



Usefulness refers to the capacity of a particular architecture or built environments to accommodate various users with disability problems. The degree of usability indicates the level of adjustments made due to accessibility reasons.

Usefulness as key parameter in assessing accessibility and usability in architecture

A theorem for explaining a twin concept in the building code

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Abstract

In national building codes, like the Danish and the Swedish ones, accessibility and usability are subjected to an open interpretation on a comprehensive level, supplemented by specified requirements on a detailed level. The aim of the present study is to position the twin concept with regard to its everyday understanding, and thereby suggest a definition. The study has been executed as a case study among a cohort of 370 experienced Danish professionals. The research material was assembled by use of mini-questionnaires. Conclusions derived from this material were synthesized with the respondents' suggestions of exemplary models, which allegedly displayed an appropriate level of accessible and usable architecture and built environment. Based on the everyday understanding of the twin concept and paired with analyses of some exemplary models, this study suggests that accessibility and usability with respect to the user can be seen as constituents of buildings' overall performative capacity. This capacity can be defined as usefulness, the potential sum of various adjustments of an accessible and usable nature. Ultimately, usefulness refers to the individual user's level of independent usages of the particular architectural space.

Introduction

Regulating frameworks, which pertain to architecture and the built environment – here understood as architectural designs for future buildings and town planning, as well as existing pieces of buildings and town planning – have historically been used to define communal obligations for all real estate owners to respect and individual ones, active within a particular property. Towns or densely populated areas have been targeted by requirements that have focused on the physical character of architecture and built environment, like optimal exploitation of the individual site, building heights, delivery of goods to and from the building, safety considerations, sanitation systems and transportation network between buildings or connecting various built districts in towns. In a ranking order, the need of controlling open fire, promoting commerce, imposing fiscal systems and introducing aesthetical orders have guided these frameworks. Spectacular incidents, like great city fires or catastrophes have had a reformative influence on the development of national building codes. For instance the British naval bombardment of Copenhagen in 1807, which promoted the demand on, at least, two exist possibilities from a building in case of emergency.

From the 1970s and onwards, reforms of the Danish building code have focused on the performative quality of architecture and the built environment in relation to users with cognitive impairment or functional disabilities. The building code has a compulsory effect on both private and public real estate owners. In 2007, Denmark signed the UN Convention on Rights of Persons with Disabilities. This resulted in two consecutive reforms in 2008 and 2010 of the building code (Bygningsreglementet 2010, in the following termed BR10). In particular, these changes targeted eight specific criteria for the architectural

design to comply with, in order to promote an increased level of accessibility and usability in architecture and the built environment:

1. Level-free access to all services situated on the ground floor of a building;
2. Level-free access to any services situated on the same floor in a building, and above ground floor;
3. specially designated parking places in front of a building, and with a level-free access for entering the building;
4. in public buildings, access to hygiene facilities that are adjusted to the needs of a person who uses a wheel chair or have special needs;
5. barrier-free access to level-adjusting installations (elevators, lift tables or similar) that are adjusted to a person who uses a wheel chair,
6. barrier-free access to specially designated seats in public assembly halls or similar for people who use a wheel-chair;
7. induction loops (integrated, mobile or wireless) in public assembly halls or similar;
8. legible signage and information for improved wayfinding in public buildings or similar spaces.

In the BR10, the key words accessibility and usability have a tandem function that is intended to highlight the needs of a person with disability issues. The concepts become a twin concept that is to be implemented during the design process of new architectural space or refurbishing old ones. Given their frequent use in Danish language to describe other conditions than those referring to accessibility and usability, these words or their derivatives words occur in several connotations in the BR10: the Danish word for accessibility generated 7 results, while national words for usability produced 4 to 97 occurrences.¹ However, the building code does not supply a precise definition of neither of words. In consequence, accessibility and usability turn into a twin concept that supposedly includes all spatial aspects that are essential with respect to the special needs of people with a disability problem.

Background

The search for the implications of the twin concept has been explored previously by the Danish Building Research Institute, SBI² (Ryhl et al, 2009). This has resulted in a twofold definition of the twin concept:

- Accessibility suggests a dominantly physical entity. However, it is quantitatively assessable.
- Usability refers to the perceived fit between human beings and architecture and built environment. It is perceivable through an intellectual and qualitative analysis of the architectural space that takes into account the adjustable level in architecture and built environment with respect to cognitive impairments and functional disabilities.

In colloquial language, accessibility has become synonymous with adjusting the built environment to people with locomotory problems, mainly people who use a wheelchair. This understanding of accessibility and usability among the practitioners in both private and public employment suggest that the understanding hasn't progressed in the same pace as the reformative work of the building code (Frandsen, 2012). These reforms have evolved from prioritizing functional disabilities, which resulted in physical requirements to respect for architecture and built environment, to include cognitive problems, which pertain less quantifiable entities such as navigating in built space and way-finding. In contrast, the general understanding of architectural quality is still very much in line with the Vitruvian bi-millennial credo.³ This concept is closely harmonized with the detection of human needs and experiences and the architectural design (Rasmussen, 1957). In this thinking, accessibility and usability are a set of parameters to respect during the development of the architectural design.

Attempts have been made to range the twin concept under the roof of universal design, UD. This approach is currently strong in Denmark and Norway, but largely unexplored in Sweden. By applying UD perspective on architecture and built environment, accessibility implies the unconditional making of artefacts, design objects and built space accessible to as many people as possible (Steinfeld, Maisel, 2012). Usability refers to the creation of artefacts, design objects, and built space that to the largest possible extent are usable for people of all ages and abilities (Storey, Mueller, Mace, 2011). However, there is an inherent dilemma with this definition, which has influenced the spread of the idea. The emphasis on making an artefact, design objects or built space accessible and usable for everyone assigns an equal value to any variable in this operation. In addition, UD assumes that, in every situation, in which accessibility and usability are an issue, an optimal solution for everyone exists, and that can be imperatively implemented. The European approach has a less dogmatic posture, and, here, the twin concept is associated with inclusive design or design for all.

A more detailed and human-oriented way of defining the twin concept has focused on the relationship between the particular shape of an artefact, design objects or space, and the individual capacities of the individual. This approach is found in research on the person-environment fit like gerontology, occupational therapy and physiotherapy. This research suggests that architecture and built environment influence human behaviour, which, in turn, is moderated by the individual competence. Hence, adaptive or mal-adaptive behaviours may fall out and result in a sensation of well-being or mere discomfort (Lawton & Nahemov, 1973). In this understanding of accessibility and usability, three important components derive from the interaction between the individual or a group of individuals, and the artefact, design objects or built space: the person's individual competence, the environmental pressure and the activity he/ she is performing (Iwarsson, Ståhl, 2003). Instead of a static definition, the twin concept describes a dynamic relationship:

1. Accessibility can be seen as the outcome of the interaction between the personal component, that is the functional capacity of the individual or of a group, and the environmental component, that is barriers that an artefact, design objects or a built space may impose on the user (Ibid);
2. Usability can be seen as the outcome the interaction between the personal component and the environmental one in combination with the particular activity that the individual user or a group of users perform in the particular type of environment (Ibid).

