in many ways, but it is always better to have these one after the other. The nice thing is also that it is not a revolving door. Some dogs don't like revolving doors and you never know when they are turning, especially if they are doing it alone. But my dog is used to it because it should be part of dog training. And, downtown, near where I live and where I used to work, there are many of these doors, so if there is a revolving door she follows it. And I, of course, would find it out along the way, but I think these automatic doors are just better and easier for me.

R Now we are inside.

U It is interesting because the acoustic is very different when we are in here. Yeah, it's really, it's not that usual that acoustics is so different. It is good

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R Once here, where would you go?

U I would follow straight. I hear voices from there, Usually, when I hear other people's presence, I go in that direction. I know that I can then take it from there. I can ask, or I can understand where I am from what the other say. Both outside and inside there are maybe shops and you know they exist. You could pass by something many, many times and never knew it there, until suddenly somebody say, "this is the office for something, something" so you can find things by accident, just listening what the other people say.

R Along the corridor on the right there are many doors. Do you think it would be a problem using the cane and having all these interruptions along the wall?

U Not for me, I don't use the cane because I like to walk fast, and she has been trained to walk fast. I don't have to speculate about any obstacles. Every time you walk with a cane, it's just a matter of when the cane stops you before you walk into something. But I think in general doors are better than openings because with openings you could accidentally enter and then suddenly not be in the corridor you were following. Like in Aarhus station, where there are all these openings outside the lifts, but also between the stairs there are openings in the waiting areas. It's also a bit tricky acoustically as well. It's difficult to find your way around.

R what do you think about the fact that there are different systems for the doors? There are some doors that are completely automatic. Some other that have the buttons and others with sensors?

U Consistency is always nice. Yeah. They you can decide what kind of consistency, but I can imagine that it would not be practical to have all those kind of going being automated. I don't know, this door from the outside should be automated that makes sense. But this door should not be automated. I don't know if it is a choice or is it just that was just how they ended up?

R Why you say that shouldn't be automatic?

U I think maybe the doors will pop up. I think that they could have thought that if too many people came close to the door you couldn't go in there. I don't know. But I think automatic is nice but it is rare that you have a setting where all those would be automated. This is of course because we are in this adapted place and it makes sense to have automated doors. So of course, again this may just be kind of accidental that you have to press the button to open the door. We don't know if somebody has made a conscious choice or if it's just like it ended up being that way.

R Where would you think the swimming-pool is?

U Close to the entrance. I smelled the swimming-pool. But I know it is a special area because you can encounter many obstacles. So I would talk to someone and ask them to take me to the changing rooms and explain how the spaces are organised. I would never go here without knowing anything about where I am going.

R In here the floor is pretty clear, there are two benches on wheels that you can move.

U Yes, it depends, usually it is very hard, you go around and you keep hitting your legs so I would say it is a nice thing about having space and moving things so at least you don't hit. They don't hit so hard because maybe you just push them away.

R Do you think it would be possible for you to find your way to the gym?

U No, not the first time. The more we move around the more I get an idea about where we are. After I have been in a place once, it is easier for me, but not the first time.

R Now we are in the corridor where we were before, and on the right you have the doors I told you before.

U Ok, I think one or some of them are open because I hear there is something going on. What are they doing? I hear there is music

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R They are doing yoga. That's why there is this relaxing music. I think you can feel that is a big space, but what do you think about the acoustic?

U I think it is good. I can distinguish different noises pretty well.

R Do you think it would be different if it rained outside?

U Maybe, I don't know. Inside it might not make any difference, but outside when it rains there are fewer people, so finding the school without anyone to ask would be more difficult.

APPENDIX 14

R What do you think about the entrance?

U First thing I see that I like are the windows. It doesn't make a big difference for me. But I have a friend who is completely deaf and she had a bad experience once. She works in the bank and once there was a fire alarm and she was alone in the copy room without any view to the outside. After some time she left her office and saw there was anyone in the building. She got scared at first and then she saw there were people coming to look for her. They told her what was happening and luckily was not a real emergency, but still she got really scared. Since she told me what happened to her I think how it is important to see what is happening from wherever you are.

R Interesting. Is there something else that you like here?

U I like the lights, they show you the way and the colors. They are simple and clear. I feel that I should continue in that direction. I don't know what's there, but I think it's the main way

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R Do you think it would be easy for you to orientate?

U Yes, I like when there are clear indications. Sometimes there are many colors, here it is mostly black and white. I do not know what would be better. The important for me that it is easy. Here the indications are pretty visible.

R Do you usually ask for indications when you do not know where you should go, or you just go and find your way?

U In general I prefer not to ask. Of course I do if I need to, but I think I would feel better if I know where to go without asking. And sometimes there are no people to ask to.

R Is there something you do not like?

U Don't know. I like everything looks fresh and clean, but maybe it is too simple. It would be nice to have some more colors or pictures, something to look at. When you cannot ear, you also get easily bored. I like when there is something that attract my attention.

R This is the corridor that leads to the canteen and the older part of the building. How do you like this?

U I feel we are going in a different area. I like the ceiling is lower here. If I were alone, I would ask myself if I am allowed to come here, because at the entrance with the high ceiling, it seems to me to be a space where everyone can stay, here I feel like I am in a more private area or where there are probably offices. But again, as I said before, it is nice that there are these doors that you can see what´s in the other room. And it makes me more confident that I am not going where I shouldn´t.

R Do you think could you guess how the spaces are organised from here?

U I saw where the swimming pool is from outside, when we entered. From here, I can see the gym here. Yes it depends on what I can see, but that´s for everyone.

R What do you think about the gym?

U It is nice. Nothing to say. What really bothers me in gyms and swimming-pools is the acoustics. Everything becomes more confused than it already is. Now it's hard to tell because there's no one there, but usually when there are a lot of people there it becomes difficult for me to hear someone talking to me.

R From here we can go to the fitness room

U I like this place better, it looks quieter.

R Over there, there is a door, and you can see there is the swimming-pool but the door is closed so you have to come back to the entrance and go into the swimming-pool from there

U Yes, it would be strange to be allowed to enter in the swimming-pool from here. you know, you have to have the clean shoes and all the rest, but it is nice that you can see in there.

R This is the uni-sex changing room

U I like there is some color here and as at the entrance, here too it is clear that the light shows you the way

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R This is the main swimming-pool and the other one is a smaller pool with warmer water.

U I see, again, it is nice that you have a full view. I imagine the acoustic here it is a bit difficult when there a lot of people, especially children playing, but it seems a nice place where to stay.
The lighting here is really focal and selective. It is easy to see the space.

APPENDIX 15

R Why you come here at Musholm?

U I'm a member of Muskelsvindfonden. I also have Muscular Dystrophy. The type called the CMT 1a. I've been in in the foundation since I was like eight years old. That was when I was diagnosed. Now I'm leading some of the courses. I've been volunteering in Green concerts. I do not know if you have heard about them. It's eight concerts, concerts around in the big cities in Denmark, every summer, and that is how Muskelsvindfonden is earning their living as well. This weekend, I am leading the course that it's called parents with Muscular Dystrophy and the partners. So, yeah, it's about having fun and not thinking about that we have muscular dystrophy. And it's mostly because of the kids so they can see themselves in other families.
I have been here since they built it. So I've been here since the beginning

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R The old building you mean?

U Yes, the old side. So I've seen everything. Yeah. I started to come here when I was, I think around 14 and then it was brand new everything. And I was attending in some occasions with other children with muscular distrophy. So for one week, every summer, that was the highlight of the year.

R I would like to ask you some of your opinion about the building. But not only, I would like to know about the accessibility and the usability and the social impact of this building. if you want to just give you your opinion based on your experience

U My experience is that it's all kinds of people who comes here. Because, have you seen the double house? The big double house? Have you seen that? You can stay a lot of people in there.
You see people with Down syndrome, their foundations come here and people with all kinds of disabilities come here. It doesn't matter. You can also come here if you don't have a disability. It is for everyone. Yeah, I think that's a bonus. And you can see the pictures. Yeah, they're trying to show us it fits for everyone, no matter who you are.

R So when you come here you feel safe. And apart from that you have acess everywhere. Do you feel that it's easy to use?

U For me it's a second home, because I've been here from the start. So I feel home every time we come here. I know the people who comes here. Every time we're here for weekend. I know. I know a lot of people. Yeah. I feel safe for sure and all work fine, at least for me.

R To what extent you consider the physical environment of the building in accordance with your needs?

U it's been better it's been improved. In the old part the focus was for people who was in the wheelchair. But for me who can walk a bit, it wasn't very good.
Because the chairs and the tables, the tables are still bad for me. And the chairs are better now, but the chairs I couldn't sit for a long time now. They are pretty bad because they were chosen by people who were in a wheelchair, so they didn't know how it was to seat on them.
The new ones there, you can see that there are different types of chairs, that one you can move easily. And the other one, next to you it is hard. It depends what kind of need you have.
For me the tables are a bit low. And then I have my back. I cannot bend it. So I'm all sitting like this all the time. So for me, they are low. For me it would have been nice if they could, you could raised them. And for many of the people in wheelchairs, they can't get under it. I don know but probably because it was cheap.

R What do you think about this big double room?

U Well, I haven't used much. Because when I was young, it wasn't here. We used to be outside and we had a playground for the wheelchairs and that was it actually. So we just had fun but there wasn't a lot and we thought actually was quite boring. We didn't like it. No, but now it's different.

R How do these bathrooms work for you?

U Yeah, for me they work perfect because they are high. When you use a toilet, even in the handicapped toilets, they are often too low for me. And you have to use the one on the side. I don't know what it's called. Yeah, like a handle. But here I don't need that because the toilette is built high. That's perfect. And, and there are the ones that you can choose how high or low it can go

R What about the aesthetic of the building? Because usually, especially talking about bathrooms, they're not so nice. What is your opinion?

U My husband told me in the car over today, he said, they look like a hospital. Why can't you build it prettier? It's a hotel room. It's an apartment. You can build that in so many ways. But I know it's expensive to make it pretty. I know that.

R Here there are different kinds of bathrooms. What's your experience? Do you prefer one in particular?

U For me. I know I can use everyone because they are all tall toilets. But for others, they choose the one way you can have help to get up and stand. So they took the electric one. so I just I don't I don't use a specific one. Because I can use them all. Okay, I just take the one that's free. Yeah

R What do you think is missing here for people with mobility impairments?

U For me, one thing I think that is missing here is water. Like a swimming pool. I think if it was here. It would be perfect. Yeah. Because when you have a disability, the water is the only place where you have a chance to feel free. Anyway, you don't need other people's help. Yeah. And that is what I'm really missing. Yeah.

R How do you move upstair? do you use the ramp, or you prefer the elevator?

U I have never used the elevator. Because I have the electric chair. So it just takes me up faster if I use the ramp. I hate slow elevators. I hate it because my life is slow enough so for me the faster the better. But I know that for other people that don't have the electric chair it is difficult to come up all over here. So if they want to come here, in the middle level they usually take the elevator and come down from the ramp till here. So, it is easy anyway.

APPENDIX 16

R What do you think about the entrance?

U For me what's important in the entrance is actually the floor. Because if people take water inside, and if you enter and walk, you will fall. That's quite important but also the carpet in the entrance. If it's too soft, it's actually quite difficult to dry that. It can then change your direction. So it's very important for me. Yeah. I mean, that's quite important. Also, it's important that it don't get away. You know what I mean? So we could fall in that. And it's also important for me that the doors can open quite fast. Because if it's raining, you just want to go inside. And then if they go too slow you get wet.

R And what about the reception here?

U I think it's very good because it has, it has different heights. So it doesn't matter if you stand or if you sit. Everyone can use it. Even if you are a little person. no problem. Okay.

R And the pavimentation?

U Yeah. it's just as long as it is dry it is perfect for me, it's perfect. But as long as somebody drops something, it's very important they clean it right away. Otherwise I will fall in.

R And the space that you have for moving with the wheelchair?

U When we are a lot of people over here, this will be set up. Otherwise there won't be this. This this would be gone. I think when we are many people. The space gets too small. If you have five wheelchairs on that side, it will be a problem to get back and forth.

R What about the furnitures?

U For me they're just on the way. But for other people who needs a break when they walk, they're perfect. But it would be a lot smarter if they were put in the wall so that this floor didn't get a couple chairs. This looks pretty, but you can fit three wheelchairs here. But you can stay you can get across to each other there but no It will be a lot smarter like in the window you know you can make a bench in. That it would be better for me.

