Usefulness as a key parameter in the evaluation of accessibility and usability issues in architecture and the built environments, a concept for the understanding of the twin concepts in the Danish building code.

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Abstract
In the Danish building code, the twin concept of accessibility and usability has an open interpretation on a comprehensive level of thinking, whereas the notions generate specific physical requirements on a detailed level when it comes to architecture and built environments. This study has been executed as a case study among 34 experienced professionals, active in the implementation of the twin concept in the built environments in order to facilitate for people with a cognitive or functional impairment. The research material has been assembled by the use of mini-questionnaires that have been synthesized with the informants’ recommendations of exemplary models of appropriately accessible and usable architecture and built environments.

The aim of the present study is to position the twin concept of accessibility and usability with regard to their implementation in various types of architecture and the built environments. The informants’ definition of accessibility and usability, paired with their recommended models, suggest that the former refers to computable facts, while the latter encompasses perceivable consequences of the built space that requires further ad hoc solutions in order to promote a universal user-friendliness. Seen as opposing forces, the informants use accessibility and usability in order to define the perceived degree of usefulness of the particular architecture or built environments. Based on the informants’ understanding of the twin concept, this study proposes that accessibility and usability are constituents of the building’s performative capacity in relation to a large and varied group of users. In this paper, this capacity has been termed usefulness. It refers to the fit between the individual user and architecture and the built environments, i.e. the perceived level of independent usages of the built space.

Usefulness supplies a theorem for an improved understanding of accessibility and usability in relation to architecture and the built environments. It can be ranged under the roof of the Vitruvian credo of a threefold combination of an aesthetical appearance (venustas), a sustainable structure (firmistas), and adjustments that equip this space with commodity for the user groups (utilitas). This study contributes to the positioning of the twin concept of accessibility and usability in the Danish building legislation. The theorem defines accessibility as a physical constituent of architecture and built environments, while usability refers to both physical and other measures that have been deemed necessary to realize in order to create a usable built space. A high level of accessibility, but a low degree of usability, indicates a high fit between user demands and the programming of the built space. There is a high level of usefulness in an appropriate architectural design.

Keywords: usefulness, accessibility, usability, Danish building act, building programming

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Introduction

In Denmark, regulations that pertain to architecture and the built environments have historically been used to define the communal burdens versus the ones of the individual real estate owner. Towns or densely populated areas have been targeted by requirements that have focused on the physical character of the architectural design: optimal exploitation of the site, building height, delivery of goods to and from the building, sanitation, transportsations between the buildings and connecting various built districts in the towns. In a ranking order, the following items have guided the regulations.

1. the need of controlling open fire;
2. promoting commerce;
3. imposing fiscal systems
4. and, introducing aesthetical orders

Defensive considerations in relation to architecture and the built environments have had a reformative influence on the Danish building code: The British naval bombardment of Copenhagen in 1807 was one of the first terror bombing of a densely populated area, that lead to serious damages in the inner city region, and subsequently to a heightened security thinking with at least two emergency exits from the building. From the 1970s and onwards, reforms of the building code have focused on the performative aspect of architecture and the built environments in relation to future users with cognitive impairment or functional disabilities. In 2007, Denmark signed the UN Convention on the 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 BR 10) that increased the level of accessibility and usability in architecture and built environments. In particular, these changes target eight aspects in the architectural design in order to promote accessibility and usability in architecture and the built environments, see table 1.

Table 1. The eight criteria with reference to accessibility and usability (BR08 and BR10).

<table>
<thead>
<tr>
<th></th>
<th>Criteria</th>
<th>BR08/10 Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>specially designated parking space in front of the building, and with a level free access to the building;</td>
<td>2.6.3, section 2</td>
</tr>
<tr>
<td>2</td>
<td>level free access to all services situated on the ground floor of a building;</td>
<td>3.2.2, section 3 and 4</td>
</tr>
<tr>
<td>3</td>
<td>level free access to any services situated on the same floor, but above the ground floor;</td>
<td>3.2.1, section 2</td>
</tr>
<tr>
<td>4</td>
<td>in public institutions or buildings intended for professional use (offices, work environments), access to hygiene facilities that are adjusted to a person who uses a wheel chair or demonstrate special needs;</td>
<td>3.4.1, section 5</td>
</tr>
<tr>
<td>5</td>
<td>barrier free access to level adjusting installations (elevators, lift tables or similar) that are adjusted to the needs of a person who uses a wheel chair,</td>
<td>3.2.1, section 2 and BR08/10 3.2.2, section 5 and 6</td>
</tr>
<tr>
<td>6</td>
<td>in public assembly halls or similar barrier free access to specially designated seats for people who use a wheel chair;</td>
<td>3.4.1, section 7</td>
</tr>
<tr>
<td>7</td>
<td>audio induction loops (integrated, mobile or wireless) in public assembly halls or similar</td>
<td>8.1, section 12</td>
</tr>
<tr>
<td>8</td>
<td>legible signage and information system in order to promote wayfinding in public institutions or buildings.</td>
<td>8.1, section 12</td>
</tr>
</tbody>
</table>