This approach allows for explaining why individuals, who are familiar with the particular built space, still perceive a measurable lower level of accessibility as usable (Ryhl, 2003). It also accounts for why the mere installation of elevators in residential buildings may influence older people's need of eldercare services (Ekwall, 2005). Hence, accessibility and usability become part of the performative character of architecture and built environment, which are integrated in a measurable architectural quality (Odggers & Samuel, 2010). This notion has also been associated with the Vitruvian credo. In consequence, a quality assessment tool for architecture and built environment has been elaborated by the Royal Institute of British Architects (RIBA), the Design Quality Indicator tool (Gann, D. M., Salter, A. J., & Whyte, J. K. 2003).

Purposes and aims

The purpose of this study was to explore the everyday meaning of the twin concept of accessibility and usability among three cohorts of Danish respondents. The study proceeded from a person-environment-fit definition of accessibility and usability like the one stated above. This understanding is in line with the intention of the new Danish building code, BR10, which make accessibility and usability into integrated aspects in the performative character of the building. The working hypothesis for this study was that the experts' definition of the twin concept that could be further evaluated through a sample of exemplary models of architecture and built environment.

The respondents could be labelled as experts, who were either active in the practice of adjusting architecture and built environment to the plethora of disability issues, or in research on buildings with the intent to produce new guidelines for an increased implementation of the twin concept. In addition to the respondents' reasoning about the appropriate understanding of accessibility and usability in an everyday context, the study aimed at establishing a sample of exemplary models of architecture and built environment that could be analyzed further. It was presumed that this sample, which, according to the experts, incarnated an accessible and usable environment for people with cognitive impairments or functional disabilities, would shed new light on how to understand the twin concept.

Methodology

The study was performed as a multiple case study (Stake, 1995; Yin, 2003), in which the research material was collected through mixed methods, qualitative and quantitative approaches (Creswell, Plano Clark, Gutmann, & Hanson, 2003; Onwuegbuzie & Johnson, 2008). Later, this material was subjected to an analysis that also used mixed qualitative and quantitative methods (Ibid). The research evolved in a sequential manner, in which the questionnaires generated research material for the next step in the research process. In order to triangulate the empirical findings, the study used overlapping research methods:

- Key word queries on the Internet by use of the Google Search Engine
- Three item questionnaires diffused by email to key respondents.
- Expert assessments of the eight criteria of the BR10 and the exemplary models.

The internet-based queries were performed in the Danish language. These were oriented towards finding implemented and realized examples of accessibility and usability measures in architecture and the built environment, and in line with the BR10. The searches also targeted respondents, who worked with this matter in civil administrations, interest organizations or real estate management. In addition, researchers at the SBi were included.

Respondents, questionnaires and exemplary models

The searches resulted in three groups of respondents, all in all 370 respondents. The first group, Group A, was a group of 54 experts, who were employed by civil administration or interest organizations. From this group, 11 persons chose to respond (response rate 20.4 per cent). The second group, Group B, included 7 respondents from a list of 254 national or local real estate companies (response rate 2.8 per cent). The third group, Group C, included 62 researchers at the SBi, of whom 16 chose to respond (response rate 25.8 per cent). All of the members of these three groups received an email with general information about the study and its objectives. A questionnaire in word format was attached to the e-mail. The time for answering the questionnaire was set to a period of 25 days (25th Oct-15th Nov 2012). The questionnaire contained three items about accessibility and usability; see Table 2.

Table 2. The questionnaire.

Item	Question theme	Response rate
1	According to your opinion, what are the most important issues on which to focus when you realize a refurbishment project of a classified building or a renovation of existing built space in order to realize an increased level of accessibility and usability?	100 %
2	Could you mention one or several examples of exemplary refurbishment projects that according to you demonstrate an appropriate level of implementing accessibility and usability in architecture and the built environment, realized between 2008 and 2012?	95 %
3	Could you mention one or several strategies that in the long term could vouch for the implementation of an increased level of accessibility and usability in the existing architecture and the built environment?	85 %

The research material included both affirmative and negative answers, all in all 34 answers. Besides being negative, the 13 refusals supplied a motive for not participating. The 21 affirmative answers were correctly filled-out questionnaires. Out of this number, 19 respondents chose to supply one or several exemplary models of architecture and built environment with an allegedly high level of accessibility and usability in accordance with the BR10. This generated 45 models (Group A: 34 examples, Group B: 8 examples, Group C: 3 examples), of which one was situated in Sweden with a Danish manufacturer, see Table 3.

Table 3. Overview over the sample of exemplary models.

Respondent group	Answers	Public space	Residential use	Work space	Oth. built space	Total
Group A	10	16	9	6	3	34
Group B	7	2	0	0	1	3
Group C	2	2	6	0	0	8
	19	20	15	6	4	45

Table 4. The assessment protocol.

Items regarding accessibility and usability in the BR10.	Score:	Perceived level of accessibility, A	Perceived level of usability, U
1. Level-free access to all units of a building's ground level.	(0-2)	0-2	-2-0
2. Level-free access to other units situated on other floors in the building	(0-2)	0-2	-2-0
3. Parking places in the proximity of the building, and with a level-free access to the building.	(0-2)	0-2	-2-0
4. Hygiene facilities in public building that are adjusted to persons who use a wheel chair or demonstrate other special needs	(0-2)	0-2	-2-0
5. Barrier-free access to elevators, lift tables or similar that are adjusted to persons who use a wheel chair	(0-2)	0-2	-2-0
6. Barrier-free access to specially designated space in public assembly halls or similar for people who use a wheel chair.	(0-2)	0-2	-2-0
7. Inductions loops (integrated, mobile or wireless) in public assembly halls or similar.	(0-2)	0-2	-2-0
8. Legible signage and information systems in public buildings.	(0-2)	0-2	-2-0
9. Individual rating	(0-2)	0-2	-2-0
10. Overall assessment	SUM	sum	Sum

Note: Accessibility: Poorly integrated, in need of adjustment = 0); (adequate/ in need of some additional adjustments=1); (highly accessible/ usable through self-explicative design=2). Usability: Poorly integrated, in need of adjustment =-2); (adequate/ in need of some additional adjustments =-1); (highly accessible/ usable through self-explicative design=0). Usefulness: Poorly integrated, in need of adjustment =2); (adequate/ in need of some additional adjustments=1); (highly accessible/ usable through self-explicative design=-2).

Analysis

The accumulated research material was submitted to a close reading analysis (Brummett, 2010) that focused on the meaning of the discourse (Gunnarsson, 1998; Van Dijk, 1998). In order to render the respondents' answers anonymous, the reasoning in Danish was translated into approximate English with correct grammar.