R Is there something you do not like or it difficult to use?

U The problem in Musholm for me is actually the long halls. They are too long for people who doesn't have like a mini scooter, a wheelchair or something. But you can borrow one for free if you need it. The thing is that you need to book them.

R What do you think about all these different bathrooms?

U There are two bathrooms that I usually use. This one is good for me, because it is a bit higher. But there is space only in one side. So it is not perfect, because I need space on both sides. There is one there which is better for me.

R Do you like the aesthetic of the bathrooms?

U For me You can make that a lot nicer and I know it has to be all the gray and you see all these tubes but I know it's because you can move it back and forth if you need. So it has to be practical also. But for me it would be nice if it's like incorporated in the wall for somehow and it has the same color as the wall and then won't be so obvious.

R How is your bathroom at home?

U Not like that. No, we've built our own house. So we made it with a high toilet. So I don't need all that kind of stuff and handles. And our sink just has the same height all the time.

R What about the door? can you easily open it and enter?

U For my wheelchair, it can be difficult to close the door behind me. Usually, when I enter other bathrooms there is no way for me to close the door. Here there is enough space to enter, turn and close the door.It takes a lot of room for the floor. That is that could be an issue. Another problem is the toilet paper. I don't understand sometimes in handicapped toilets you cannot reach it, but they have put it on the handle instead. That's also an issue often. How can you make it in a smarter way?

R We could go in the main room now. Do you use this room often?

U Yes, when we have big meetings, we stay in here. It is quite hard to sit at the tables because you have to turn your head all the time. But if they don't put the tables in a certain position, there won't be room for everyone. So you can't have like when you're in school, and you sit like and when you look in the blackboard, you can't sit like that. But how can you make that more effective? Because, the disposition of the table is like this and the stage is there, you have to turn your head at a time to look. Or you have to turn your wheelchair and sit without table. Yes. because either you have a table and you can't see or you can turn to see and don't have a table right?

R Do you know if these benches here are used?

U I haven't actually seen anyone else except the kids to use it. Okay because it's very low. It isn't that tall. But it's definitely because it's hard to walk up so is there for a break? I think, but I would never use it. I like this handles in the side though.

R And what about the turning spaces? Like here? There is a quite big space for turning.

U Yes. is perfect for me. I need a big space. I don´t turn when I am on the ramp, but I can do here where is flat. But It takes more than one maneuver. It is ok. Back and forth back and forth. Like in the car. But for me, it doesn't have to be any wider.

R What do you like about this room or this building in general?

U For me the most important thing about about a place like this is when you don't feel like you have a disability. Because every time something doesn't work, you feel disabled. Yeah.

R Is there a place or a room where you prefer to stay?

U I don't know, because I just stay where other people are. I don't know there are certain things but one of my issues outside actually are the tables and the chairs are extremely heavy. We stay a lot outside when there is good weather, but you cannot move them, unless you have a good physic so if you want to seat it in a different way, and you have to move the table then it's a problem. I cannot move the chairs, but I think they've chosen some heavy chairs and tables because of the wind. So it's either heavy chairs or no chairs sometimes.

R And how is the acoustic here when there are many people?

U Is very good. Good. Very good. Yeah, very, very good and the sound is awesome. Because the sound is very important when for some people in a wheelchair because sometimes they won't be able to see they have to lie down or something. So the sound is very important. It is to understand what is around still without seeing.

R We could go to the canteen, the restaurant

U Yes and you can see those tables over there are smart for people with a wheelchair because the legs are in the center of the table. But none of them are that smart because you can't make them higher or lower. And you can actually do that in some way so you can't sit. You could do it in a pretty way. And the chairs also, they are actually comfortable to sit in, but they're still heavy to move. And for some people you look they can't move the chairs backwards, because they need to have wheeled back in the other room where we started. There was some of them that had wheels. Yeah. Yeah. But the bench is actually quite high. So that's a plus.

APPENDIX 17

R I would like to know your general opinion about the building, but also what makes the difference for you staying here and playing here than in the other buildings that you probably experienced.

U Yeah, I mean the biggest difference that this is all connected because this thing is the biggest upside for us that we live in a place to sleep and eat and play simply. Because we played a lot of teams, we have to go into car, travel, like maybe only 10 minutes without the car again and it takes a while and if you go to the toilet, that's the toilet. But when we're finished simply that's really convenient for us. I recognize that something special, but for me it's like moving around my own house. I got used to it. But I mean, the good thing about it is the more I can use this probably because there are no obstacles. Like everything is just like a free flow is easy to go around. The biggest problem is basically that the doors do not open fast enough, you know and that's a small one. That's not a problem. And then that's the only thing you can do. Everything else is just like perfect.

R Here you say that also what makes the buildings special is that it is all level free and at the entrance there are some different kind of textures and different change of the material, from the parking to here inside. Have you never experienced any kind of problems with the wheelchair?

U No. I think it is about the cost of materials and opportunity. It is also a decoration thing I guess. The grass that needs to go around could make your wheels dirty. But you keep going to continue even though whatever the weather is, which is nice is not a problem at all.

R Here the reception there is this different hights for the table. And can you say something about it?

U I mean it's nice that I look them in the eye if you want to talk with them I guess that's why they done like that. There are many wheelchair people or smaller sits lower and they're standing people right? They can look the receptionist in the face and communicate properly if they take the lower portion.

R What do you think that there are always some stuff on that part?

U Doesn't matter to me. I mean I guess it needs to be somewhere. Yeah, it's just like this where it is okay. If it was up there it would block even more the vision for me at least. Over there, I can look over Yeah, because they're the receptionist. Yeah, I didn't know also I can see products if I need to buy some. or me it is not a problem. I could still do it. It is still functioning. Yeah. And if it's a problem, they can just move it.

R I see, you seem a really practical person

U I'm actually not that practical person. It is like this place. It's a practical place for me. Yeah.

R Is this an important space for you socially wise?

U Yes, of course, but it is not why I am here. The purpose of being here is to play. Yeah, mostly. We have such a good relationship with everybody here.

R What about the chairs and little tables here, I don't know if it's a problem but having furniture along the corridor, is it a problem maybe when you are with other persons?

U Yeah, no problem. Is it just a little bit nicer, it doesn't seem like it. If you remove them then there is too much room or institutionalized. So they tried to make a normal place, which is like the nice thing. I think the things that I like about it is it's both usable for people like me, but also for people like you. And I watched them once in a while and they look pretty and I guess that's the purpose. I mean, we could go around

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R And here the bathrooms. There are several bathrooms. Each one has its own characteristics. Do you use a specific one everytime?

U Yes, I use the same one everytime. You know it is just because my habits. I use the one in the changing room, because nobody else use it, but that is the only reason. They are all really practical. These two are a bit ugly though. They are old, and everything is not that integrated. And I mean a disabled bathroom also works for not disabled even though it looks different. But, I know it's also difficult to hide the helping things. Yeah. Because there are actually there if you want good helping it's then maybe you cannot camouflage them in good design, necessarily. Yeah, I mean, if we do toilette like this, I guess exactly my point would be first of all it needs to work, because although that doesn't, it's not suitable for the disabled people. And then of course afterwards you have the nice material and you hope to get it look as neutral as possible. So if you just pick something because it's pretty and then it does not work it's like the worst.

R The doors for the changing rooms are automatics and the other one no. But, you said something about the automatic doors before?

U Yes, they open really slow.

R Do you use the changing rooms?

U We usually use the other one or we don't use it at all. Because I change in the room and I shower in my room too.

R I imagine that you experienced changing rooms in many other places, right?

U I experienced a lot of bad changing rooms. They are almost always quite small and there are always things in the middle that you need to go around stuff like that, because there's no seating opportunity. And then here is not I mean, this is all placed around. And we need a lot of space, 24 wheelchairs and all the equipment. we also have all the bags. Here I think that everything could fit, but in other changing rooms usually when we want to change we have to take a lot of the chairs out in the hallway.

R What´s your equipment?

U Wheelchairs, sport wheelchairs and then we have a back pack with extra wheels and also a lot of stuff, like our clothes

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R In terms of bathrooms, what is your experience around different countries. Do you see a big difference?

U Main difference is that there's plenty of bathrooms here. Which is good for many reasons. maybe there was one toilette, okay? And you have to be in line or whatever. Probably always uglier, but usually works just as fine. But that's only one that's going to be a big line and then people are going to have to use the regular ones, which can be a little bit tricky. And you need to know a lot of people have sometimes, we have tournaments with other teams we don't feel like disabled because you don't have to wait for the toilet, you do not have to be in line or look for bathroom just like the bathroom that you used to go. You don't have to think about it because it's just there. There's just so many of them.

R And here the gym hall. When you use this room are there some kind of fences around here or it's open like this.

U Yes, it is open like now.

R And, how is the acoustic here?

U Oh, I guess it's okay. Anyway, you have to yell even though there is no audience, right? Like, what was its name? Olympic gym in Vancouver, where there are ten gyms within a gym and at the end you cannot hear your mates really well. Even though there is no background noise. But in here is fine. I guess that's about the acoustics, but I never thought about it

R Do you like the ramp?

U I mean, it's quite nice. If you have more than one level, it's not going two levels. It's one of those moments. Want to take this session so you can go through without taking elevators all the time which is nice.

R Do you usually use the ramp or the elevator?

U If I have to go upstairs and I'm like tired, then I use the elevator. It's nice to have the opportunity to move around freely up in the ramp. It is a bit rougher. So it's not hard to go up but it's not easy. All the way at least. A lot of people here have electric wheelchairs so it doesn't matter. I like that you can move around freely. Here you can pick your own spot.

R What is your experience of this room?

U I like a lot to be here. It is a beautiful gym. It is a pleasant place to stay. We use a lot of time in here. And it's not, it doesn't feel like you got lousy school gym or something like that. It's nice to be here. It's relaxing. It's pretty. Another thing it makes it if you sit here, and I guess the acoustics. the wood and the light. Light is good in here like outside. And normally have the opportunity to shut the light off.

APPENDIX 18

R We could start from here and then you could go inside and have a tour. Have you never been here?

U No, I've never been here, but I know something about this place. A friend of mine came here for a concert last year. It was a while that I wanted to come and see it.

R How do you imagine it is inside? What would be your expectations?

U I know that it is a good place and it is very accessible for me. From outside it also looks nice and new. I like this little movements of the floor. They are funny. I can see from here that there is a nice ramp. This makes me think all the spaces inside are accessible and I will not have many problems. Every time I go somewhere new it is always a big question mark. It's also a bit stressful, because you know that somehow there will be a problem, a situation I may find myself in, I have to ask someone. You know, that kind of thing. Especially if I'm alone, it's very stressful. Yet I manage to walk a bit, so it's never anything impossible.

R Then we can go inside and see what it looks like. This is the entrance, what do you think about it?

U Very beautiful. The first thing that catches my attention is the ceiling. I like it when there is not the usual ceiling. Then the wood makes a nice effect, it's very pleasant to look at. There's a nice light, the skylight above that little table attracts my attention as well. Of course, I'm happy to see that the reception is lower here.

R Yes, they did this and also the coat hanger here in double height.

U That´s fantastic. It might sound stupid, but it is frustrating to have to ask others to do things I can do very well by myself, like hanging up my coat. In general, it weighs heavily on me to have to depend on people for everything. You feel like a child, you know? So having the chance to do something independently is a great thing.

R What kind of problems do you encounter most in other places? Maybe in sports facilities especially.

U Mainly stairs, gaps, yes. And as I told you, I can walk a little, but still doing the stairs is difficult for me. And anyway, once I've done the stairs, I still need someone to carry my chair up the stairs. The toilets, those are not a problem because in public places you can always find accessible toilets, but they are not really nice you know. And you always feel like a second-class person because then you see the other toilets that are nicer and better.

R From here we can enter in the main hall, is a multi-purpose hall where they usually have sport activities but also big meetings, conferences, and concerts

U Yes, I saw some pictures on internet, and my friend told me about it. Now I see the ramp, yeah yeah, really nice. Again, I really like the wood in here. The ceiling looks dynamic. I feel like swinging and moving to see the play of light and shadow.

R Do you do any sport activity?

U Yes, I swim.

R Where do you go swimming? How is the pool where you go to?

U I go to the Bellahøj swimming pool. it is very nice.