Background

In Denmark, the year of a building’s erection year will define the particular version of the building code that will be applicable to this building. This means that parallel versions of the building code
may influence the architectural design of a building. In the most current versions, the BR08 and BR10, the key words accessibility and usability have a tandem function that is intended to highlight the needs of a person with disability issues during the process of conceiving new architectural space or refurbishing old ones. The Danish homologues of these words or derivatives are frequent in the BR08 and BR10: the word “tilgængelighed” (accessibility) produces 7 results, while “anvedelighed or anvendelse” (usability) generate 4 and 97 results respectively. However, the code does not supply a precise definition of these words. In consequence, accessibility and usability turn into a twin concept that supposedly includes all spatial aspects essential to respect with regard to the needs of disabled people.

The search for the implications of the twin concept has been explored by the Danish Building Research Institute, SBi (Ryhl et al, 2009). This has resulted in a definition of accessibility that suggests that it is a) a physical entity, and b) quantitatively assessable. On the other hand, usability refers to a dimension that is perceivable through an intellectual and qualitative analysis of the architectural space in relation to cognitive impairments or 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 implies that the understanding of accessibility and usability among the practitioners in both private and public employment has not evolved in the same pace as the reform work of the building code that has gone from functional disabilities to include also cognitive problems in relation to the built space (Frandsen, 2012). The probable reason for this understanding is the Vitruvian bimillennial credo that is still very much active in the architecture profession:

An appropriate architectural design can be distinguished by a threefold harmony that unites universally acknowledged values for the built environments with respect to: functionality (utilitas), sustainability (firmistas) and aesthetics (venustas) (Vitruvius).

Attempts have been made to range the twin concept under the roof of universal design, and, thereby, defining accessibility as making artefacts, design objects and built space accessible to as many people as possible (Steinfeld, Maisel, 2012), and usability as creating artefacts, design objects, and 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. On the one hand, the emphasis on making an artefact, design objects or built space accessible and usable, and, thereby, assigning an equal value to any variable that is part in this operation, and, on the other hand, the underlying assumption that in every situation, in which accessibility and usability become an issue, there is one optimal solution for everyone. A more detailed and human-oriented way of defining the twin concept is to focus 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 the field of research on the person-environment fit, occupational therapy and physio therapy. Assuming this view on accessibility and usability, three important components fall out of this interaction between the individual or a group of individuals, and the artefact, design objects or built environment: 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 turns into a dynamic relationship:

- *Accessibility can be seen as the outcome of the interaction between the personal component (functional capacity of the individual or of a group) and the environmental...*
component (barriers that an artefact, design objects or a built space may impose on
the user);

- 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 individu-
al user or a group of users perform in this environment.

Purposes and aims
This report proceeds from this person-environment-fit definition of accessibility and usability, since
this fit allows for explaining why some built environments with a measurable lower level of acces-
sibility might be perceived as usable by those individuals who are familiar with this particular envi-
ronment (Ryhl, 2003). It vouches for why the mere installation of elevators in residential buildings
diminishes an older person’s need for eldercare (Ekwall, 2005). In addition, if this definition is ap-
plied to the eight spatial criteria that the BR 10 stipulates, accessibility and usability become inte-
grated in the performative character of the building, an assessable architectural quality (Odgers &
Samuel, 2010).

The notion of architectural quality can be housed under the roof of the threefold Vitruvian credo,
and a quality assessment of architecture with this scope, the Design Quality Indicator tool, have
been elaborated by the Royal Institute of British Architects (RIBA) in 1999. The purpose of this
study is to explore the everyday meaning of the twin concept among a group of informants who are
experts within the practice of adjusting architecture and the built environments to a panorama of
possible disability issues. In addition to the informants’ reasoning about the appropriate understand-
ing of accessibility and usability, the study aims at establishing a sample of exemplary models of
architecture and built environments that according to this group of experts incarnates an accessible
and usable environment for people with cognitive impairments or functional disabilities. The work-
ing hypothesis of this study is that such a group of experts will supply an accurate definition of the
twin concept that could be evaluated through the informants’ suggestions of exemplary models of
architectural designs.