The questionnaires supplied a conclusion on the understanding of accessibility and usability that was developed into an assessment protocol with eight key criteria, see Table 3. These reflect the paragraphs on accessibility and usability in the BR10.

In order to test the conclusion, derived from the respondents' answers in relation to accessibility and usability, two exemplary models were chosen from the sample of exemplary buildings supplied by the respondents. For comparison, two other buildings, which had received allocations for improving accessibility and usability in the existing built space by the Danish foundation LOA Foundation,⁴ were randomly included based on proximity to the headquarters of the SBi.

Accessibility issues were assessed by an expert (the author) by evaluating the compliance with the stipulated requirements of the building code, and present in the 19 checklists issued by the SBi. Usability issues were explored by interviewing users of the particular building, and, then, assessing the implemented adjustments in relation to other cognitive impairment and functional disabilities. Both types of assessments used a scale of 0 to 2 points, positive scoring for accessibility and negative scoring for usability.

Results

This section is divided into two parts. The first part will address the respondents' definition of the twin concept, and strategies for adjusting architecture and built environment to people with disabilities. This part is a compilation of quotations taken from respondents' answer. These are put in italicized style. The second part will present different types of architecture and built environment that the respondents put forward as exemplary buildings with a high level of accessibility and usability.

Accessibility and usability in everyday practice

The thirteen respondents, who declined to participate in the study, stated a perceived lack of an adequate professional background for participating. One respondent said: *As a layman, I do not have the required competence for correctly assessing the matter* (BI-5).

The respondents, who chose to participate, situated the accurate knowledge on accessibility and usability to the architecture or engineering professions: *The most important thing is to find an architect who has the necessary experiences and understanding of this field of knowledge, and who share the ambition to preserve qualities of the existing space, but, at the same time, integrate a new level of accessibility* (SI-11).

The main asset of these professions was their ability to predict and visualize the spatial implications of an increased level of accessibility and usability in the built environment: *It is important to undertake a thorough analysis of the building's construction and material by use of drawn documentation combined with proper testing in order to define the building's full constructive potential prior to refurbishing* (BI-3). A second respondent concluded: *It is important to balance the legal demands with the potential of the existing building in order to avoid too invasive refurbishment actions* (NI-9).

Complex notion – inherent quality

The respondents perceived the twin concept of accessibility and usability as complex and difficult: *In order to understand the core value of the accessibility, the best way is to go to the United Kingdom or the United States of America. These countries are the best places for understanding the importance of long-*

term strategies for the implementation of accessibility and usability in architecture and built environment. I do not believe that there is any correlation between accessibility and general user-friendliness. Instead, the particular interest has to focus on how financial solutions for people with disability problems can generate universally appropriate solution. This dual perspective makes it possible to generate a financial gain that will promote the solution of the twin concepts simultaneously. This transfers the problem, often costly for either society or the individual, to becoming common problem for all with a shared financial responsibility (NI-8).

The respondents viewed accessibility and usability as an integrated quality in architecture and the built environment: *The projects in which I have been involved have often touched several types of disability problems. One way of increasing accessibility and usability would be moveable walls, an individually adjustable height of kitchen cabinets, and parking space with exterior power supplies for charging assistive equipment. (BI-4).*

According to the respondents, the level of accessibility and usability was defined either during the early phase of the planning-process of a new building, or during an assessment of an existing building's capacity to integrate necessary adjustments: *One has to analyse the adjustments that the particular architecture may include, define the financial level of the adjustments, and circumscribe the envisioned refurbishment actions (BI-6).* In the case of a refurbishment situation, a balance between the twin concept and the existing built space was emphasized: *It is important to respect the architectural value of the building and to integrate the envisioned adjustments due to accessibility and usability reasoning accordingly. (NI-4).*

Remove physical obstacles – create accessibility

The respondents deemed it necessary to adjust the twin concept to the type of building projects at stake, publically owned versus private real estate: *In public buildings, adjustments have to implement a higher level than in privately owned buildings, but the overall goal has to be: the highest possible accessibility for all users, not only people who use wheel-chair but also other people with cognitive or visual impairments. (NI-4).*

Refurbishments were a debated matter: *In my mind, I cannot agree with the idea that refurbishments are subject to special considerations. Even, these projects have to respect universally acclaimed demands on an accessible and usable built environment. But it is also about promoting wayfinding by explaining the built environment with signage, colour cues, or wireless information services. An increased level of accessibility and usability for people with reduced cognitive or functional abilities is vital for a larger group of people that we tend to include in the dual notion of accessibility and usability (NI-8).*

The respondents suggested that accessibility implied the removal of physical obstacles in architecture and the built environment, which challenged the individual physical capacity: *It is my belief that there are several accessibility projects that are never realized due to the fact that the focus has been too concentrated on wheelchair accessibility. It is important to promote accessibility in a more holistic way, so that the existing built environment can be adjusted to both the needs of people with locomotory problems and people who suffer from respiratory problems like asthma, but also to people who have visual impairments, or those with a hearing problem (NI-6).*

While the respondents supplied definitions of accessibility, usability remained largely undefined and vague. One respondent suggested that usability would be the outcome of various accessibility actions: *At its core value, accessibility is about the degree of user-friendliness for each and every one. (NI-6).*

Tools for assessing accessibility and usability

Given the open interpretation of the twin concept in the Danish building code, the respondents reported the need of a special assessment tool for evaluating accessibility and usability in architecture and the built environment: *An internet-*

based assessment tool would be useful, especially in the context of a refurbishment project for which a municipal administration prepares a building permit. In principle, this is a parallel to the new energy limits (BI-6). A second respondent had another idea: *I hope for an anthology that lists extreme case solutions that are somewhat in conflict with the legal demands of the building legislation. The focus should be on performative details of new measures aiming at an increased level of accessibility and usability* (NI-12).

The respondents found the realization of the twin concept was problematic: *In my mind, the overall conclusion is, when it comes to the matter of accessibility and usability, that it is difficult to implement the new and stricter demands of the BR10, since these are not sufficiently integrated in the assessment process for granting a building permit* (BI-1).

The respondents suggested that higher demands on accessibility and usability in architecture and the built environment necessitated public funding and an extended knowledge of the matter in general. One respondent detected the need for a closer correlation between the juridical wording and the conversion into built space, while another respondent emphasized cases of best practice on the matter: *I think the easy removable obstacle campaign in Sweden could be of interest for the Danish situation. Another example could be the British strategy for equal opportunities and building refurbishments that are closely monitored by standardisation. To some extent, this is also visible on the EU level, in particular when it comes to the construction of rail bound infrastructure and other facilities in this area.* (SI-14).

A societal strategy for an increasing accessibility and usability

The respondents emphasized the societal aspect of promoting an improved accessible and usable built environment: *An important strategy is to allocate public means for these, often, costly investment projects in order to vouch for their realization. It is important that all actors who are involved in such projects collaborate in a pragmatic manner, for instance, regulations that pertain to surface and distance must be correlated with the design of the elevator and the overall structure of the building* (BI-3).