R The other case study I am looking at for this study is a swimming-pool called Vandhalla. It is in Jutland, close to Odder, it is really nice because it has a ramp that goes into the water so that you can enter with your wheelchair. Do you know it?

U No, ok. That sounds fantastic. I never heard about it. No, in Bellahøj there are no ramps. There is one outside, that goes in the yard behind, but not for the water. I would love to try though.

R How do you enter in the water in Bellahøj?

U I leave my wheelchair on the side. I walk to the, I do not how they are called, where you jump in the water, I sit there and then I push myself and jump from there.

R I see. Yes, this is the multi-purpose hall and this is the famous ramp. What do you think about the ramp?

U When I have my manual wheelchair, it is more difficult to go up the ramps, but the thing here I like is that the seats are not on the way, otherwise it would be impossible for me to get around them while pushing the chair. It is a long ramp but you can stop whenever you need both with and without wheelchair. I like the pavimentation, it looks like the lanes where you run. The race ones. I like the light too. Because if it was all dark it wouldn't be the same. What are these spaces for?

R Along the ramp there are these balconies where you can do different activities, there is a video room, a place mostly for children where there is a balls pool, and there is the last balcony over there where you can be hooked to the rope on the ceiling and go to the other side of the room.

U Ah, yes, I saw that on the pictures on Internet. This is also a really nice spot. It is not really easy to see the sea from here though.

R No, from here we can take the elevator and we can go down where the toilettes and the changing rooms are

U You see? also the elevator is a right one. It is big enough, I think that two wheelchairs can fit together and also the numbers are no over there, so I can reach them you know. Great. Yeah Yeah

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R Here there are different bathrooms. Of different size and with different support. Do you have any preferences on the type of bathroom?

U No, not really. Well, of course it needs to be big enough so that I can fit with the wheelchair. In case it is not big enough I can stand and walk in, but I am more confident if I can bring my wheelchair with me inside. I need a lot of support, yes. and I do not really like the classical white ones. They are really cheap and look like hospitals, I know that is how bathrooms for handicap are, but they look really bad. What I always check in the bathrooms is the alarm system. It happened to me once to fall in a toilet. There was the thing to pull to call for assistance but it was high up and I was on the floor. so I couldn't reach it. Now we have mobile phones with us and we can call with them, but when this happened, was many years ago and we didn't use phones. Anyway, one could feel really sick and not have the ability to use the phone, but just pull a cord. But it should also be reachable from the ground, because if you feel sick, most of the time you are on the ground, for one reason or another

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APPENDIX 19

R I will not take up much of your time. I would like to take a quick tour of the building to see what your experience of the space is, if there are any features here that facilitate your activities and why. First, if I may, I would like to ask you a little bit about yourself, why you are in a wheelchair and for how long?

U Yes no problem. I'm in a wheelchair because when I was 23, I had a car accident, so that was 15 years ago now. and I've been in a wheelchair since then. That´s the long story short.

R I imagine that for 15 years your life has been quite different. What challenges have you faced in relation to the built space?

U Eh eh, in this case it is difficult to keep it short. Practically everything. Yes life has changed, of course, I used to do everything very quickly, but that's also why I'm here. Since the accident everything is very slow, everything takes time, everything needs help. From a certain point of view it's not bad, I always have a good excuse to be late, but yes, it's not the same.

R Is this your first time in this building?

U No, we often do meetings here, at least two or three times a year, I know the building well, I know it is special or how you want to call it.

R Now that you have a break we could go inside the main hall and have a tour along the ramp

U Yes

R Is there something you particularly like about this space? you said earlier that this building is special, what makes you think it is?

U There are many things. I like that there are no problems with levels. Outside the floor is a bit uneven, but once inside I feel the floor under my wheels is very smooth, and I like the ceiling that is not smooth and is nice to look at. Actually I can't see much of what's around me, the ceiling is one of those few things. I know where I am by the kind of ceiling I see. I like the roof at the entrance and of course this one here. Yes, really like it

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R So you use the type of ceiling as a sort of wayfinding?

U Yes, you could do that, but yeah, I've been here many times, and I do not always keep my chair reclined, only when I get back pains so I know what I have around, but now I also associate it with the type of ceiling

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R But this happens in all buildings right?

U Yes yes, but here at least there is something nice to look at. Usually I only see white ceilings or dazzling lights

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R What about the spaces. Is there enough space for you to move around in a wheelchair?

U Yes, there is plenty of space, perhaps the only place that is a bit tight is the restaurant, especially when we are there all together, we have to get organised to move around because if we all do it together we get stuck. No, it's never happened, but there are a lot of us with wheelchairs, even bulky ones, and then there are the tables and chairs, and maybe you have to do some manoeuvres around and you can't see what's behind you. There can be a bit of confusion in there but otherwise there's plenty of space.

R What about the acoustic?

U I think it is good, yes. Do not know. Never thought it was a problem at least. They almost always use the microphone as they do today. Never had problems listening at the meetings

R I see now your break is over and you probably have to come get. May I ask you a general opinion of this building?

U I think it is a really good building. It is clearly different from other buildings. Many people with disabilities come here, have meetings here, or stay for holidays or something. Which is good. It's very nice that there are places like this. But the bad thing is that there are so few of them. I'm sorry that we have to come here all the time because it's one of the few places that we know we can stay here without problems. This is not a right of choice. Also, when I come here, I look around and there are mainly people in wheelchairs. It could almost seem like a ghetto. But absolutely nothing to say about the building. All I'm saying is that they should all be like that, does it makes sense?

APPENDIX 20

R Maybe we could go a little bit further so I can describe you a little bit how is the space. It's a parking where there are some different kind of texture that I don't know if you can feel the difference

U I did yeah but , you know, parking spaces always also could be a difficult place as you know, they are big space, maybe only with asphalt line so the first time you might be or if there are no things to navigate along, you know, it could be very difficult to keep straight.

R Now we are on asphalt and if you go straight you'll probably feel that there is another kind of material.

U Yeah. there are changes, a kind of stone.

R Can you identify the way for the entrance with the change of textures?

U I'm not sure that I would be able to be sure that it is that way. But you know, more like in this situation, I think it would be helpful that the pathway to the door that there is something on the floor to go along from here to the entrance.

R Yeah, because there is a difference in the pavement. But there is a continuous line of stone. So probably from here, it's not possible to identify actually, where is the access.

U It seems like there was a short moment of stone and then we are on some asphalt again, right, I feel like there are too many different surfaces, I could easily get lost out here, but the edge between the asphalt surfaces is really good for finding my way, it just takes me a while to figure out where to go.

R Now on the right and on the left, there are sponsors flags that are not usually here. And in front of you, there is the entrance. How automatic doors work for you?

U It's fine. And as long as they are sideways, they're not dangerous and you will not walk straight into them if they were open like this, here, they're just going like, yes from each other. Did they go that way, it would be more dangerous. Oh, and if that's the case, the wider the space between doors the better. So let's say if that door would open this way. And that order opens this way here, you know, there would be very close together. Whereas if the distance were bigger, and it won't be that dangerous that the doors are not opening sideways. And also the dimension matter, when I am with someone. Because otherwise you had to go a little bit backwards and then maybe, you know, you are half a step behind and your partner so you don't bump into the door. The wider are the doors the better

R So we can enter right here.When you enter here where would you expect to find something like a reception?

U It could be organized in many ways, but some kind of straight ahead are helpful.But that's not necessary. Anyway.But usually people who sees someone with the white cane they are good at making themselves known or ask Oh, what are you looking for? So nine out of 10 people will ask me

R From the acoustic of this place how would you imagine this space?

U I think it is pretty good actually. It's the sound is pretty dead you know. There is actually an okay sound in here. It seems that the ceiling is not that far above my head. I don't know how far the wall ahead of me is or to the right. You know, it could be far away overthere because the ceiling is not that high and makes it feel very okay. But my initial feeling is that if we turn left, there are plenty of room over there but not to the right.

R We can turn left then and go straight

U There is nothing on the floor? I feel there is something going on here, maybe here there is the reception or something similar.There is some kind of carpet. Carpets could be a way of leading someone along giving you direction. Also because often there is a conflict of having textures and different kind of materials on the floor for people on the wheelchair, and carpet could be like a good opportunity to have a guide on the floor without being like a trouble for wheelchairs. Yeah, anything on the floor that could guide you along you know, is good. So, I think that the material for me is not that important. So and the materials, our ways of doing it are very important for wheelchair users you know, then you know, if you could combine it in a way that is a material they could live with and something that guides me along then have a good compromise. Yeah but carpets are in many ways no problem if they are not all over the place. Like if the floor here is you know just flat, then it doesn't lead you anywhere. So, the idea is that you have different material that could lead you along and even let's say that you get an idea of you have to go straight and when you meet a new surface or new material then you know that you are on your right way. But the best thing is that there are materials on the floor that lead you to the useful direction.

R This is a quite big room. it's a triangular room. On his widest part it's like seven meters and here it's more or less four meters and it's 10 meters long. Now there is a big table in the center that usually it's not there it's for the buffet. So if we go straight, then we can turn and go to the corridors that goes to where the changing rooms and the bathrooms are.

U Yes it turns right here, right?. That's quite easy to find. Because I walked along the reception, then still there is a wall to your right. And you will probably sense that there is something that tells you to go to the right. I use it as a personal mind. I'm noticing this then I need to focus on turning right in the next step or two steps that I have to turn right otherwise I could follow this one as well. But that gets stuck in the bookshelf than it seems like the sound is changing a little bit to my right. Okay. It is a pretty wide space as well. The entrance.

R Now we are in the corridor. Is there something that you can perceive differently from the entrance?

U Yes, the sound, the acoustic is very different. You know. It's not like before. Maybe the ceiling is higher here. Which is good because I know I am in a different place, but it would be a bit difficult for me to say where I am exactly.

R Yeah. The ceiling here is higher. I would say four meters, three meters and a half for sure. And if we go on along this corridor there are two chairs and a small table along the way.

U Things you need to be aware of because I think the example we were talking about. It is actually a very good example of why something in the middle of the corridor could be nice to walk along. Yeah. Because if you're using the wall on that side, then you will probably use that because you have to keep right okay. Then you would meet, you shall meet an obstacle, whereas if I had been in the middle of the road, there is nothing to fall into, I would have past them without even noticing. Yeah. So, the wall is a good path finding but not so good when stuff have been placed along the wall.

R There is a long line along the corridor on the left side, they initially thought that it was a good guideline, having the water here, but then they decided to close.

U It seems a bit dangerous if there was water, I would imagine. but it is actually a very good pathfinder because there is a different sound to it. Yeah. And also with a different feeling. But for that, in that sense, is more by coincidence.

R If you keep walking along the corridor, where would you go or turn?

U I would turn right here. I think that what matters more is the fact that suddenly, there is no wall anymore. So the sound from whatever disappears, it won't come back to me. But as I'm far away from it over there, the sound coming back to me is not that clear. It's much clearer from this side, I can really feel okay, here there is something very close to me. Whereas there's something away from me over there. So following that to distinguish between the sound that comes back to me when there is wall and when there is no wall as the corridor opens. I need to get the sound of my footsteps or touching the floor with the cane.

R The door on the left is the one to the changing room. We could enter here so that you tell me what do you think.

U It is good that there is this space before actually entering in the changing room. For me, you know and I don't have the exact knowledge of what to expect but still you know, being traveling all over the world having experienced the hundreds of changing rooms You know, there are certain things you might experience you know, things like this, where you have a little space so that the people changing inside are not exposed. So I would expect something like this, that when I get in here, I probably have to, at some stage turn left or right, you know, to get outside of the door and then turn again, you know, to get things like that.

R so here we turn left. In front of you there are the lockers. How do you usually recognize your locker?

U Usually I would take the one closest to the wall. Or if that was not free? I would say the next one maybe or that one and then I would remember it is the third one from the wall. Yeah. But in this specific case, I can feel that there are some very big numbers, but usually I do not go around touching the walls and look for something. Now I would rather wonder where are the benches to take off my shoes.

R Benches are along the wall on the opposite side, behind you.

U Ok, that´s fantastic. It is not good to have them in the middle of the room. If you think about wheelchair accessibility, you know, they can go straight through, and I don´t risk ripping. So, this is really good for me too. There is a place for sitting, but the benches are not on the way. Are really dangerous. Here there is different tactile impression you know. Yeah and things like that. usually suggest water somewhere

R Yes, here is where the showers are.

