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Assessing standards for usable and safe environments for sight impaired

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Assessing standards for usable and safe environments for sight impaired

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Abstract. When revising national standards and guidelines facilitating for sight impaired persons in transport systems, Norwegian authorities needed an assessment of current standards and practices. Two issues concerning design of streetscapes and public transport stops were of particular concern for the authorities: Tactile paving seems to be laid out in situations where more thoughtful design with natural leading elements could better have ensured usability, accessibility and safety for sight impaired, and; Lack of consistency where tactile paving is laid out, causing potentially dangerous situations. The aim of this paper is to discuss how and why qualities of standards and guidelines, as well as of current practices, contribute to planning- and design-processes producing such results. Further, to arrive at recommendations for improving the situation.

Keywords. Research & development, Code of practice & standards, Safety & Hazards, Pavement design

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1 Introduction

1.1 Background and aim

Making transport systems accessible, usable and safe for visually impaired people is an important part of creating an inclusive society. In their efforts towards such a society, many governments have introduced the concept of Universal Design (UD) in their transportation planning systems (Tennøy and Leiren, 2008). The concept of UD has no one definition and is subject to different interpretations across countries, sectors and disciplines. The United Nations' Convention on the Rights of Persons with Disabilities (2006) offers the following definition (Article 2): "Universal design means the design of products, environments, programmes and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design".

In order to increase awareness and knowledge of UD throughout the professions, treaties and legislations have translated into standards, guidelines and handbooks for UD provision. The current Norwegian planning framework demands that all new infrastructure investments and buildings must be universally designed (Odeck et al, 2010). The Norwegian Public Roads Administration (NPRA) and the Norwegian Building Authority (NBA) are responsible for producing standards, guidelines and handbooks ensuring accessible, usable and safe transport environments for all. When revising standards, guidelines and handbooks (hereafter collectively termed "standards"), NPRA and NBA initiated a joint project to assess current standards.

For visually impaired people, a universally designed travel chain is one in which they can find their way, while not being exposed to dangerous situations. Norwegian

standards emphasise that this includes continuous “lead lines” to follow. A lead line is defined as a chain of natural leading elements and specialized tactile paving that is easy to follow for visually impaired, where elements provide visual and tactile information that is easy to recognise and understand (Norwegian Building Authority, 2010; Norwegian Public Roads Administration, 2011). The standards distinguish between natural leading elements and specialized tactile paving. Natural leading elements are elements naturally belonging in the environment, such as facades, well-defined kerbs, or tactile differences between surfaces. Useful reference points can be a fountain, a crossing, or changes in the auditory stream of traffic sound. Specialized tactile paving has a standardised design, and solely serves the purpose of guiding visually impaired.

As a commissioned work for the responsible authorities, Institute of Transport Economics together with Leeds University assessed Norwegians standards, guidelines and handbooks. The authorities were particularly concerned with two issues relating to lead lines. *Firstly*, the use of standardised tactile paving in situations when design with natural leading elements would better ensure accessible, safe and usable environments for sight impaired people. This practice was also understood to increase risks, since too frequent use of tactile paving could cause confusion and reduce awareness. The understanding was that specialized tactile paving rather should be reserved for warning risks (crossings, stairs) and for guiding in especially complex situations (open places, shared spaces, complex terminals). *Secondly*, lack of consistency and system faults when tactile paving is laid out, resulting in tactile paving systems often being neither logical nor homogenous. This could increase risks, as users relying on tactile paving for guidance can be misinformed.

With these two issues in focus, the main questions for the assessment were:

- How and why do qualities of current standards and characteristics of current practices contribute to some planning- and design-processes producing such results?
- How can the situation be improved?

The paper aims at answering these questions, by drawing on the assessment of current standards and practices in Norway. We believe that the findings and discussions are relevant for an international audience, since many countries have similar systems and face similar challenges.

1.2 Facilitating usable and safe transport environments for visually impaired

In order for pedestrian environments to be usable for visually impaired, it needs to be designed so that they find their way, feel safe, and are not exposed to dangerous situations.

Wayfinding is a key issue in visually impaired people's mobility. It] is defined by Farr et al (2012) as "the process of finding your way to a destination in a familiar or unfamiliar setting by using cues given by the environment". This process is so commonplace that it often is perceived as simple. In reality, Farr et al (2012) claim, wayfinding is a deeply complex process, involving our cognitive abilities and use of all senses, as well as interaction between human and environmental factors.

When finding our way around, we need to relate to what Lynch (1960) discusses as five elements of mental mapping: Paths (familiar streets, walkways, bus lines), edges (physical barriers of walls, fences, rivers, or shoreline), districts (places with a distinct identity), nodes (major intersection or meeting places) and landmarks (tall, visible structures). Use of sight is generally acknowledged to be the most effective way to gather information about such elements in the environment. However, this presents difficulties for those with a visual impairment, who need to rely more on information through sounds, smells and changes in surfaces. Totally blind people will rely entirely on these non-visual sources.

Visually impaired often learn about a new area or route together with a sighted companion (Storliløkken et al, 2012). When learning a route, usable reference points and tactile street elements are identified which can be useful in orientation and wayfinding. Hence, when designing pedestrian environments, care needs to be taken to ensure that the environment offers lead lines that are easy to orient along. Within the ideals of universal design, the built environment should be designed such that visually impaired can orient themselves and find their way without specialized tactile paving.