In line with this view on an increased level of accessibility and usability in the existing built environment, the respondents applauded strategies of local real estate companies or municipal policies: *To increase the level of accessibility and usability in the existing built environment, the management of the real estate has to monitor closely the concerns among the users* (NI10).

In addition, the strategies of organizations that adhered to the equal rights movement for people with disabilities were put forward: *I think that the work of the association *Appropriate Access*⁵ is a good example of both a strategy and a tool that assist various organizations and municipalities in their daily work with accessibility and usability issues. They implement experience-based findings and catalogue appropriate examples. This vouches for a continuous and on-going dialogue about these issues* (NI-6).

The respondents suggested that the matter depended largely upon conscientious initiatives by the real estate owners that had to be promoted by the welfare state: *In my mind, this ambition can only be promoted further if the municipal administration for building matters makes explicit claims on an improved level of accessibility and usability in the existing built environment when extensive refurbishments are planned* (BI-1).

Exemplary accessible and useable models

The respondents found it difficult to supply exemplary models that demonstrated an appropriate level of adjustments of architecture and the built environment. Two trends in the answering of this question appeared. One group said: *No, I do not have any knowledge of such projects* (BI-5). Or: *There are not many examples. I am thinking of adding new flats on the attic floor. I am also thinking of a refurbishment project, where they installed a new elevator in the open column of the existing main staircase* (BI-2).

The other group of respondents had some ideas, but hesitated whether their examples would have an exemplary status: *Now, we are converting a block of flats with a communal kitchen into new ones with individual kitchens. We have supplied a level-free access, but the flats are so condensed in space that they are too small for people with disabilities* (BI-6).

With regard to this item in the questionnaire, one respondent supplied an extra dimension in the understanding of accessibility and usability by declaring: *In principle, I could say that the new entrance to the Danish Parliament Building has an appropriate design that makes it into an exemplary model. But this exemplarity does not cover the full implication of the concept of accessibility and usability. For instance, in the entrance, the alert button is not reachable for a person in a wheelchair (...). Secondly, the inner double doors necessitate that both door blades are opened in order enter; otherwise it is not possible for a wheelchair user to pass this opening. In addition, there is no adjustment for those who have visual impairments. And, returning to the alert button outside, there is no wireless support for people with hearing problems. (...). It is my conclusion that I cannot give any examples of exemplary models since such an assessment demands a thorough analysis of the pros and cons from several perspectives in order to establish whether you have reached the goal or not concerning accessibility and usability* (NI-8).

However, the majority of respondents chose to recommend some exemplary models (19 respondents out of 34 respondents). Some respondents added several examples, but the full sample included 45 buildings. This sample included buildings opened to the public, residential buildings, work space and other built space.

Public buildings

The majority of the suggested exemplary models were found in this category. Three examples were museums, and the exterior adjustments of the terrain in order to create a level-free access by use of ramps or elevators were put forward. In two cases, the installation of a wireless induction loop for people with hearing problems was mentioned. Interior-wise, adjustments due to accessibility and usability motives were combined with an architectural idea in which ramps served as mitigating spatial element in a space of various heights. This category included several adjustments of sports and swimming facilities or refurbishments of public space (educational facilities, airports or train stations).

Residential buildings

In the case of residential buildings, the respondents selected their examples based on either minor alterations of individual flats or major renovations of the full building complex. Such renovations aimed at a level-free access and the introduction of a vertical communication. In some cases, they added an exterior space to the flats through an open balcony or passage. The respondents labelled these actions as basic interventions to increase accessibility and usability. Exterior changes in the landscape promoted level-free access by use of landscape levelling, ramps and elevators.

Work environments

The six examples of appropriate accessible and usable work environments referred mainly to a level-free access from the outside, but also to the improvement of the vertical communication between different floor levels. Often, these buildings had a central location within the old city centre structure, with a stairway starting directly on the sidewalk, a situation that is frequent in the Danish towns with an intact medieval centre. In most cases, the work space was intended for information services to the public and part of public administration.

Other built space

This category referred to built space for various purposes that had undergone refurbishment actions in order to increase the level of accessibility and usability. In two cases, the models were adjustments of space for a religious use, a church or an adjacent assembly hall. Another example was a refurbishment

project of a medieval castle in order to create a hotel and conference centre, while another example referred to an assembly hall for public use. One example referred to the refurbishment of hygiene facilities for people with disabilities.

Preliminary findings

The presented research material reflected a discussion among the 34 respondents on the topic of how to understand the twin concept of accessibility and usability. The notions conceptualized the inherent intention of the building code to implement welfare goals that intend to create a barrier-free access to any type of architecture and built environment for all people regardless disabilities. In combination with the exemplary models, the research material supplied two approaches for analysis:

1. a discourse that pertains to the accurate definition of accessibility and usability; or
2. a listing of architecture and built environment that had promoted the realization of the twin concept.

Accessibility enables usability in order to promote usefulness

Consistent with the nature of jurisprudence, the demands of accessibility and usability in architecture and the built environment require further detailing in order to become applicable to the realization of architectural space. Through its 19 checklists, the SBi has implemented the intention of the twin concept as a type of a natural law that is based on human reasoning and rational objectives to fulfil in the future architectural space (Ryhl, 2009). However, the respondents' answers promoted a comprehensive understanding of accessibility and usability that was close to a type of legal realism that suggested that the practice of this law would define the boundaries of accessibility and usability. Based on the respondents' answers on the items in the questionnaire, the following set of preliminary conclusions could be formulated:

- Accessibility is concrete, measurable and quantifiable;
- Through its physical and spatial elements, accessibility adjusts the particular architectural space or the built environment to the rational needs of a cohort of randomized users;
- Accessibility is the most known concept, often including the usability aspect;
- Usability is perceptual by nature, and therefore assessable in qualitative terms;
- Usability indicates the capacity of architecture and the built environment to adjust to a comprehensive assessment of the implications of a cognitive impairment or a functional disability;
- Usability refers to flexible dimension that depends on the capacity of the individual user, and the possible level of assistance from bystanders that this person would require in order to cope with the particular type of architecture and built environment.
- Usability attenuates shortcomings in accessibility of a particular architecture and built environment;
- Accessibility and usability describes a continuum on which the notions are two opposing forces.

By focusing on the models of exemplary accessible and usable built environment, which the respondents suggested, it was possible to conclude that a handful of physical and spatial elements were active in the adjustment process of architectural designs, so that the goal of the twin concept was met. These elements were promoted by the SBi checklists as essential for an accessible and usable environment. In consequence, the following set of preliminary conclusions can be stated:

- Accessibility refers to elements that are part of the architectural space or the built environment: elevators, lift tables, ramps or other types of permanently installed assistive technology;

- Accessibility and usability suggest the potential of the particular architecture or built environment to empower the future users' independent usage of the space;
- Given the opposing characteristics of accessibility and usability, this potential is essentially integrated in the architectural design, and situated in between the tangible and the intangible;
- This potential can be termed usefulness, and it refers to the level of independent usage of the particular architecture or built environment that a randomized user could realize in this particular space.