U Yeah. And I do think also having something on the floor will be good like to give you the information that there is like a change for example, like in this case that it's a big change that from like a dry side to the wet one. There's nothing on the floor to indicate that we are in the showers, but I've noticed that the wall here has tiles and tiles usually suggest water, which is a good information for me. Well, there is also the fact you know that usually when you come to places like this one, there will be people around. And, and after the fact that you could ask them, you will also usually hear the shower running. It's not as certain organizer because there might be no one.

R Now we are back in the corridor. Here there are many bathrooms, in different sizes and with different kinds of supports. How do you experience the different dimensions of bathrooms?

U The bigger is the bathroom the more space to discover it. And I do not really want to touch around when I know I am in a bathroom. So, the smaller for me, I think the easier it is. Still that could be a big room to discover but for a small toilet it's quite obvious where things are. Obviously you have to check out where is the toilet you can often hear banging against some things.

R From here, we take the door in front of us and we enter in the big gym.

U Very good acoustic as well. Which material they use?

R There are wood panels on the wall and on the ceiling as well

U It sounds really good.

R Okay, now we are on the ramp that goas all along the building.

U I like there are handrails and the handles are the same we have at Høje Taastrup. They do not become cold or anything

R Is there something you can easily perceive here and which makes it easier for you to navigate?

U The ramp is just so cool. I feel there is a different pavimentation now. The same there was at the entrance, and another one that was on the ramp. I see that now we are back where we started.

APPENDIX 21

R I would like to ask you what´s your general feeling of this building from the outside.

U From the outside I think I've already had a sense that this is working better than other buildings. Parking for disabled people are all in front of the building, and I think that's a good thing. But maybe I would like it to be a bit more mixed in a way that every third parking spot is for everyone, for instance, because it's like, all of a sudden, you're giving a VIP treatment because you're having a disability. And I think it might be a little too obvious.

R How do you expect the spaces are organized inside?

U I don't know where the office spaces are but I would think that are somewhere here on the left, while the main space is the big one to the right. It is clear this is the main entrance, the building on the right is the main space and, on the left, there are probably offices or other functional spaces Dimensions are different, the materials are different and I like it makes this kind of V shaped and that means that you know where to enter. Yeah, it's nice to have kind of overview of everything you can have here from the entrance as like what I like is that you can see all the good thing you can experience here. You can have an understanding while you enter. I know that this is where I have to go inside because the other buildings sort of lead into this entrance because they're forming like a triangle.

R So now we can enter.

U I see this line. It's looks sort of like an art installation. But it also says, a practical purpose, you know to walk into that door. Buildings made for disability have straight lines on the floor So yellow or red, or whatever, and I think it's too much.

R And what about the reception and the environment here?

U it's obvious that this reception area. Yeah, I have no comment. I think it just works. I like that when you come inside, you have a feeling that you're sort of in the middle of everything. Yeah, it's a central spot.I saw when I entered where the gym is. I can also see on my left there is a dining room and a corridor probably leading to the changing rooms or similar. And I like there are windows on the door and I can see what is happening inside there, also I can see that behind the door there is the gym. Usually, there are doors, and I don't know what's behind them. Here, I can look through the glass and see who is inside.

R So from here, we'll move over to the changing room to the bathroom. So whatever you want to tell me about the corridors, the space, the windows, the lights, and please come.

U How do you know where the changing? There are no signs. If I'm a bit late and I'm thinking, Oh, I'm like where am I going? So Maybe it wouldn't be natural for me to go into that way. It is not like for example at the airport, that it is clear where the toilets are. Here I feel like I am going in the wrong direction.

R These are the changing rooms.

U It looks great, and new. The benches look good.

R Yes, they can also be moved up and down

U Cool, and I really like that are not in the middle. Classically changing room would look differently, maybe there would be a bench here. And you would have something to hang up, it would be sort of more benches in rows. But I mean, this of course, if you think about wheelchair accessibility, you know, they can go straight through, they don't have to go around anything and they can go straight to the benches. And I think it's really nice. And for me, if I'm sitting like this, and someone is sitting on the other side of the bench who couldn't communicate, but like this, If I'm sitting here, and someone is sitting on the other side we can communicate, and

I have a clear view all around what's going on. Because if I would sit over here closest to the entrance I would be sort of surprised when people enter because I cannot either ear or see them. But if I sit here, I still have a sense of Okay, someone is coming in. I have some sort of distance. And if I were to talk to someone who's still in the shower, I can actually sit here and I can see them in the shower and we will be able to sign to each other.

R Do you like the layout and how it is organized?

U Yes, I think that whereas you can have the visibility of everything, but still having different spaces and kind of privacy also is fine to me. And also some safety places.

R From here we can go to the main big room and take the ramp

U Again, it is nice you can see what's going on in the other corner. I like that visually. Where am I? What's going on the other side? I can see where other people are and where I am.

R How do you like this room?

U I like it, but I think it's a bit boring that the wall and the floor has the same color. But I still think that this is a nice room, but the only thing is that the colors are a bit too small. Everything just flows together. I do not why but I prefer this side than the other one. I think you have to get used to in a way that there are two gyms that somehow can be combined. I mean, I think it surprised me a little bit that it's, it's very two different experiences being in those two points of the gym. Maybe because from here I have that sense of openness all around. I mean, for me it always good to see everything, for example if my kids are playing outside I can just keep an eye on them and always have this sense of where people are. I can see the game, but I can also see if someone is coming, or I can check my children playing outside

R Now we are back from where we started, and over there there is a dining room for the restaurant.

U I don't have any comments it looks good. And the way I get I, I do understand that you have to prioritize to know who gets to view and then the kitchen has to be on the other side, other side because the guests now have the view. And I guess that's the way it is when you have to accommodate guests. So yeah. Maybe also because it's quite easy for supplies to be delivered right off the driveway. So I think so. Yeah, there's a reason for most things.

R What is your general feeling about the building? What were your expectations?

U I think what I liked the most is that you're actually not reminded that you have a disability while using these spaces. Of course, there are some things you have to have, I mean, a toilet where the sink can go up and down and some things you need to have. But apart from that you're not sort of reminded that you have a disability. I feel like normal being here. Actually, there's nothing special for me that everything is the same for everyone. I think it's really comfortable.

APPENDIX II

ARCHITECTURE AND DISABILITY: A QUALITATIVE STUDY OF THE INDIVIDUAL EXPERIENCES OF PEOPLE WITH MOBILITY, VISUAL AND HEARING IMPAIRMENTS IN SPORT AND LEISURE BUILDINGS

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INTRODUCTION

The spatial experience of a person is unique and influenced by characteristics that belong to both the person and the environment. The user-environment relation that occurs every time a person carries out an activity within a spatial setting is the result of a dynamic interplay between personal and environmental characteristics. On the one hand, each person perceives and relates to dimensional and sensory spatial qualities according to individual kinaesthetic, visual, tactile and auditory abilities. On the other hand, possibilities of user's actions are dependent on the way the space is arranged.[1] The design of the architectural features of an environment might either allow, suggest and facilitate or forbid/hinder users' activities.

The combination of the individual abilities of the person and the design of the architectural features of the environment affects and qualifies the spatial experience and therefore the personal assessment of the built environment. When the design of architectural features is responsive to personal characteristics and necessities, the environment facilitates and supports user activities. In this case, the user qualifies the spatial experience positively. Contrarily, when the design is not responsive to user's needs and the demand for performing activities exceeds the abilities of the person, the environment is experienced as a barrier.[2] In this case, the user experiences a condition of disability and the quality of the space is negatively assessed.

With the aim of identifying the architectural features that better support activities of persons with mobility and sensory impairments, it is necessary to articulate the dynamic user-environment relation through a systematic investigation, which involves individual and environmental factors and their reciprocal interrelations.

This paper presents a qualitative study that investigates the individual spatial experiences of users with mobility, visual and hearing impairments, while they carry out activities in Sport and Leisure Buildings. It interrogates how users relate to the built environment, specifically focusing on how architectural features facilitate users' activities and contribute to enhance their personal perception of buildings' usability.

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THE QUALITATIVE STUDY OF THE INDIVIDUAL SPATIAL EXPERIENCES: METHODOLOGY

With the aim of systematically investigating the user-environment relation, the study employs a newly developed analytical model (Figure 3). The model draws upon the theoretical concepts of *affordances* and *usability*. For the purpose of this study, the concept of *affordances* has been defined as the architectural features that suggest and support users' activities. While *usability* is defined as the personal assessment of the extent to which the environment supports social and physical individual needs during an action performance.

The model offers a structured way to address and analyze the complex interactions that occur while people with mobility, visual and hearing impairments perform activities within an environment. The analysis evaluates specific architectural features in relation to the user impairments and their personal assessment of usability. By linking the analysis of these interactions with the aspects of usability it is possible to advance the understanding of which architectural features support the active participation of people with mobility, visual and hearing impairments and how these features affect the overall usability of the building.

In fact, the use of the developed model allows to evaluate how architectural features - materiality, dimension, organization, lighting and acoustic - influence the personal user perception of physical and social criteria of building's usability - safety, cognition, body fit/low effort, comfort/wellbeing and social relevance.

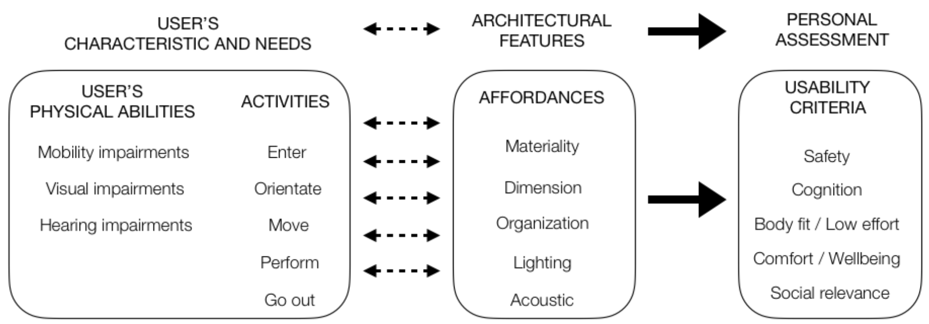

Figure 1 The Analytical Model for the assessment of user-environment relation

The qualitative study has been carried out through non-participant observations and video-recorded semi-structured interviews. Users were observed while they engaged with activities in order to identify inclusive design solutions and understand how these influence users' behavior. Interviews, on the other hand, collected detailed and qualitative descriptions of individual spatial experiences under the first-person user perspective. The study involved 12 users, of which eight users with mobility impairments, two blind users and two deaf users.

Interviews and observations have been carried out in two selected case studies. These are contemporary buildings that implemented innovative approaches for an improved inclusion of people with physical and sensory impairments. The first case, *Vandhalla* (Odder, Denmark), is a sport, rehabilitation and water training building, which has been designed by Force4 and CUBO architects and completed in

2009 as an extension of Egmønt highschool (Figure 1). The second case, *Musholm* (Korsør, Denmark), is a sport and conference facility, designed by AART architects and completed in 2015 as an extension of a holyday residence (Figure 2).

Figure 2 Vandhalla

Figure 1 Musholm

During the interviews, users with different abilities were asked to describe their activities within the facility: the access into the building, the orientation as well as the use of bathrooms, changing rooms, and activities rooms. Questions were prepared for collecting information about:

1) which architectural features, do users with mobility, visual and hearing impairments interact the most while they carry out a selected activity?

2) how do these features support their activity by affecting one or more of the considered usability criteria?

The analysis of findings gathered from the non-participant observations and the semi-structured interviews allows us to articulate the diversity of spatial experiences and gain information for identifying the architectural features that best meet the needs and expectations of individuals.[3]

THE INDIVIDUAL SPATIAL EXPERIENCES OF PEOPLE WITH MOBILITY, VISUAL AND HEARING IMPAIRMENTS: FINDINGS

The way users perceive and experience the space contains information about how their needs and expectations are fulfilled and, therefore, how they can be better addressed for supporting and facilitating physical and social activities. In what follows, the users' personal perceptions and assessments of spatial experiences are presented for each usability criteria defined in the developed analytical model.

Safety

The users perceived the two buildings studied in this qualitative study as very safe. From what all the interviewed users stated, this is mainly due to the fact that both the buildings have wide and clear spaces where to easily move without physical obstacles and with multiple and level free openings to outside. Although safety did not appear as an issue for the buildings studied, two users with mobility impairments and one user with visual impairments explained how room dimensions and spatial organization can influence their perception of safety.