Methodology
This is a multiple case study (Stake, 1995; Yin, 2003), in which the research material was collected
through a mixed method approach, and, later, analysed with mixed qualitative and quantitative
methods (Creswell, Plano Clark, Gutmann, & Hanson, 2003; Onwuegbuzie & Johnson, 2008). In
order to triangulate the empirical findings, the study has recurled to overlapping research methods:

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

The internet-based queries was performed in Danish, and oriented towards the implementation and
realization of accessibility and usability in architecture and the built environments according to the
BR 10. The searches targeted informants working in civil administration, interest organizations or
representing real estate management who worked with this matter. In addition, researchers at the
Danish Building Research Institute (SBi) were included.

Informants, questionnaires and exemplary models of built environments
The searches resulted in three groups of informants, all in all 370 respondents. The first group,
Group A, attained a number of 54 experts employed by civil administration or interest organiza-
tions, of which 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 group, Group C equalled a number of 62 researchers at the SBi, of whom 16 chose to respond (response rate 25.8 per cent). The three groups received an email with general information about the objectives of the study. A questionnaire in word format was attached to the email. 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 in the Danish built environment; see table 2.

Table 2. The questionnaire.

<table>
<thead>
<tr>
<th>Item</th>
<th>Question theme</th>
<th>Response rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3</td>
<td>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? 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 environments, realized between 2008 and 2012? 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 environments?</td>
<td>100 % 95 % 85 %</td>
</tr>
</tbody>
</table>

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

**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).

Figure 1. The assessment protocol.
Affirmative and negative answers were included in the sample, all in all 34 answers. The 13 refusals supplied a motive for not participating, while 21 affirmative answers were correctly filled-out questionnaires. Out of this number, 19 informants chose to supply one or several exemplary models of architecture and built environments with an allegedly high level of accessibility and usability in accordance with the BR 10. 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.

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 informants’ answers anonymous, the reasoning in Danish was translated into an approximate, but grammatically correct, English. The questionnaires supplied a conclusion on the understanding of accessibility and usability that was developed into an assessment protocol with eight key criteria. These reflect the paragraphs on accessibility and usability in the BR 08 and BR10; see figure 1.

Accessibility issues were assessed by an expert (the author) by evaluating the compliance with the stipulated requirements of the building code. Usability issues were explored by interviewing the user of the particular building, and assessing the adjustments in relation to possible cognitive impairment and functional disabilities. Both assessments used a scale of 0 to 2 points, positive for accessibility and negative for usability. In order to test the conclusion that was based on the informants’ answers in relation to accessibility and usability, two exemplary models were chosen from this sample. For comparison, two refurbishment projects that had received allocations for improving the twin concept by the Danish foundation LOA fund, i.e. Lokal- og Anlægsfonden (www.loa-fonden.dk), were randomly chosen.

3. RESULTS
This section is divided in two sections. The first part will address the first and the third item in the questionnaire; i.e. the informants’ definition of the twin concept, as well as their strategies for adjusting appropriately architecture and built environments to the needs of people with disabilities. The second part will present the exemplary models of built space that the informants suggested in response to the second item in the questionnaire.

3.1 Accessibility and usability in everyday practice
The thirteen informants, who declined to answer, stated also a reason: a perceived lack of an adequate professional background. Some informants overcame this reluctance by minimizing their validity: As a layman, I do not have the required competence for correctly assessing the matter. (BI-5). However, the informants placed the accurate knowledge on accessibility and usability by 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 the ambition to preserve qualities of the existing space, but, at the same time, integrate a new level of accessibility (SI-11).

The main quality of these professions was the ability to foresee 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 informant 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 and inherent quality of appropriate built environments
The informants perceived the win 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 US or the U. These are the best places for understanding the importance of long-term strategies for the implementation of accessibility and usability in architecture and the built environments. I do not believe that there is any correlation between accessibility and general user-friendliness. Instead, the particular interest is to focus on how the US connects financially solutions for people with disability problems with universal solution. This dual perspective makes it possible to generate a financial gain that promotes the solution of the two aspects simultaneously. This transfers the problem, often costly for either society or the individual, to a common problem with a mixed financial responsibility (NI-8).