In combination with the conclusion on the respondents' definition of accessibility and usability, these assumptions supported the following hypothesis on usefulness in architecture or built environment:

- If the implementation of accessibility (A) and usability (U) in architecture or the built environment indicate a level of possible independent usages by a randomized user, then, this aspect could be evaluated through the eight key criteria of the building code;
- In a particular architecture or built environment, the performative quality of A and U correlates with the perceived level of the possible independent usages that a randomized user may perform;
- The level of independent usages can be termed usefulness (Us). In order to visualize usefulness, the graph of usefulness could be described by the formula $Us = ((A_{max} - U_{min}) - (A_1 + U_1))$ based on the assumption that the level of accessibility and usability can be assessed on a five graded scale that ranges from -2 to +2. A_{max} equals +2 and U_{min} equals -2. In addition, a secondary condition must be fulfilled in the equation: $A_1 \geq -2$ while $U_1 \leq 2$.

In order to test this hypothesis, the eight key criteria of the BR10 were evaluated in a selection of four exemplary models of accessible and usable architecture and built environment. This selection consisted of two buildings, which the respondents had supplied, and two randomly chosen objects, which had received an allocation from the LOA Foundation in order to adjust the existing built space in view of people with disabilities.

Usefulness as outcome of accessibility and usability

This section is divided into two parts. The first part will present two models of exemplary architecture and built environment that the respondents suggested, while the second part will display two random buildings that had been adjusted to the new demands of the BR10.

The main entrance of the Folkopera in Stockholm, Sweden,

Originally, the Swedish Folkoperan was a cinema, erected in 1928. The theatre has two levels for the audience, but no elevator. In 2010, the theatre was part of a municipal project called "Dignified Entries"⁶ that aimed at adjusting classified architectural space to people with disability problems. Two lift tables were installed; one integrated in the exterior stair, and one inside in the lower vestibule zone. These were delivered by the Danish manufacturer Guldman A/S, Aarhus.

Assessment of accessibility and usability

The theatre's PR-coordinator was pleased with the adjustments, since these had improved the capacity to welcome people with disability problems. However, the vestibule had to be staffed during performance nights; outside on the street and in the dim lobby. At these locations, the interaction between those without disabilities issues and the lift tables created problems that had to be monitored.

The exterior one was a risk at the end of the performance night, since people forgot to raise the lift board platform. A chain had had to be mounted in order to seal off the pair of entrance doors through which the two lift tables

EXEMPLARY MODEL A. FOLKOPERAN IN STOCKHOLM, SWEDEN.

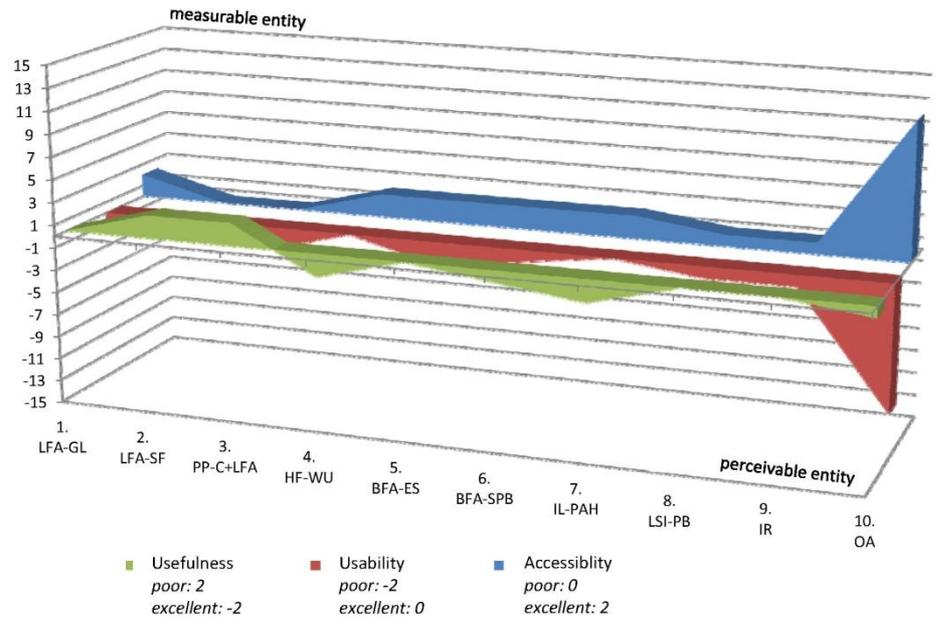


Figure 1. The perceived level of accessibility, usability and usefulness. The Folkoperan in Stockholm, Sweden. LEGEND: 1. LFA-GL: level-free access to ground level. 2. LFA-SF: level-free access to units on same floor level. 3. PP-C+LFA: Parking place with a level-free access and close to the building. 4. HF_WU: Hygiene facilities adjusted to a wheel chair user. 5. BFA-ES: Barrier-free access to elevator or similar function. 6. BFA-SPB: Barrier-free access to designated seats in public assembly halls. 7. IL-PAH: Induction loops in public assembly halls. 8. LSI-PB: Legible signage and information systems in public buildings. 9. IR: individual rating. 10. Overall assessment (sum of previous items); (Figure © author).

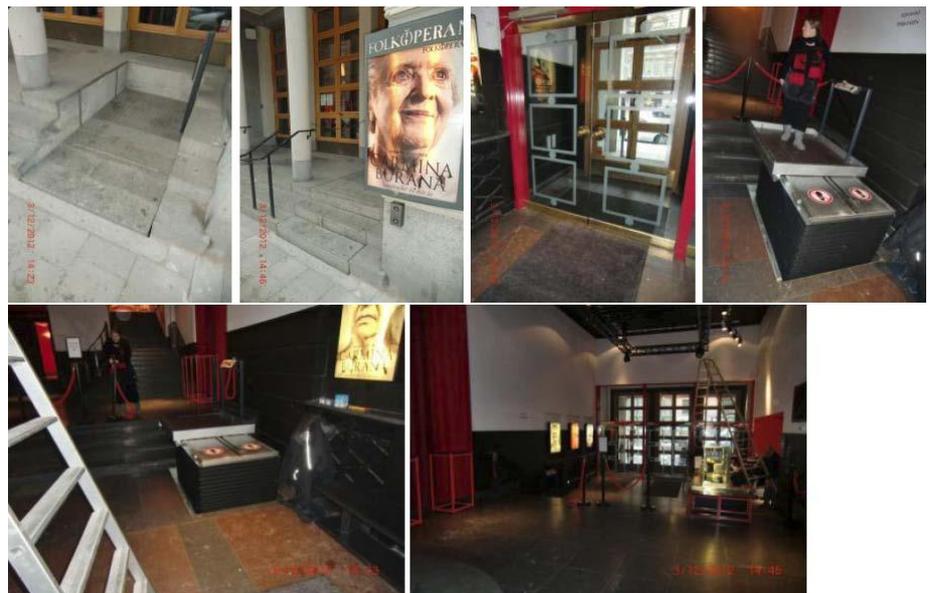


Figure 2. Overview of entrance conditions: lift tables integrated in exterior staircase, and close to inner stairs in lobby space.at the Folkoperan in Stockholm, Sweden (Photographs © author).

communicated. The interior lift table was the most problematic one, since it was powered by batteries that tended to falter. Another problem was that the red stop button that projected from the upper bar of the lift was unintentionally pressed, which resulted in the elevator stopping.