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During the interviews at Vandhalla, the two users with mobility impairments referred to possible problems in relation to lack of sufficient manoeuvring spaces when rooms are crowded. One of the users with mobility impairments stated that "*in the dining hall, it can be difficult to get out all together after we have morning session. It gets pretty crowded, so I imagine it could be a problem in case we have to evacuate quickly*" (Figure 4). Two wheelchair users and one user with walking impairments, when asked about their perception of safety during their activities, mentioned the presence and the distribution of bars in the swimming pool. The possibility to grab the bars and support themselves at the entry to the swimming-pool does not only make the access and the use of the pool safer, but also allow some persons to access independently without the assistance of another person (Figure 5).

Figure 4 Vandhalla - dining hall

Figure 5 Vandhalla - swimming pool's bars

During the interviews at Musholm, one user with visual impairments explained how the possibility of finding obstacles or not perceiving the steps while walking could be very dangerous. He described his concern with tripping over something while walking: "*if I am walking alone and there are things along the corridor like seats, low lamps, etc, then it can be dangerous if I do not catch them with my cane*".
Stairs are another source of danger for blind users who may not notice their presence. In Musholm, the long ramp that connects the ground floor with the first floor is interspersed with seating areas that are integrated within the thickness of the wall (Figure 6). Along the same ramp, the stairs are located on the side – not along the path. In addition, the stairs zone is clearly marked with different material, which is timber against PVC on the ramp (Figure 7). Furthermore, each step is marked and made more visible and perceivable with a strip in a contrasting color and texture.

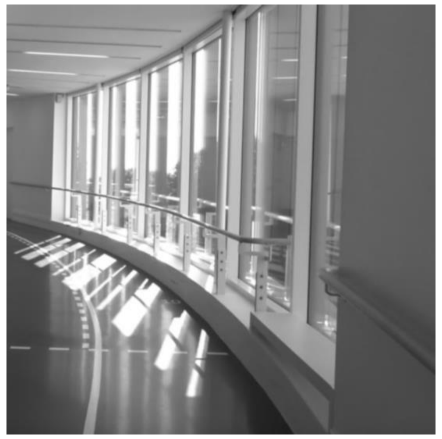

Figure 6 Musholm - seats along the ramp

Figure 7 Musholm - stairs on the side of the ramp

Cognition

The interviews showed that spatial cognition is a crucial aspect mostly for users with visually and hearing impairments.

During the interviews at Musholm, blind users explained how spatial dimensions and organizations might for example suggest directions and facilitate spatial navigation. One of the blind users stated that "*the good thing of corridors is that I can easily move from A to B without getting lost many times*".

Another blind user explained the importance of identifying the shower area inside the changing room, stating that "*the presence of these tiles usually suggests me the presence of water*". In Musholm, this is easily possible due to the change of wall finishing materials, from plastered to tiled wall. This change informs the user about the transition between dry and wet zones and therefore facilitates the identification of the shower area (Figure 8).

Any other graphical or tactile element may also improve the cognition of the space and facilitate the use. For example, the presence of tactile numbers on the lockers' doors allows blind or visually impaired users to perceive the numbers by sensing through fingers and to identify the right locker (Figure 9). One of the blind users stated that "*usually, I start from a point of reference, like the wall, and I count the lockers. I know, for example, that mine is the third from the wall. But here I do not need to count*".

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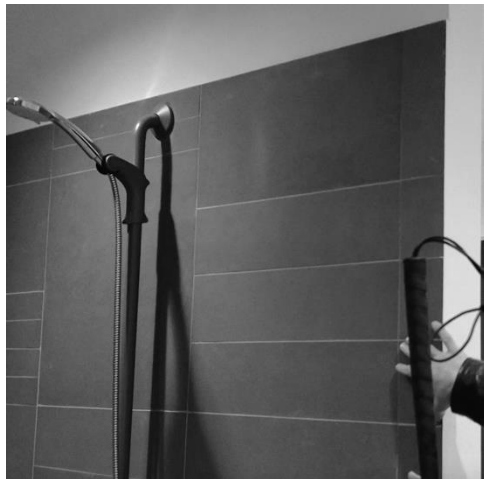

Figure 8 Musholm - tiled wall in the shower zone

Figure 9 Musholm - raised tactile number

Interviews with hearing impaired users showed that architectural features such as the materiality, the organization and the lighting of the space enhance visual connection and contribute to improve the spatial cognition. In Vandhalla, multiple transparent openings around the large gymnastic hall allow users to be aware of what is happening inside and outside the room (Figure 10). For hearing impaired people who communicate with sign language or lip reading, it is important to have a lighting without glares to clearly see the interlocutor. In both the investigated buildings the balance between artificial and natural lighting is provided by skylights, openings, and distributed artificial lights (Figures 10, 11, 14, 15).

Figure 10 Vandhalla - transparent openings

Figure 11 Vandhalla - natural and artificial light

Body fit and low effort

An innovative inclusive design solution adopted in Vandhalla swimming pool is the raised edge of the pool (Figure 12). This rise, which is of variable height along the edge of the pool, facilitates the transfer from/to the wheelchair and allows users to go in and out from the pool independently.

Both in Musholm and Vandhalla, bathrooms differ in size, layout and fitted equipment. Lockers are located at different heights and showers are equipped with support handles on both the right and left sides. Users can choose the bathroom or the locker that fits better with their necessities. All the interviewed users with mobility impairments explained that the presence of at least one bathroom which fits with their needs allows them to use the bathroom without the need for assistance. In Vandhalla, within the changing rooms, bathrooms have different dispositions of the toilet, the sink, the shower and the handles. One user with mobility impairment stated that "*I always use this bathroom, because the handle is on the right side, which is the part of my body where I have more strength*". In Musholm, an electronic wheelchair user explained how important it is to have a bathroom that is large enough to enter and maneuver with her wheelchair, which is considerably larger compared to the manual one (Figure 13).

During the interviews, users with visually and hearing impairments did not mention any issue about the physical fit between their body and the environment. And yet, all the users with mobility impairments who had been interviewed explained how dimensions and proportions of occupied spaces can greatly influence their activities. Interviewed users described their physical impairments and explained how different spatial dimensions and equipment distribution, like doors width or furniture high and location, are more responsive to their personal needs.

Figure 12 Vandhalla - swimming pool's raised edge

Figure 13 Musholm - big size bathrooms

Comfort and wellbeing

The materiality, the lighting and the acoustic are the features that users have referred the most when asked about their perception of comfort and wellbeing. However, it was difficult for users to clearly explain how these features influence their perception of comfort and wellbeing. One user with mobility impairments, at Vandhalla, stated that "*As soon as you enter you see that it is a good place to be, you feel there is good karma*". Another deaf user, at Musholm, stated that "*I see that something good is going on here, but I do not why*".

Wheelchair users motivate their perception of comfort with the possibility to choose between spaces of different size and organization. The possibility to choose which bathroom, locker or shower to use, as

described the above sub-section of *body fit and low effort,* makes them feel more comfortable. In the activity rooms, such as in the swimming pool in Vandhalla (Figure 14) and the gymnastic hall in Musholm (Figure 15), all the users, regardless of the disability, appreciate the natural/artificial lighting balance and the controlled acoustic, which improve their feeling of wellbeing and make more comfortable for them to stay and perform in the room.

Figure 14 Vandhalla - swimming pool

Figure 15 Musholm - gym hall

Social relevance

Design solutions that express equity and inclusion are important added values, which are recognized and appreciated by all the users, regardless of the impairments. In Vandhalla, all the wheelchair users referred to two design solutions: the access ramp to the swimming pool and the presence of unisex changing rooms. The ramp provides direct access to the water for wheelchair users. Due to this ramp, users do not have to use mechanical aids such as lifters, which are considered very embarrassing to use for all the wheelchair users interviewed (Figure 16). Another solution adopted in Vandhalla, which highly accommodates the needs of users who require assistance, is the presence of unisex changing room situated beside the single gender-dedicated ones (Figure 17). Users could in fact have personal health requirements or mobility challenges for which may require assistance from relatives or care givers of a different gender. This solution of providing the unisex facilities empowers users by leaving them the choice and avoids uncomfortable and embarrassing situations for themselves and for the others. One user with mobility impairments stated that "*I do not like to be naked in front of others, especially if they are men. In this way I am sure that in my changing room there are only women*".

Figure 16 Vandhalla - swimming pool's ramp

Figure 17 Vandhalla - unisex changing room

DISCUSSION

The research findings presented allow to make some considerations about the initial questions:

1) which architectural features, do users with mobility, visual and hearing impairments interact the most while they carry out a selected activity?

2) how do these features support their activity by affecting one or more of the considered usability criteria?

The interviews showed that, in the user-environment relationship, depending on the type of impairment, some architectural features are more relevant than others in supporting and enhancing users' activities. Due to the lack of certain abilities, users experience the environment by making full use of what the environment can offer them for performing the activity. Architectural features which are often used and designed by architects for purely aesthetic reasons, here are analyzed as *affordances* which contribute to facilitate users' activities and thus influence their perception of building's usability.

Users with mobility impairments

The activities that users with mobility impairments can perform in the environment are very dependent to rooms' size and organization. Limited body strength or the use of mobility aids such as wheelchairs, walkers or canes require the need for supports, larger spaces for maneuvers, level free accesses and solutions that can facilitate transfers to and from wheelchairs. Level free floor and accessible heights are considered by users as minimum requirements for accessibility. Specific dimensional and organizational solutions, such as the raised edge of the pool and the presence of bathrooms with different layouts, greatly increase the users' perception of body fit. The possibility to choose the space/room that best suits their needs – above all the possibility to carry out activities independently – increases the perception of comfort. (Figure 18)

USER'S PHYSICAL ABILITIES	←- - -→	AFFORDANCES	➡	USABILITY CRITERIA
Mobility impairments		Dimension		Safety
		Organization		Body fit / Low effort
				Comfort / Wellbeing
				Social relevance

Figure 18 User-environment relation - Mobility impairments

Users with visual impairments

Users with visual impairments experience the environment mostly through tactile and acoustic cues. These cues give them important information about building's organization and functions. Tactile cues are perceived by blind users, not only through the touch but also through the feet and the cane. Change of floor materials can inform users about directions and building's different zones and functions. In addition to this, the use of materials with good sound absorption allows blind users to better perceive the conformation of the space and the type of activity in progress.
Materiality and logical spatial organization support the user for a better spatial cognition and therefore an increased perception of safety and comfort. (Figure 19)

USER'S PHYSICAL ABILITIES	←- - -→	AFFORDANCES	➡	USABILITY CRITERIA
Visual impairments		Materiality		Safety
		Organization		Cognition
		Acoustic		Comfort / Wellbeing
				Social relevance

Figure 19 User-environment relation - Visual impairments

Users with hearing impairments

Because of the lack of acoustic cues, hearing impaired users need to establish and maintain eye contact with other people and with the space around. This allows them to get information about the circumstances that are going on in the building. The use of transparent materials and clear spatial organizations improve visual connection and allow them to see what is happening within the room, but also in adjacent rooms. The lighting of spaces should avoid glare or shaded areas in order to facilitate different types of communication used by hearing impaired and deaf users, like sign language and lip reading. The improved cognition of physical and social circumstances, which are given by the visual connection and a balanced lighting, makes users more comfortable in staying and performing their activities. (Figure 20)

Figure 20 User-environment relation - Hearing impairments

Regardless the impairment, the perception of comfort and well-being is subjective and influenced by individual and external variables, like moods, presence or absence of other people, weather, temperature, and so forth. The feeling of comfort is mostly described as a pleasant perception through all the senses, which make the user perceive a good atmosphere.[4]
Finally, any design solution that aim to empowering users' independency and dignity has a great influence on the perception of social inclusion. These solutions, in addition to facilitating and supporting users' activities, reflect the architect's intention to embrace and improve inclusiveness alongside with spatial accessibility and functionality.

CONCLUSION

Different individual kinaesthetic, visual, tactile and auditory abilities imply different ways of perceiving and using the built environment. Although spatial experiences are unique and based on personal expectations and perceptions, the qualitative study showed a relationship between the type of impairments and the architectural features that most influence the spatial experience and the personal perception of building's usability.
A further collection of users' spatial experience within the developed analytical framework will widen the understanding about how users with physical and sensory impairments relate with the environment and how architectural features can be better designed for supporting users' sport and leisure activities. This knowledge will give new contribution to the theoretical understanding of the design for the inclusion and it will also provide guiding principles for architects and designers for the design of physical settings that better fit with the variety of users' necessities and expectations.