The informants viewed accessibility and usability as an integrated quality of 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). The level of accessibility and usability was defined either during the early phase of a new building, or during an assessment of an existing building’s capacity to integrate adjustments: Analyse the adjustments that the particular architecture may include, define the financial level of the adjustments, and circumscribe the envisioned refurbishment actions (BI-6). A balance 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 in order to create accessibility
The informants deemed it necessary to adjust the twin concept to the type of building projects in question, publically owned versus private real estate: In public buildings, adjustments describe a higher level than in privately owned buildings, but the goal has to be: the highest possible accessibility for all users, not only people who use wheelchair 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 informants suggested that accessibility implied physical obstacles in architecture and the built environments, mainly challenging 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 is adjusted to both the needs of people with locomotory problems and people who suffer from respiratory problems like asthma, people who have visual impairments, or have a hearing problem (NI-6). However, usability remained vague. One informant 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 in the built environment
Given the open interpretation of the twin concept, the informants stated the need of an assessment tool for accessibility and usability in architecture and the built environments: 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 informant 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 (NI-12). The informants suggested that 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 informants suggested that higher demands on accessibility and usability in architecture and the built environments necessitated public funding and an extended knowledge of the matter in general. One informant saw a closer correlation between the juridical wordings and the realization as existing built space, while another informant emphasized theory and practice of the matter: I think the easy removable obstacle campaign in Sweden could be of interest for the Danish situation. Another one would be the British strategies for equal opportunities and refurbishments that are closely coordinated 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. The refurbishment of the Nørreport station will be an excellent example to compare with the BR10 (SI-14).

A societal strategy for an increased level of accessibility and usability
The informants suggested that this 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 environments when extensive refurbishments are planned (BI-1). The informants 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 refurbishment projects collaborate in a pragmatic manner, for instance some 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 environments, the informants applauded strategies of local real estate companies or municipal policies: To increase the level of accessibility and usability in the existing built environments, the management of the real estate has to monitor closely the concerns among the users (NI10). In addition, the strategies of organizations that adhere to the equal rights movement for people with disabilities were mentioned: I think that the work of the association Appropriate Access" 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).

3.2 Exemplary models of accessible and usable built environment
The informants found it difficult to supply exemplary models that demonstrated an appropriate level of adjustments of architecture and the built environments. Two trends in the answering of this question appeared. One group said: No, I do not have any knowledge of such projects (BI-5). There are

2 The author’s translation of the Danish organization God Adgang (Appropriate access).
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 informants 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, one informant 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 accessibility and usability. For instance, in the entrance, the alert button is not reachable for a person in a wheelchair, if you want to contact the staff inside the building. Secondly, the inner double doors necessitate that both door blades are to be open in order enter; otherwise it is not possible for a person who uses a wheelchair 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. And, I could add other things. Therefore, 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 out of several aspects in order to establish whether you have reached the goal or not concerning accessibility and usability (NI-8).

However, the majority of informants chose to recommend some exemplary models (19 informants of the total sample with 34 respondents). Some informants added several examples. The full sample included 45 exemplary models of built environments that spanned from residential complexes to various public buildings, see table 3.

Table 3. Overview over the sample of exemplary models.

<table>
<thead>
<tr>
<th>Informants</th>
<th>Number</th>
<th>Residential buildings</th>
<th>Work environments</th>
<th>Public buildings</th>
<th>Other buildings</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>10</td>
<td>9</td>
<td>6</td>
<td>16</td>
<td>3</td>
<td>34</td>
</tr>
<tr>
<td>Group B</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Group C</td>
<td>2</td>
<td>6</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>19</td>
<td>15</td>
<td>6</td>
<td>20</td>
<td>4</td>
<td>45</td>
</tr>
</tbody>
</table>

Residential buildings
In the case of residential buildings, the informants 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 informants 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 appropriately 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.

**Public buildings**
The majority of the suggested exemplary models were found in this category. Three examples were museums, and the exterior adjustment 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 loop for people with hearing problems was mentioned. Interior wise, adjustments due to accessibility and usability reasons were be 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).