The illustration indicates that the graphs for accessibility and usability were almost identical, see Figure 1-2. This compromised usefulness, since the theatre had to monitor random users in order to help them cope with the built environment. This circumscribed the random users' independent spatial usages of this architecture. In this case, this refers to users without disability issues.

The PTU Centre in Rødovre

The association for victims of polio, traffic and other accidents PTU⁷, founded in 1945, has its headquarters in Rødovre. A former industrial building was converted into a rehabilitation hall with a training basin along with cloakrooms, therapy space and offices. In the beginning of the new millennium, this space was refurbished and extended with new buildings. This resulted in a quadratic building shape with an interior open atrium.

Assessment of accessibility and usability

The site had a slight slope to the north, with ramps integrated in the new space (less than 1:20). The space was accessible both from the outside and from the inside. The access points between the outside to the inside, from the parking space as well as to the inner atrium space, were all level-free.

EXEMPLARY MODEL B. PTU CENTER, RØDOVRE, DENMARK.

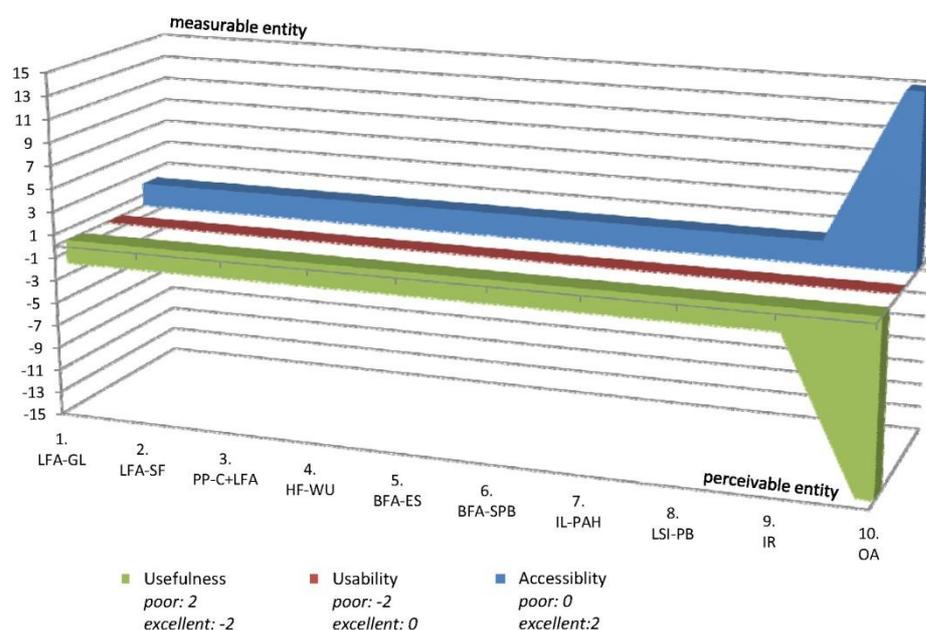


Figure 3. The perceived level of accessibility, usability and usefulness. The PTU Centre, Rødovre, Denmark. LEGEND: 1. LFA-GL: level-free access to ground level. 2. LFA-SF: level-free access to units on same floor level. 3. PP-C+LFA: Parking place with a level-free access and close to the building. 4. HF_WU: Hygiene facilities adjusted to a wheel chair user. 5. BFA-ES: Barrier-free access to elevator or similar function. 6. BFA-SPB: Barrier-free access to designated seats in public assembly halls. 7. IL-PAH: Induction loops in public assembly halls. 8. LSI-PB: Legible signage and information systems in public buildings. 9. IR: individual rating. 10. Overall assessment (sum of previous items); (Figure © author).

Inside, the same type of flooring, a slippery-proof and matt plastic carpet in pale grey, was mounted on the floor, ground floor as well as first floor. In addition, the new glazing was coated with a coating that blocked bright daylight. The building had a wireless audio system. Close to the entrance, there was a stand equipped with information technology that created barrier-free access for the visitors to reach services outside the centre.

The graph indicated that accessibility was excellent, and that few or none action that referred to usability was of necessity, see Figure 3-4. The user, with or without disabilities, could independently use space without assistance from other people. The usefulness seemed to be optimal.



Figure 4. Overview of architectural space: level-free access from the outside to the inside, distinct signage in grey and white, glazing with opaque and transparent fields, and sophisticated railing in staircase at the PTU Centre, Rødovre, Denmark (Photographs © author).

The Sofies Bad, Copenhagen

The bath establishment of Sofies bad was designed in 1909. It was a two storey red brick building, assessed as preservation worthy building in 2000. At the ground floor, there was a Turkish bath with octagonal hummaum, a steamed sauna. In 2008, the LOA Foundation allocated means for adjusting the space to people with disability problems: a larger bathroom, and an accessible sauna. The establishment had also received other means for the installation of an elevator to the upper floor, and, thereby, create a level-free access from the outside. This was not realized at the time of the study visit.

The establishment was filled with architectural references to the oriental idea for cleansing the body and revigorating the mind. The present situation created a clear usability problem, since the different interior floor levels could not be solved by the use of ramps. The different levels made the entrance from the courtyard the most suited one for people with disability problems. However, this created a hygienic problem, since the bathing area had to be crossed in order to reach the cloakrooms.

These were situated some five steps above this floor level, which required additional help from staff members in case of a visitor with disability problems. In addition, the building preservation status blocked changes to the narrow doorways, which inhibited a widening in order to achieve necessary width for passing with a wheelchair. The Turkish bath suggested the presence of

EXEMPLARY MODEL C. SOPHIES BAD, COPENHAGEN, DENMARK.