AKNOWLEDGMENTS

This study is part of a PhD research project that aims to develop new design strategies focused on improving usability of Sport and Leisure Buildings for people with physical and sensory impairments. The research project is funded by Innovation Fund Denmark and Bevica Fonden in collaboration with Force4 Architects.

Experiential Design – Rethinking relations between people, objects and environments

Florida State University, AMPS, Architecture_MPS
Tallahassee, Florida: 16-17 January, 2020

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User-Environment Interaction: The Usability Model for Universal Design Assessment

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Abstract. Universal Design (UD) aims to provide designed environments that allow users to fully participate in all kinds of activities. Especially, the design of Sport and Leisure buildings should support and encourage the participation of mobility and sensory impaired people in any physical and social activity. Yet, the variety of physical and social users' needs calls for different approaches to investigate, analyze and assess how the environment fulfills users' needs and expectations.

This paper presents a new analytical model that: a) investigates how people with mobility, visual, and hearing impairments interact with specific architectural features; b) links the examined user-environment interaction with the user´s personal assessment of the spatial experience.

The study employs the literature review of the existing analytical models, which are based on the concept of user-environment interaction and framed around empirically deducted basic human needs. These models address the issue of user-environment *fit* by focusing on the identification of environmental barriers. Also, some of these models are too descriptive and cannot inform the practice in creative design processes.

The proposed analytical model, which is built upon the theoretical concepts of *affordances* and *usability,* aims to develop a qualitative evaluation method for identifying environmental facilitators by linking the design of architectural characteristics with the influenced perception of users of the physical and social aspects of the built environment.

The model consists of three groups of elements: (1) users' physical abilities; (2) architectural features and (3) usability criteria. The inter-relations of each element across the groups develop the narrating scenarios that can be investigated from the user's perspective.

This new model does not only advance the understanding of the spatial experiences of persons with mobility and sensory impairments but also offers new insights for exploring UD solutions by identifying the architectural features that enlarge the spectrum of possible user-environment interactions.

Keywords. Universal Design, Person-Environment Fit, Usability, Affordances, New Analytical Model

1. Introduction

While we carry out our daily activities, we always interact with the built environment. Whether it is our home, office, school, supermarket, cinema, or gym, we relate ourselves with physical settings that are designed to be used and functional for physical and social needs. As we experience these spaces, it may happen to encounter difficulties in carrying out some activities. The shelf at the supermarket may be placed too high to reach; the bathroom at the airport may be too small to enter with the suitcase; the stairs to the office may be difficult to climb up. It could happen that some characteristics of the environment do not fit with our physical conditions or with our personal needs. These characteristics are therefore experienced as barriers.

At the same time, spaces can be designed to suggest, support, and facilitate our actions. A glass wall can allow us greater visibility between two rooms; a handrail can support us while we climb the stairs and hangers placed at a reduced height can allow children to hang their coat by themselves. Environmental properties and the design of physical settings play an important role in affecting the way that people perform within a space. Architecture influences and shapes the spatial experience of individuals by hindering or supporting their behaviors and activities.

Furthermore, each person perceives, relates, and experiences the environment differently, due to diverse individual physical and sensory characteristics. A child, an old lady, or a blind person can have a different experience of the same hallway. A child, who experiences the hallway from a lower point of view, might have a reduced visual connection to the surrounding environment. An old lady may probably pay attention to the presence of handrails or seats along the way. A blind person may struggle to find the right way towards the desired destination.

Certainly, most individuals experience and qualify a space according to their visual, kinesthetic, tactile, and auditory abilities. Therefore, when one or more of these abilities is compromised, the individual perception of the space, and, thus, the quality of the experience is also affected. On one hand, the personal physical and sensory characteristics influence our perceptions and interactions with the environment, and on the other hand, the designed features of the environment affect our actions and experiences within it.

For many people with mobility and sensory impairments, participation in sport and leisure activities is often compromised. Because of physical and social barriers that they might experience, persons with these impairments participate less in all forms of sports activities compared to those without impairments [1]. Despite the undoubted importance for people with disabilities to engage in physical activity, most sports and leisure buildings, even if they are considered accessible, do not necessarily influence disabled users´ spatial experiences positively.

Architects usually hypothesize how people are going to use the space and they design solutions that fit with these hypothesized uses and users. However, it could happen that suggested solutions, even if they are architecturally remarkable and comply with legislation, can actually be experienced as not usable by some people, especially when it comes to people with physical or sensory impairments. Instead, architects should find new ways for designing spaces that increase the supportiveness of an environment both physically and socially, especially for disabled people [2].

In particular, the design of sport and leisure buildings should offer spaces that enable and support people to carry out desired activities with satisfaction regardless of their physical or sensory abilities. The design of a built environment that is more responsive to users' needs can help to improve their experiences and thus also increase their active participation in the activities. The main challenge is to better understand how people with mobility and sensory impairments perceive and interact with the built environment and how these interactions positively influence their experience of doing sport and other leisure activities.

Building regulations and guidelines that suggest good practice are often based on objective spatial evaluations, which are limited to quantitative and measurable variables and do not include the complexity and contextuality of the individual-environment interaction. The use of such objective methods, which sometimes do not engage the user directly, makes it difficult to determine how and to what degree space could enhance individuals' activities. Existing analytical models analyze the analysis of the complex user-environment interaction but predominantly focus on identifying environmental barriers. Also, some of these models are too descriptive and cannot inform the practice in creative design processes.

In contrast, the new analytical model presented in this paper tackles individual-environment interplay by focusing on the architectural characteristics that support users with mobility and sensory impairments. The proposed model unfolds individual-environment relations as well as engages with users to assess their personal perception of the experienced interactions with the built environment. Through a comprehensive and qualitative investigation of real spatial experiences, the model aims to identify how architectural features (such as materiality, dimension, organization, lighting, and acoustics) have an influence on supporting users' activities and on their positive experience of space. By collecting detailed and qualitative descriptions of different spatial experiences, it can be possible to inform architects about the influence that architectural characteristics have on users' activities and, thus, about how to design more easily usable and inclusive sport and leisure buildings.

This new model is framed around the theoretical concepts of *affordances* and *usability*. In this paper, affordances are considered here as all the opportunities for actions offered in the form of functional environmental characteristics for the user to perceive and interact with space to perform an action. While usability is defined as the personal assessment of the built environment and the extent to which these architectural features accommodate users' needs and expectations of acting in the space. By linking user-affordances interaction with influenced aspects of usability, it makes it possible to identify not only the barriers but also the facilitators that the environment can offer to users with different mobility and sensory abilities for fulfilling their needs.

In what follows, the paper introduces the user-environment interaction and discusses the importance of investigating the interplays that occur between individual and environmental factors within the UD perspective. Subsequently, existing models for the analysis of user-environment are presented and discussed, articulating the pros and cons of these models in applying to design practice. Finally, a new model, which is built on the concepts of affordance and usability, is suggested to better evaluate, from the first-person perspective, the spatial experiences of disabled people in sport and leisure buildings, and to identify the architectural features that can contribute to improving users' satisfaction.

2. The Role of the Environment in the User-Environment Interplay

Within UD approach, a built environment is accessible when it is usable by any person with any temporary or permanent impairment [3]. When the demand for performing activities in the environment exceeds the abilities of the person, the environment, which is not responsive to the individual's needs, is experienced as a barrier [4]. The interaction between a person with impairments and environmental barriers results in a condition of disability and thus in reduced participation in society [5].

This definition explains disability not as a consequence of a disease but as the result of individual and environmental factors that interact with each other [6] influencing the spatial experience and the participation in any physical or social activity. In this perspective, the match or mismatch between the individual and the environmental characteristics respectively eliminates or creates a situation of disability. The extent to which the environment hinders or enables user activities reflects the degree of disability experienced by the user. Figuratively speaking, disability can be represented as a gap between individual and environmental factors (Figure 1) [7, 8], where the size of the gap is inversely proportional to the extent to which the environmental factors can match with individual factors.

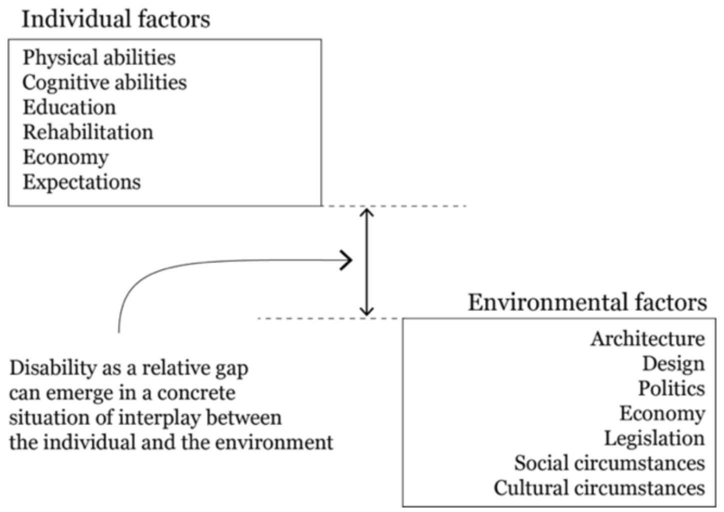


Figure 1. Gap model of disability [8], redrawn by the authors

In recent decades, architects and designers have become more aware of the importance of reducing this gap by designing environments according to their actual uses and users' characteristics. In particular, the attention to the design of accessible environments for disabled people has given rise to various approaches that aim to eliminate the so-called architectural barriers. Within these different approaches, UD promotes design solutions and products responsive to users' variety and complexity [9]. In particular, UD does not focus only on creating accessible environments for people with disabilities, but it aims to create physical and social inclusion for the entire population, recognizing diversity as an added value to be considered and included in the design process.

According to UD, the built environment is considered indispensable and significant for the independence and the wellbeing of people. Furthermore, it is considered as the means for facilitating people's participation in society [10]. For this reason, the built environment should be designed with the aim of not only supporting persons but also accommodating bodily complexity and different forms of physical and sensory impairments [11].

Architectural characteristics contribute to support or hinder participation by offering or not offering users with different abilities the opportunities to act upon. By

accommodating different user's characteristics and needs, specific architectural features offer users with certain abilities the possibility to perform and thus to improve their personal perception of building's usability. When environmental characteristics match with individual's characteristics, users' needs are satisfied, and the environment can be considered usable for performing the desired activities.

The goal is to design "universally usable" [12] environments, which consider a wider range of abilities and increase the possible matches between the individuals and the given environment. But how is it possible to address and investigate the match between the person and the environment? How is it possible to evaluate the extent to which an environment accommodates bodily complexity and individuals' needs? How is it possible to identify the architectural features in sport and leisure buildings which are considered to be the most important by persons with mobility and sensory impairments to better perceive, use and enjoy the environment?

3. State of Art – the Existing Analytical Models

There are several models that evaluate the built environment based on UD approach. These have the purpose to assess how the environment influences users' performance and participation. The sub-sections below present and discuss three dominant analytical models 1) the Person-Environment-Occupation model, 2) the Housing Enabler model, and 3) the User-Built Environment model.

3.1. The Person-Environment-Occupation Model

The Person-Environment-Occupation model describes the relationship between the person, the occupation, and the environment for further unfolding environment-behavior theories and supporting practical guidelines in occupational therapy [13]. The model is based on three elements: 1) the *person*, 2) the *environment*, and 3) the *occupation*.

The *person* is defined as a dynamic being, characterized by qualities and skills, which influence the way the person interacts with the environment. The *environment*, or rather the context in which the person behaves, is also dynamic and characterized by variable aspects that affect the performance of the person. And finally, the *occupation*, which could be any activity performed by the person for fulfilling his or her needs. The *occupational performance* represents the intersection between the *person*, the *environment,* and the *occupation* in spatial and temporal conditions that characterize the performance as a complex and dynamic phenomenon.

The model describes the fit between these three elements as their intersection, where a small intersection corresponds to reduced occupational performance and, inversely, a bigger intersection corresponds to a wider occupational performance and therefore wider participation (Figure 2).