**Other buildings**
This category of models 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, the church or the 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.
4. PRELIMINARY FINDINGS
The presented research material reflects a discussion among the 34 informants on the topic of how to understand the twin concept of accessibility and usability. These notions conceptualize the inherent intention of the BR 10 to implement welfare goals that intended to include people with or without disabilities issues on equal terms in architecture and the built environments. In combination with the exemplary models, the research material can be analysed in two ways;

1) a discourse that pertains to the accurate definition of accessibility and usability, or;
2) a description of physical elements in the architectural space that promote the realization of the twin concept.

Accessibility enables usability and together they promote usefulness
Consistent with the nature of jurisprudence, the demands of accessibility and usability in architecture and the built environments require further detailing in order to become applicable to the realization of architectural space. By its 19 checklists, the Danish Building Institute (SBi), Aalborg University, 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 informants’ answers promote a generalistic understanding of accessibility and usability with an interpretation that is close to a type of legal realism that suggests that the practice of this law will define the boundaries of accessibility and usability. Based on the informants’ answers of the three items in the questionnaire, the following set of preliminary conclusions can be stated:

- Accessibility is visual by nature, but measurable and quantifiable; Through its physical and spatial elements, accessibility adjusts the particular architectural space or the built environments 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, and indicates the capacity of architecture and the built environment to adjust to generalistic 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 environments.
- Usability attenuates shortcomings in accessibility of a particular architecture and built environments;
- Accessibility and usability describes a continuum of appropriate and inappropriate architectural quality. In this continuum, the twin concept describes two opposing forces when it comes to what is included in the physical environment (accessibility), and what has to be added in the subsequent phase of using the building for everyday living and work.

By focusing on the models of exemplary accessible and usable built environments that the informants suggested, it is possible to conclude that a handful of physical and spatial elements are active in the conceptual adjustment of the architectural design in order to meet the goal of the twin concept. It is probable that these elements are promoted by the BR 10, since they are consistent with the eight criteria that the SBi checklists promote 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 environments: elevators, lift tables, ramps or other types of permanently installed assistive technology;
• Accessibility and usability suggest the potential of the particular architecture or built environments to empower the future users’ independent usage of the space;
• Given the opposing characteristics of accessibility and usability, this potential 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 environments that a randomized user could realize in this particular space.

In combination with the conclusion on the definition of accessibility and usability, this realization supports the following hypothesis on usefulness in architecture or built environments:

• If the implementation of accessibility (A) and usability (U) in architecture or the built environments indicate a level of independent usages of a randomized user, then, this aspect could be evaluated through the eight key criteria of the building code;
• In a particular architecture or built environments, the performative quality of A and U correlates with the perceived level of independent usages of a randomized user;
• This level of independent usages is here termed usefulness; In order to visualize usefulness, the graph of usefulness could be described by the formula Us=((Amax-Umin)-(A1+U1)) 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. Amax, Umin=+/-2 and -2≥A1; U1≤2.

In order to test this hypothesis, the eight key criteria of the BR 10 were assessed in a selection of four exemplary models of accessible and usable architecture and built environments. This selection consisted of two objects that the informants had supplied, and two randomly chosen objects that had received an allocation from the LOA fund in order to adjust the existing built space for people with disabilities.
5. USEFULNESS, A THEOREM ON ACCESSIBILITY AND USABILITY

This section is divided into two sections. The first part will present two models of exemplary architecture and built environments that the informants suggested, while the second one will display two random buildings that have been adjusted to the new demands of the BR10.

5.1 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” that aimed at adjusting the architectural space to people with disability problems. Two lift tables were installed; one in the exterior stair, and one inside in the lower vestibule zone. These were delivered by the Danish manufacturer Guldmann A/S, Århus.

Assessment of accessibility and usability

The theatre’s PR-coordinator is pleased with the adjustments, since these have improved the capacity to welcome disabled people. However, the vestibule has to be staffed during performance nights. Outside on the street and in the dim lobby, the interaction between those without disabilities issues and the lift tables has created problems that have to be monitored. The exterior one is a risk at the end of the performance night, since people forget to raise it to its stair position. A chain has been mounted in order to seal off the pair of entrance doors through which the two lift tables communicate. The interior lift table is the most problematic one, since it is powered by batteries that can falter. Another problem is that the red stop button that projects from the upper bar of the lift is unintentionally pressed, and the elevator stops. The graph indicates that accessibility and usability are almost identical. This compromises usefulness, since the theatre has to monitor random users in order to help them cope with the built environment. This circumscribes the users’ independent spatial usages of the particular architecture. In this case, it refers to users with and without disability issues.