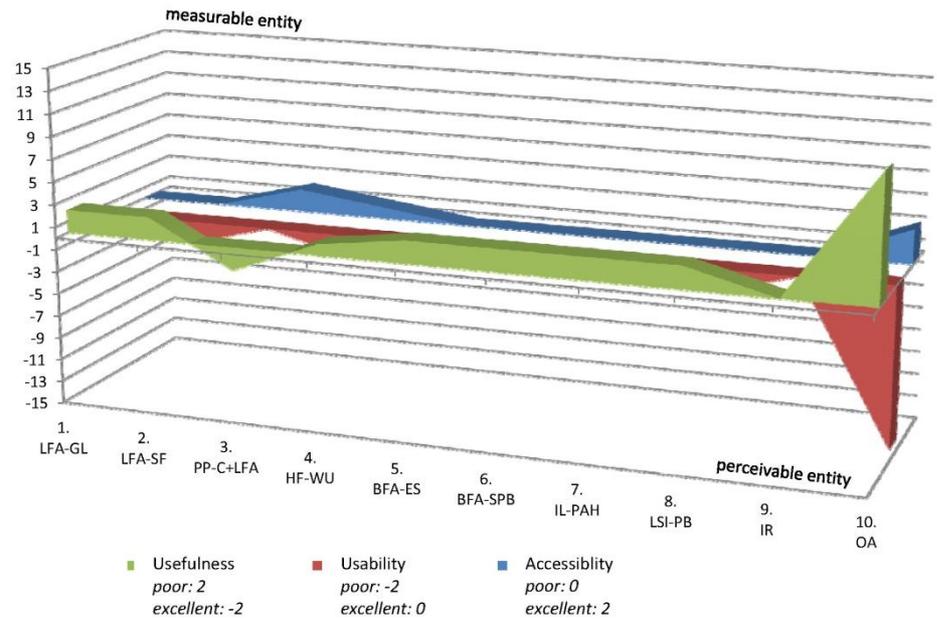


Figure 5. The perceived level of accessibility, usability and usefulness. The Sophies Bad, Copenhagen, Denmark. LEGEND: 1. LFA-GL: level-free access to ground level. 2. LFA-SF: level-free access to units on same floor level. 3. PP-C+LFA: Parking place with a level-free access and close to the building. 4. HF_WU: Hygiene facilities adjusted to a wheel chair user. 5. BFA-ES: Barrier-free access to elevator or similar function. 6. BFA-SPB: Barrier-free access to designated seats in public assembly halls. 7. IL-PAH: Induction loops in public assembly halls. 8. LSI-PB: Legible signage and information systems in public buildings. 9. IR: individual rating. 10. Overall assessment (sum of previous items); (Figure © author).



Figure 6. Overview of the architectural space: architecture with a cultural heritage status, the Sophies Bad, Copenhagen, Denmark, creates a series of accessibility and usability issues that have to be solved by ad hoc solutions (Photographs © author).

therapists: in consequence, extra staffing had to be booked so that persons with disability problems could visit the establishment.

Assessment of accessibility and usability

The illustration indicated that the graphs for accessibility was far from excellent, and that actions, which referred to usability were of necessity, see Figure 5-6. However, the staffs were part of this usability aspect, since the variety of accessible adjustments of the architectural space was limited, and ad hoc solutions had to be implemented.

This led to a poor level of independent usages of space for users with disability issues. In consequence, the graph demonstrated a high level of usability, and low level of accessibility. As a consequence, the level of usefulness was poor.

The Knabstruphall in Knabstrup, Zealand

The Knabstruphall, a sports hall in yellow brickwork, was inaugurated in 1971. The building offered a level-free access from the outside to the interior space. The building was a magnet for local sport activities or community meetings.

A mini-elevator with pre-manufactured shaft walls in white metal was installed in the corner of the stairway to the upper level of the building. A brass plaque commemorated this event from 2009, and the allocation from the LOA foundation was mentioned.

EXEMPLARY MODEL D. KNABSTRUPHALLEN, KNABSTRUP, DENMARK.

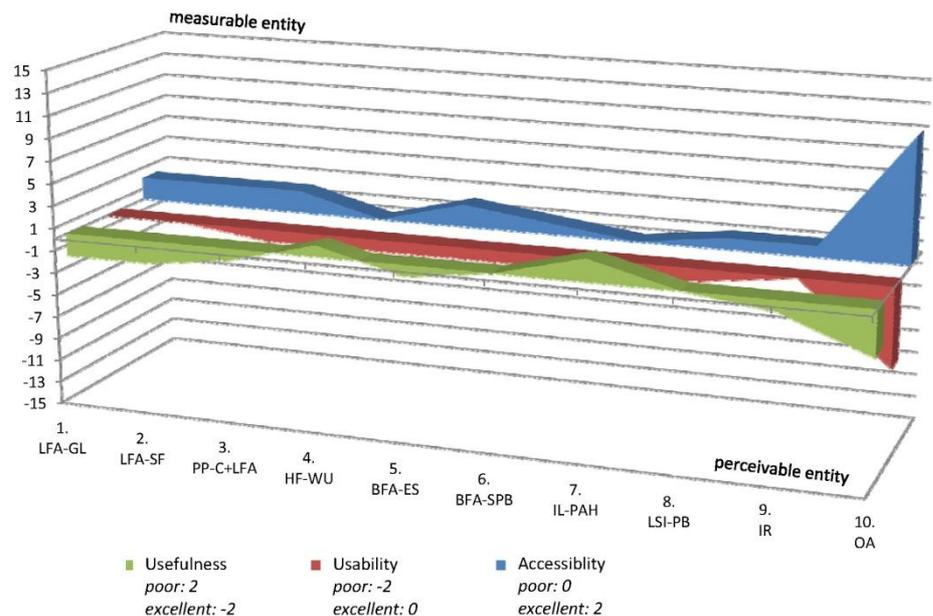


Figure 7. The perceived level of accessibility, usability and usefulness. The Knabstruphallen, Knabstrup, Denmark. LEGEND: 1. LFA-GL: level-free access to ground level. 2. LFA-SF: level-free access to units on same floor level. 3. PP-C+LFA: Parking place with a level-free access and close to the building. 4. HF_WU: Hygiene facilities adjusted to a wheel chair user. 5. BFA-ES: Barrier-free access to elevator or similar function. 6. BFA-SPB: Barrier-free access to designated seats in public assembly halls. 7. IL-PAH: Induction loops in public assembly halls. 8. LSI-PB: Legible signage and information systems in public buildings. 9. IR: individual rating. 10. Overall assessment (sum of previous items); (Figure © author).

Assessment of accessibility and usability

The entrance door lacked an automatic opening device. The elevator was positioned in the corner of the main vestibule, and adjacent to an existing stairway. On the upper floor, the elevator annexed about 30 cm of the free width of the stairway.

Here, the shaft was of the same height as the balustrade that surrounded the stairway. However, the opening of the door to the elevator would require assistance from another person due to a too condensed space for independent access. When opened, the door blocked the stairway.

The graph indicated that the level of accessibility was good, see Figure 7-8. In addition, the existing building had a great potential for increasing the level of accessibility. This would decrease the usability aspect and increase the level of usefulness.



Figure 8. Overview of the architectural space: a modernistic floor layout allows automatically for level-free access and for vertical adjustments like low-rise elevators at the Knabstruphallen, Knabstrup, Denmark, (Photographs © author).