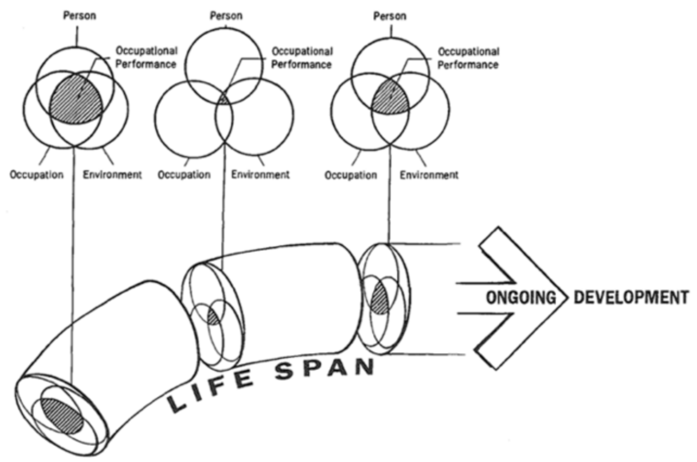


Figure 2. Occupational performance based on person, environment, and occupation fit [13]

This model acknowledges the complexity and the dynamism of the person-environment interplay. It recognizes the changes caused by different personal circumstances and contexts, and therefore requires continuous monitoring to better determine the possible interventions in the built environment [13]. The Person-Environment-Occupation model clearly expresses the condition of disability by representing it as a mismatch of the three main components.

This model considers the environment broadly by including cultural, socio-economic, institutional, physical, and social contexts [13] for identifying and operate on disabling mechanisms. This comprehensive approach provides occupational therapists with important information about the individual in relation to the environment and therefore allows them to intervene in the environment for the improvement of a specific context related to that individual.

However, the environment component is not specified through a description of the architectural features that characterized it. This makes it impossible to directly link specific aspects of architecture with an increased or reduced occupational performance. Without having the possibility to identify the most relevant architectural features, it is then not possible to inform architects about the most influencing characteristics to work with for improving occupational performance.

3.2. The Housing Enabler Model

The Housing Enabler model [14, 15, 16] is a tool for a more objective assessment of physical barriers and housing accessibility. The tool helps to identify accessibility problems in housing and to evaluate their degree of influence on user's performance by following three main steps: 1) the assessment of the functional limitations of the individual (Figure 3a), 2) the assessment of physical environmental barriers belonging to the four main areas – outdoor environment, entrances, indoor environment and communication (Figure 3b), and 3) the calculation of the accessibility score through the combination of the individual functional limitations and the physical environmental barriers (Figure 3c). The main aim of this model is to develop an instrument for

identifying, assessing, and scoring causes of individual's disabilities in home physical settings.

Unlike the previously presented Person-Environment-Occupation model, the Housing Enabler model has a time-limited approach and directly indicates the environmental aspects correlated with the accessibility of persons with functional limitations [15]. The Housing Enabler is a powerful and effective tool for the identification and subsequent improvement of the architectural barriers experienced by persons with different functional limitations. Furthermore, the possibility of assessing the degree of influence that the identified barriers have on users makes it possible to prioritize any improvement. Although it is a good model for the analysis of the relationship between the functional capacities of the individual and the environmental aspects, this model does not allow to identify the features that facilitate user's performance. Also, the model is difficult to apply to other environments than the home.

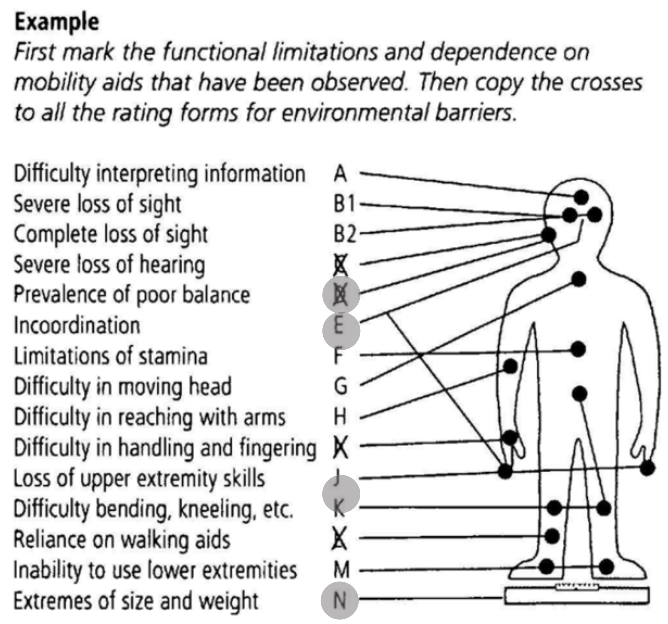
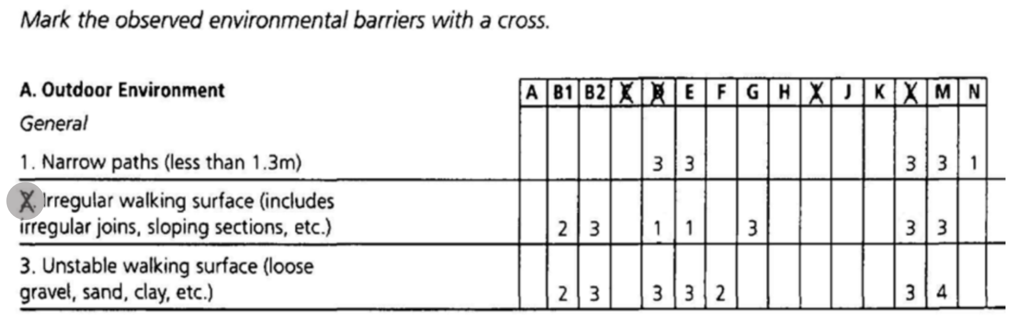


Figure 3a. The Housing Enabler assessment tool – step 1 [15]


Mark the observed environmental barriers with a cross.

A. Outdoor Environment	A	B1	B2	X	X	E	F	G	H	X	J	K	X	M	N
General															
1. Narrow paths (less than 1.3m)					3	3							3	3	1
X. Irregular walking surface (includes irregular joins, sloping sections, etc.)		2	3		1	1		3					3	3	
3. Unstable walking surface (loose gravel, sand, clay, etc.)		2	3		3	3	2						3	4	

Figure 3b. The Housing Enabler assessment tool – step 2 [15]

Then put a circle around the points (1-4) in the squares at the intersections of functional limitations and environmental barriers.
The total of the points is a measure of the degree of accessibility problems.

A. Outdoor Environment	A	B1	B2	~~C~~	~~D~~	E	F	G	H	~~I~~	J	K	~~L~~	M	N
General															
1. Narrow paths (less than 1.3m)					3	3							3	3	1
~~2~~. Irregular walking surface (includes irregular joins, sloping sections, etc.)		2	3		1	1		3					3	3	
3. Unstable walking surface (loose gravel, sand, clay, etc.)		2	3		3	3	2						3	4	

Note. The figure shows only a minor part of the extensive Enabler instrument.

Figure 3c. The Housing Enabler assessment tool – step 3 [15]

3.3. The Users-Built Environments Model

The Users-Built Environments model [17] aims to map, document, and resolve conflicts between users and built environments by relating permanent, temporary, and situational limitations of the user with environmental features during the performance of observed activities. The model is framed around two main components: 1) the *user* and 2) the *environment*. In this model, the *user* is defined based on lists of possible impairments and activities, while the component of the *environment* is subdivided into lists of aspects and elements belonging to the physical setting (Figure 4).

This model offers a framework for describing user-environment conflicts by connecting the variables influence each other. The model is detailed and the lists that specified the components are used as building blocks for the description of real situations of interaction.

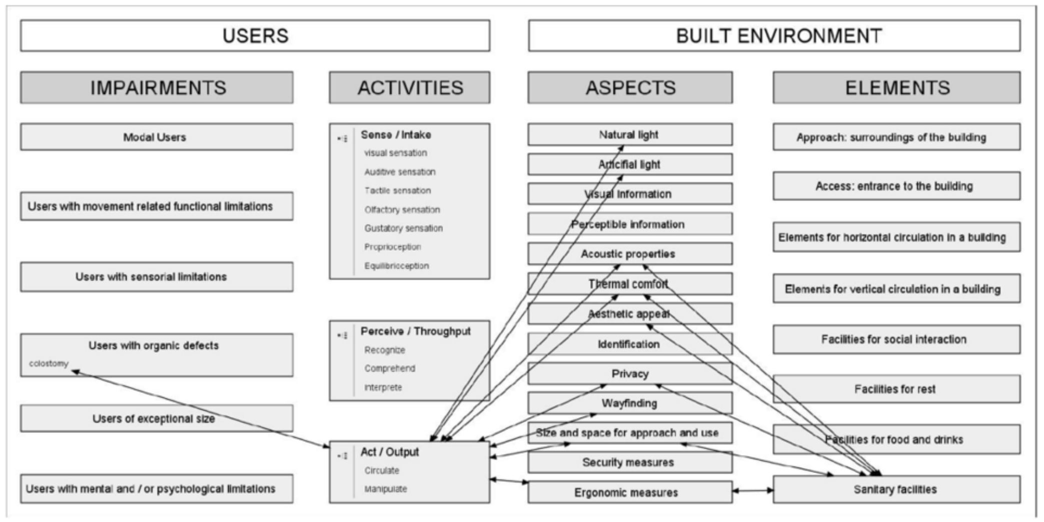


Figure 4. Users-Built Environment Model [17]

The interactions between the variables are mapped by the researcher to show some key circumstances, called *patterns*, that affect a person's activity in a specific environment. The collected patterns are important information for designers to eventually intervene and solve the identified conflicts.

Although this model is very useful for improving the knowledge of the dynamics happening between the individual and the environment, it aims at identifying the disabling mechanisms, and not the enabling ones, which the proposed model intends to investigate. Furthermore, even if the Users-Built Environment model allows to connect all the variables that participate in the user-environment relation, it does not make it possible to assess the spatial experience with a user-centered perspective.

The possibility to understand which kind of positive influence environmental characteristics have on different bodily performances and preferences would only improve the knowledge on how to enhance the user’s spatial experience.

4. Theoretical Bases for the Usability Analytical Model

The new analytical model also aims to investigate the influences of the built environment on user performance and participation. However, unlike the existing models presented above, the new one focuses on identifying the features that contribute to improving the fit between the offered spaces and the users with mobility and sensory impairments.

This proposed new model is built upon the concepts of affordances and usability. As the opposite concept of architectural barriers, affordances are here considered as the functional features the environment offers to users as facilitators for preventing disabling mechanisms. To evaluate these functional features, usability is introduced as the personal assessment of the extent to which affordances accommodate bodily diversity and complexity.

4.1. Affordances

Architecture initiates, directs, and organizes behavior and movement. A building is not an end in itself; it frames, articulates, structures, gives significance, relates, separates and unites, facilitates, and prohibits [18].

In the user-environment interaction, what makes certain behaviors most likely or just possible are in fact the characteristics of the environment, which suggest, allow, and affect the way the user acts into space.

In 1977, in his article *The theory of affordances*, James Jerome Gibson introduced and defined affordances as the qualities of an object or an environment that suggest and allow an individual to perform an action. The term affordances refers to all the environmental features that offer users with certain skills the opportunity to act within that environment [19, 20].

Affordances further strengthen the definition of spatial experience as an interplay between the user and the environment. While we experience a space, the functional properties of the space are perceived by our bodies, and directly identified as opportunities offered for our purposive actions [21]. Within this interactionist view [19], the degree of freedom of action is determined by reciprocal limitations either in the user or in the environment. For example, a window located at 1,20 meters from the floor offers the possibility to look out only to people with a point of view higher than this height. Reciprocal characteristics, in addition to determining the possibility of looking out, also influence the experience itself, making it more or less pleasant for the person who performs the action.

From the introduction of Gibson´s concept to the present, the existing literature presents a vast nuance of attempts to better define what constitutes an affordance [22]. The existing definitions qualify affordances as a relational [23, 24, 21], dispositional [25, 26] and performative concept [27, 28]. In fact, affordances can be seen very much as qualities pertaining to and given by the environment, which, however, must be observed with reference to an individual acting in the same environment.

In this study, the concept of affordances is represented as the intersection between individual and architectural features, where the positive match between users' needs and environmental offers results in the ability of the user to carry on the desired physical or social activity (Figure 5). This representation, compared to the gap model of disability (Figure 1), helps to look at affordances as the opportunity to further investigate and elaborate on how it would be possible to reduce conditions of disability through a design that better relates with the end-users.