5.2. The PTU Centre in Rødovre

The association for victims of polio, traffic and other accidents PTU (Landsforeningen for Polio, Trafik- og Ulykkeskadede), 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. This resulted in a quadratic building shape with an interior open atrium.

Assessment of accessibility and usability

The site has a slight slope to the north, but ramps are integrated in the new space (less than 1:20). The space is 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, are level-free. The same type of flooring, a slippery proof and matt plastic carpet in pale grey, has been mounted on the floor, ground floor as well as first floor. In addition, the new glazing has been coated with a light reducing material. The building has a wireless audio system.

Close to the entrance, there is a stand equipped with information technology that creates a barrier-free access for the visitors to services outside the centre. The graph indicates that accessibility is excellent, and that few or none action that refers to usability is of necessity. The user, with or without disabilities, can independently use space without assistance from other people. The usefulness is optimal.-
1. Level-free access to ground level.
2. Level-free access to units on the same floor.
3. Parking place, close to building with a level-free access.
4. Hygiene facilities adjusted to persons who use a wheelchair.
5. Barrier-free access to elevators or similar.
6. Barrier-free access to designated seats in public buildings.
7. Inductions loops in public assembly halls.
8. Legible signage and information systems in public buildings.
9. Individual rating
10. Overall assessment

Figure 1. Perceived usefulness of the building, the Folkoperan in Stockholm, with a photographic collection of the vestibule in order to give an overview of the architectural space.
1. Level-free access to ground level.
2. Level-free access to units on the same floor.
3. Parking place, close to building with a level-free access.
4. Hygiene facilities adjusted to persons who use a wheelchair.
5. Barrier-free access to elevators or similar.
6. Barrier-free access to designated seats in public buildings.
7. Inductions loops in public assembly halls.
8. Legible signage and information systems in public buildings.
9. Individual rating
10. Overall assessment

Figure 2. Perceived usefulness of the building, the PTU Centre in Redovre, with a photographic collection of the some parts of the building in order to give an overview of the architectural space.
5.3 The Sofies Bad, Copenhagen
The bath establishment Sofies bad was designed in 1909. It is a two storey red brick building, assessed as building preservation worthy in 2000. At the ground floor, there is a Turkish bath with octagonal hammam, a steamed sauna. In 2008, the LOA fund allocated means for adjusting the space to people with disability problems: a larger bathroom, and an accessible sauna. The establishment has received other means for the installation of an elevator to the upper floor, and, create a level-free access from the outside.

Assessment of accessibility and usability
The establishment is filled with architectural clues of the oriental cleansing idea. The present situation creates a usability problem, since the different interior floor levels cannot be solved by use of ramps. The different levels make the entrance from the courtyard the most suited one for people with disability problems. This creates a hygienic problem, since the bathing area has to be crossed in order to reach the cloakrooms, reached by five steps.

In addition, the building preservation status does not allow the narrow doorways to be widened. A Turkish bath suggests the presence of therapists: in consequence, extra staffing has to receive a person with disability problems. However, the staffs are part of the usability aspect, since the variety of accessible adjustments of the architectural space is limited. This leads to a poor level of independent usages in the space for the users, and a high level of usability.

5.4 The Knabstrupshall in Knabstrup, Zealand
The Knabstraphall, a sports hall in yellow brickwork, was inaugurated in 1971. The building offers a level-free access from the outside to the interior space. The building is a magnet for local sport activities or community meetings. A mini-elevator with pre-manufactured shaft walls in white metal is installed in the corner of the stairway to the upper level of the building. A brass plaque commemorates that, in 2009, the LOA fonden allocated means for the elevator.

Assessment of accessibility and usability
The entrance door lacks an automatic opening device. The elevator is positioned in the corner of the main vestibule, straight across to an existing stairway. On the upper floor, the elevator has annexed about 30 cm of the free width of the stairway. Here, the shaft is of the same height as the balustrade that surrounds the stairway. However, opening of the door to the elevator will require some assistance from another person. When opened, the door will block the stairway.

However, a new facility according to the current legislation and in a closer position to the entrance hall would increase the usability factor considerably. There is a high potential of the existing architectural design to increase the level of accessibility. This would decrease the usability aspect and increase the level of usefulness for a person with disability problems.
1. Level-free access to ground level.
2. Level-free access to units on the same floor.
3. Parking place, close to building with a level-free access.
4. Hygiene facilities adjusted to persons who use a wheel chair.
5. Barrier-free access to elevators or similar.
6. Barrier-free access to designated seats in public buildings.
7. Inductions loops in public assembly halls.
8. Legible signage and information systems in public buildings.
9. Individual rating.
10. Overall assessment.