Discussion

The purpose of this paper was to explore the meaning of the twin concept of accessibility and usability among a group of Danish respondents, who could be defined as experts given their capacity as architects, engineers, real estate developers or promoters of equal rights for people with disabilities. The reason for this research scope was due to the open for interpretation of accessibility and usability, for which the Danish building code allows. The mixed method design of this study contributed to elucidate thinking on this matter, but the approach also calls for some words of caution, since the phenomenon, in which accessibility and usability are active, is dominantly perceptual. The introduction of a quantitative analysis method has supplied means to define and visualize a theorem for an improved understanding of accessibility and usability in the context of architecture and the built environment.

According to the respondents in the study, the matter of making the modern society more accessible and usable demanded an expert knowledge. The respondents suggested, perhaps biased by their own professional background, that knowledge about accessibility and usability issues were related to the architectural and engineering competences. Architects and engineers are trained in solving three dimensional problems by challenging spatial thinking in

combination with architectonic, constructive, or structural sketches. This circumstance would explain for why the respondents associated accessibility with structural solutions that are active in three spatial dimensions, and thereby computable by mathematics. In this sense, the study corroborates previous conclusions on the twin concept, which also state that accessibility refers to mainly physical entities (Ryhl, 2009).

In comparison with the definition of accessibility or usability that is put forward by theories on universal design or design for all, the definition of the twin concept in this study can be characterized as technical. The respondents had a vague idea about the correct understanding of usability. The majority of the respondents found it vague and left it unexplained. However, some respondents associated usability diffusely with an unknown sub-dimension of accessibility that referred to the user's interaction with the built environment. This is also consistent with previous Danish research on the appropriate definition of the twin concept (Ibid).

Hence, the study confirmed the existence of a blurred understanding of the twin concept. This dualism in understanding of the twin concept suggests a possible span in the definition of accessibility and usability that stretches from comprehensive and idealistic welfare goals to meticulously defined guidelines in order to make the twin concept applicable to jurisprudence, and, subsequently, realized in architecture, built environment, infrastructure or various design artefacts. The respondents' understanding of the twin concept challenged the user-based definition that has been put forward in research in occupational therapy and physiotherapy (Iwarsson et. al, 2003). In line with the findings of this study, a user-based definition of the twin concept would be:

- Accessibility can be understood as the result of the measurable aspect of the environmental component (description of the level of barriers that an artefact, design objects or a built space may impose on the user) and the characteristic of the personal component (functional capacity of the individual or of a group) based on the comprehensive knowledge of the spatial implication of cognitive, functional, hearing or visual disabilities. Hence, accessibility refers to physical adjustments of the architectural space – barrier-reducing measures in space, elevators, level-free access, lift tables, ramps, and other similar architectural elements – so that it will be accessible for a person with disability issues.
- Usability can be understood as interactive outcome of the environmental component and the characteristic of the personal component. This interactive component describes the level of the possible range of activities that a user of the particular space may perform independently or with assistance from a person with few or none disability problems. Hence, usability refers to the amount of additional adjustments, besides accessibility adjustments, with which the architectural space has to be equipped with – assistive technology, permanent staffing or random assistance from other people present in this space – so that it will be usable for a person with disability issues.

With this slight detailing work of the proposed definitions by Iwarsson and Ståhl, accessibility and usability become essential parameters of the performative quality of architecture or built environment, i.e. an assessment of the fit between the individual capacities of the user and the physical capacity of the architectural space. The models of exemplary and appropriate accessible and usable architecture and built environment, which the respondents supplied, supplied further input to validate this line of reasoning. In conclusion, accessibility and usability are opposing forces that become active in the architectural space. Seen as an entity, they predict the degree of usefulness of the particular architecture or built environment. Usefulness can be defined as:

- Usefulness refers to the capacity of a particular architectural space to accommodate various users with or without disability problems. A high level of usefulness, suggests an architectural space with a high level of

accessibility realized through physical elements such as elevators, ramps or other assistive equipment in order to allow for a maximum of independent usages of the space, in consequence a low level of usability. The degree of usability indicates the level of additional secondary adjustments that have to be realized so that a large variety of users could be accommodated.

By introducing usefulness as a resulting factor of the relationship between the twin concept of accessibility and usability, this study presents a tool for bridging the gap between the modern implication of accessibility and usability and the bi-millennial Vitruvian credo of *firmistas, utilitas, and venustas*. Hence, the ultimate aim of increasing accessibility and usability in architecture and built environment is to increase the amount of usefulness in the built space. This could be done by physical changes in the architectural space, hence, increasing accessibility, or by other types of installations in close connection to the architectural space.

In line with this thinking, new buildings contain the largest potential for attaining an optimal level of usefulness, since the architectural design is open for necessary physical adjustments and additional installations. On the other hand, in existing built environment, in particular, preservation classified buildings; the usefulness potential is conflicted by an existing physical framework, which allows for a limited amount of physical adjustments for increasing accessibility. Hence, adjusting this type of architectural space relies dominantly on installations of a usable nature in order to accommodate a large variety of users.

Concluding remarks

Given the slower pace of change that distinguishes architecture from human existence, architectural design necessitates the largest possible level of being adjustable to the needs of various user groups. The theorem on usefulness is a tool for understanding the ramifications of the twin concept of accessibility and usability. Usefulness becomes an essential dimension for explaining legislative demands on an increased level of accessibility and usability in architecture and built environment, since it correlates user needs with the performative capacity of the architectural design. It can also be used as a tool for demonstrating the difference between appropriate and not so appropriate architecture: usefulness refers to the core values of an architectural design, and, therefore, the essence of the human existence: to appropriate architecture and the built environment in order to realize individual goals in life.

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Usefulness is a tool for understanding the ramifications of the twin concept of accessibility and usability. Usefulness becomes an essential dimension for explaining legislative demands on an increased level of accessibility and usability, since it correlates user needs with the performative capacity of the architectural design.

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¹ Accessibility equals the Danish word *tilgængelighed*, while usability corresponds with the Danish words of *anvedelighed* or *anvendelse*.

² The abbreviation stands for in Danish: Statens Byggeforskningsinstitut. It was founded in 1947 as a special branch of competence for guiding the reconstruction of architecture and built environment after the end of WWII. In 2007, it merged with the Aalborg University, where it is now a special institution.

³ According to Vitruvius, an appropriate architectural design can be distinguished by a threefold harmony that unites universally acknowledged values for the built environment with respect to: functionality (*utilitas*), sustainability (*firmistas*) and aesthetics (*venustas*) (Vitruvius, 15BC).

⁴ LOA foundation stands for the Danish foundation *Lokale og Anlaegsfonden* (www.loa-fonden.dk)

⁵ This is the author's translation of the Danish organization *God Adgang*.

⁶ This is an approximate translation of the Swedish name "Värdig Entré," which was an attempt in 2006 by the Swedish branch of Design for All, the City of Stockholm and the National Property Board of Sweden to create level-free access to five public buildings in Stockholm; see link:

(www.designforall.se/templates/Page_____509.aspx)

⁷ PTU stands for in Danish the Landsforeningen for Polio, Trafik- og Ulykkeskadede).