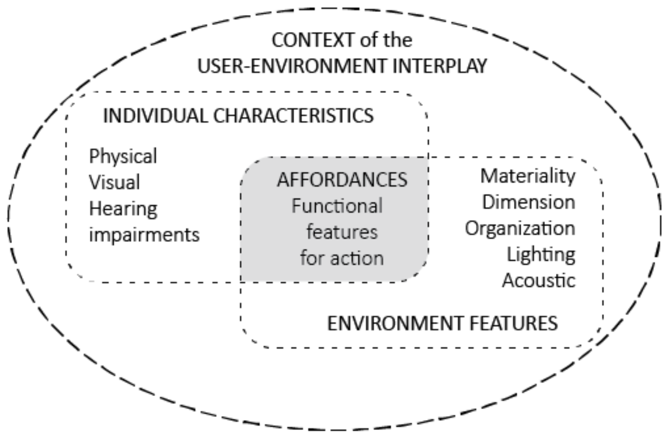


Figure 5. Affordances in the user-environment interplay

Affordances have a strict relation with users and with their physical and cognitive abilities to perceive and make use of the support offered by the environment. Features that are functional to an activity for a user may not be functional in the same way for another user with different characteristics. Tactile numbers on the changing room's lockers allow blind users to touch and easily identify their locker. This characteristic, while results important for users with visual impairments is not even perceived by other users, such as wheelchair users who are more concerned about how high the lockers are located. In this case, the physical characteristics of the lockers, such as their materiality and organization in the space, become opportunities for actions when bodily perceived and experienced by the individual with certain characteristics, skills, and expectations. For this reason, environmental features are experienced, and therefore must be also evaluated, with respect to the functional meaning given by the person who is experiencing them [29].

Regarding the environmental side of this mutual responsiveness, the existing literature suggests that designers have the great opportunity to facilitate positive user-

environment interplays by being aware of how relevant features could invite and support users' physical and social activities in different contexts [30, 31, 32, 33, 34]. For example, the presence of a ramp in the pool allows wheelchair users to enter the water. Although this action would also be possible with the use of lifters, the ramp makes the experience of entering the water physically easier, both for users and staff, as well as it offers more dignified access to the pool. In fact, affordances, in addition to making action possible for a certain user, can help to facilitate the activity, by reducing the physical and mental effort of the person experiencing the space. Most importantly, affordances contribute to make users feel less disabled and more comfortable in participating in the activities.

Affordances represent the integration in spatial settings of what architects imagine are the physical and social interactions of users within the built environment. In this perspective, it is important to consider real users' relevant interactions and expectations, so to able architects to know and translate them into actual opportunities of action.

The following section discusses how the concept of usability can help to evaluate affordances as a litmus test to assess if and how architectural features enhance positive interactions between the environment and the user.

4.2. Usability

In De Architectura, Vitruvius included the concept of *utilitas* among the three principles of architecture: *firmitas, utilitas* and *venustas*. The principle of *utilitas* highlights the importance of architecture to respond to users' needs and underlines the duty of architects to design environments that can actually be used for the intended purpose. UD recognizes the importance of usability and integrates the concept of accessibility with the need for an environment to be not only accessible but also usable, to the greatest extent possible, by as many people as possible [35]. The necessity is then to evaluate this extent, by looking at the quality of interactions between the environment and users and how architectural features support and enhance activities.

The 7 principles of UD (eg 1. Equitable use, 2. Flexibility in use, 3. Simple and intuitive use, 4. Perceptible information, 5. Tolerance for error, 6. Low physical effort, 7. Dimensions and space for approach and use) aim at evaluating the usability of existing environments and products, and intend to guide for the implementation of UD concepts in design practice [36]. However, when these principles are applied in architecture, they are difficult to translate into design guidelines. Also, they do not include the valuable individual interpretation of the spatial, sensory, and social quality experienced by the user acting in the space [8, 36, 37, 38].

The concept of usability evaluates the extent to which the environment is usable by people and how well the characteristics of the environment match with a broad spectrum of physical and social needs. It describes how and to what extent the design of the environment enables operations, performance, and well-being from the user's perspective [39, 40]. Usability evaluates more than building's functionality and accessibility [41] by including a more comprehensive analysis of the supportiveness of the built environment in relation to individuals and their actions. It integrates the component of personal assessment to qualitatively evaluate the influence of the environment on individual functional, sensory and cognitive experiences [42]

Researchers in the design field have proposed different sets of usability criteria with the aim to place value on the less tangible human needs associated with buildings [43], like personal satisfaction and the accomplishment of social needs. Usability criteria are used for understanding and evaluating users' experience and for this reason, they should reflect the wide spectrum of users' needs when behaving in the environment. Some proposed criteria derive from the UD principles [36], some others from the study of basic human needs [44], or simply from empirical deductions guided by professional experience or the requirements of a specific building [45]. What all these sets of criteria have in common is the will to evaluate human-environment relation based on users' perspective and to address users' functioning and personal satisfaction instead of users' disability and activities restriction.

For this study, a set of criteria have been suggested on the basis of the needs expressed by the users during the initial interviews made in the two investigated sport and leisure buildings.

5. The Usability Model for Universal Design Assessment

The aim of the proposed analytical method is to offer a structured way to address and analyze the complex interactions that occur while people with mobility, visual and hearing impairments perform activities within the investigated facilities. This analysis points to evaluate specific architectural characteristics in relation to the users' impairments and their personal assessment of usability.

By linking user-environment interactions with the influenced aspects of usability it is possible to advance the understanding about which architectural features are the most functional to users so to positively influence their active participation and how these features affect the usability of the building in terms of perception, cognition, physical fit, comfort, and social relevance.

The model is structured in two main components: 1) *user's physical characteristics* which include the investigated users' physical and sensory impairments, and 2) *architectural features*, that lists a set of features related to the designed environment (i.e., materiality, dimension, organization, lighting and acoustic (Figure 6).

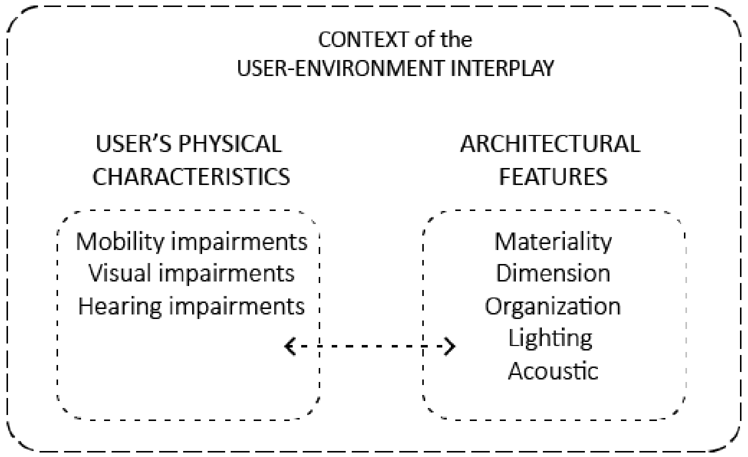


Figure 6. The Usability Model for UD assessment in Sport and Leisure Buildings

The first step is to identify, through interviews and deep observations, with which architectural features the users interact the most while they carry out the observed contextual activity. For example, when entering into the building for the first time, the materiality of the pavement, which leads the blind user towards the main entrance is considered crucial for him/her for finding the way towards the entrance.

The second step, which is also carried out through interviews and direct questions to the user, is to ask about the personal assessment of how, for example, the different materiality of the pavement supports the action and affects the usability. To allow users to express their opinion on usability, the model suggests a list of criteria related to physical and social needs, which have been deductively identified from the analysis of initial interviews. Using the same example, the materiality of the pavement supports the action of entering by improving the user's spatial cognition (Figure 7).

This model can be used for investigating all the activities that happen from the moment the user gets into the building to the moment the user gets out.

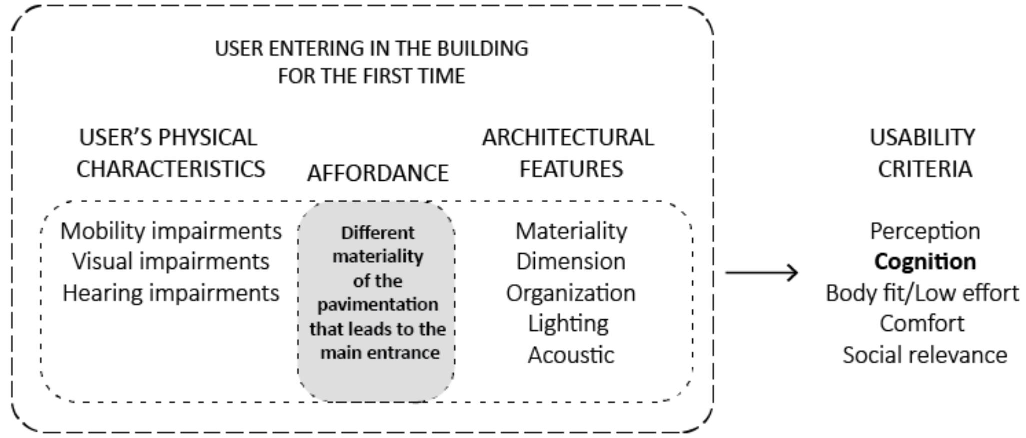


Figure 7. Example of experience investigation

This model connects and displays the interactions between the user and the architectural affordances to the aspects of usability which these affordances have the greatest influence on. Also, the personal judgment on usability is decisive for attributing a positive connotation to the experience. This makes it possible to determine whether the characteristics of architecture, which the user has interacted with, have been experienced as facilitators in their activities.

The information obtained with this analysis has both theoretical and practical implications. On the one hand, the collected information contributes to advance and define the knowledge about the interactions of users with physical and sensory impairments with the built environment. In fact, further information is acquired about how users with different abilities perceive the environment and how they can be supported and invited to physical activity and participation. On the other hand, the collected insights of personal experiences can offer designers the opportunity to experiment and design with architecture properties creatively, being aware of the influences that they may have on users and their participation.

The investigation of different lived experiences, which are qualitatively assessed by users with impairments themselves, offers the opportunity for designers to better understand the functional requirements linked to individual necessities and preferences.

6. Discussion

The proposed analytical model aims to identify the environmental characteristics that support and enable users' physical and social activities. To do this, it collects information on subjective and contextual experiences and links them with the architectural features with which users interact most. It then provides information on how the identified characteristics positively influence the experiences of users with mobility or sensory impairments.

- The Usability Model, unlike other existing ones, offers the possibility to understand how the environment can be supportive rather than just identifying possible barriers. In a UD perspective, architects' main challenge should be, in addition to not designing barriers, also to design spaces that support activities by improving usability and therefore the experiences of individuals. A paradigm shift that encourages addressing spatial experiences of users with mobility and sensory impairments not as a problem-solving process, but as the possibility of experimenting with new solutions that meet the real needs of users and that encourage participation in daily activities and social life.
- The model intends to offer an approach to qualitatively analyze the architectural features that mostly influence the individual perception of building's usability in contextual and dynamic situations. It is acknowledged that physical and social scenarios in real settings, because of their complexity and the variability of the factors involved, are always different and thus impossible to repeat with the same dynamics. However, this approach can offer a rich and comprehensive collection of personal experiences, which brings valuable insights to architects on how to improve architecture so to positively influence users' activities and participation.
- The model can provide architects with knowledge about user's experiences and how these can be positively influenced by architecture. The next important step for the actual use of this model in architectural practice is the synthesis and the representation of this information into a resource that can be used by designers. This knowledge would give architects further awareness about the influences of different design solutions on users' spatial experience.

7. Conclusion

The environment is a crucial and influencing factor in disabling and enabling mechanisms. By better knowing which and how architectural features are able to accommodate, support, and fulfill personal needs, it can be possible to design more supportive and enhancing environments which prevent the experience of disabling mechanisms by users with mobility or sensory impairments.

The presented Usability Model tackles the complex interactions between built environment and persons with mobility, visual and hearing impairments. First, it investigates the interactions that users have with architectural features based on their impairments and their needs. Then, it analyzes how, and under which circumstances architectural features – like materiality, dimension, organization, acoustic and lighting – are affordances for the investigated interaction and thus positively influence the user's personal perception of building usability.

By knowing the relation between impairments, architectural features and usability criteria, architects can increase their abilities to design architectural features that improve the usability for users with different abilities. This will lead to the design of more inclusive built environments, which consider, accomplish, and add value to the wide variety of individuals' needs.

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