Figure 3. Perceived usefulness of the building, the Sophies Bad in Copenhagen, with a photographic collection of the building in order to give an overview of the architectural space.
EXEMPLARY MODEL D. KNABSTRUPHALLEN, KNABSTRUP, DENMARK.

Figure 4. Perceived usefulness of the building, the Knabstrubhallen, Knabstrub, with a photographic collection of the building in order to give an overview of the architectural space.
Discussion
The purpose of this paper has been to explore the meaning of the twin concept of accessibility and usability among a group of informants that can be defined as experts given their capacity as architects, engineers, real estate developers or promoters of the equal rights for people with disabilities. The reason for this research scope is the circumstance that the twin concept is open for interpretation in the Danish building code (BR10), which this study confirms. The informants suggested, perhaps biased by their own professional background, that knowledge about accessibility and usability issues are related to the architectural and engineering competences. The matter of making the modern society more accessible and usable becomes part of an expert knowledge; both architects and engineers are trained in solving three dimensional problems by challenging the students’ spatial thinking in combination with architectonic, constructive, or structural exercises. This circumstance explains why the informants associated accessibility with structural solutions that are active in three spatial dimensions, and thereby computable by mathematics. In this sense, this study corroborates previous conclusions on the twin concept that state that accessibility refers to physical entities (Ryhl, 2009). On the other hand, the informants had a vague idea about the correct understanding of usability. The majority of the informants left it unexplained, or associated it diffusely as 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).

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, which this study supplies, can be characterized as detailed, measurable and technical, thus logically integrated in the daily practice of increasing the level of accessibility and usability in architecture and the built environments. This dualism in the understanding of the twin concept suggests the possible span to define 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 environments, infrastructure or various design artefacts. To some extent, this study on Danish expert informants’ understanding of the twin concept challenges the user-based definition that Swedish research within ergo therapy and occupational therapy has suggested (Iwarsson et. al, 2003). However, the results of this study can be ranged under the roof of the user-based definition of accessibility and usability, if the typical and atypical characteristics of cognitive, hearing, physical or visual impairments are sorted as results that are physical and therefore to some extent measurable, and outcomes that are personal, but perceivable, and therefore assessable. In line with the findings of this study, the user-based definition of the twin concept would be:

1) 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.

2) Usability can be understood as interactive outcome of the environmental component and the characteristic of the personal component that has guided the architectural design. 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. Thus, usability refers to the amount of adjustments with which the architectural space has to be equipped (assistive technology, permanent staffing or random...
assistance from other people present in this space) in order to become usable for a person with disability issues.

With this slight detailing work of the proposed definitions by Ivarsson and Ståhl, accessibility and usability become essential parameters of the performative quality of the particular architecture or built environments, i.e. an assessment of the fit between the individual capacities of the user and the physical requirements of the architectural design. The models of exemplary and appropriately accessible and usable architecture and built environments that the informants supplied validate this line of reasoning. In conclusion, accessibility and usability are opposing forces of the architectural space and they suggest the degree of usefulness of the particular architecture or built environments. Usefulness can be defined as:

3) Usefulness refers to the capacity of a particular architecture or built environments to accommodate various users with 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 adjustments made due to accessibility reasons.

By introducing usefulness as an aspect in the relationship between accessibility and usability, this study has bridged the gap between the modern implication of accessibility and usability and the bi-millennial Vitruvian credo of firmistas, utilitas, and venustas that still is valid in the creation of architecture and built environments. The mixed method design of this study has contributed to elucidate this line of thinking. However, this approach also calls for some words of caution: This study has focused on a phenomenon that to its nature is perceptual, and the introduction of quantitative data has merely supplied means to define a theorem for an improved understanding of accessibility and usability in the context of architecture and the built environments.

Concluding remarks
Given the slower pace of change that distinguishes architecture from the human existence the architectural design necessitates the largest possible level of being adjustable to the needs of various user groups. The theorem on usefulness can be an essential aspect for an improved understanding of the legislative demands of accessibility and usability in modern architecture and built environments, since it correlates user needs with the architectural design. It can also be used as a tool for clarifying the balance 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 environments in order to realize individual goals in life.

References
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