The *risk and safety* aspect requires, however, that tactile paving is used in particular circumstances, especially to warn against potentially dangerous situations (crossings, stairs). Where tactile paving is used, homogeneity and consistency are imperative to ensure that the message they convey is clear, in order to improve safety for users.

Pedestrians are generally considered to be vulnerable road users, borne out by the fact that they comprise over 20 percent of those killed on the roads (WHO, 2013) and it would

seem clear that there are specific dangers for visually impaired pedestrians. To the authors' knowledge, no data on road accidents involving visually impaired people is routinely collected, but in a previous issue of this journal Norgate (2012) cites survey work in which a quarter of respondents reported an incident where their cane had been run over and just under 10 percent had actually been struck by a vehicle (Carroll and Bentzen, 1999). It is important, however, to note that these dangers do not always translate directly into heightened risk, detectable in accident statistics, as visually impaired people often self-regulate their behaviour in order to avoid these dangers and mitigate the risk. This tends to mean that they suppress their pedestrian activity, and so safety becomes closely linked with issues of accessibility.

The literature is quite coherent regarding which qualities are required to facilitate wayfinding and reduce risks for sight impaired in transport environments: Simple and logical organization of the built environment; Obstacle-free walkways; Warning if danger; Smooth, even paving; Clearly defined kerbs; Crosswalks perpendicular to the kerb; Proper lighting; Strong tonal contrasts; A coherent system of natural leading elements complemented with specialized tactile paving where necessary (Atkin, 2010; Norwegian Building Authority, 2010; Norwegian Public Roads Administration, 2011; Norwegian Ministry of Environment, 1999; Ståhl and Almén, 2007; WHO, 2007).

2 Theoretical framework

As many have experienced, built environments do not always meet the requirements for being usable, accessible and safe for visually impaired people. This can be due to a number of factors.

The usability, accessibility and safety of streetscapes depend on how they are built, operated and maintained, as illustrated in Figure 1.

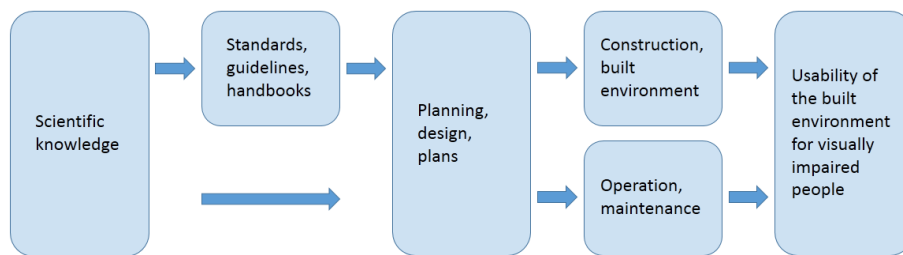


Figure 1: Our understanding of relationships between scientific knowledge; standards, handbooks and guidelines; planning, design and plans; construction and qualities of the built environment; operation and maintenance, and; the usability of the built environment for visually impaired people.

This, in turn, depends on how streetscapes are planned and designed. In order for those designing, planning, constructing and maintaining pedestrian environments to consciously and coherently be able to shape physical environments in ways making them usable and safe for visually impaired, they need to possess the necessary knowledge and expertise. To help provide this, standards are developed, intended to contribute to ensuring that streetscapes are coherently designed, and that usability and safety for visually impaired is given priority. In order for standards to contribute to usable, accessible and safe environments, they need to be based on sound practical and scientific knowledge on how visually impaired orient themselves, find their way and use different elements in the environment for this. Further, this knowledge needs to be translated into relevant and usable requirements and recommendations.

3 Research design and methods

3.1 Research design

In order to answer the research questions, a research design was chosen which scrutinized how qualities of the scientific knowledge base, of standards, handbooks and guidelines, as well as of practice affect qualities of the built environment. This consisted of three distinct parts.

Examination of the scientific knowledge with respect to whether it offers sound and accessible knowledge regarding:

- How visually impaired actually orient themselves and find their way with the help of cues given by the environment
- How characteristics of the built environment affect the usability, accessibility and safety for visually impaired

Studies of Norwegian standards, handbooks and guidelines with respect to whether they:

- recommend use of natural leading elements rather than standardised tactile paving
- present recommendations that point in the direction ensuring usable, accessible and safe environments
- are consistent with each other
- are usable, clear and understandable to practitioners using them
- include the type of situations often faced by practitioners
- are in accordance with scientific literature

- differ from standards developed in other countries and by international bodies

Concerning practice, research is directed towards disclosing:

- knowledge and understandings, which form the basis for practice
- if and how practitioners use standards, whether they find them usable and useful, and if they have suggestions for improvements
- how procedures of planning- and design-processes affect results
- if other considerations are given higher priority than usability for visually impaired

The findings were used in analyses aiming at disclosing how and why these factors can explain deviations between ideals of universal design and the actual built environment. Based on this, recommendations for how the situation can be improved were developed. Extra attention was given to how standards, guidelines and handbooks can improve in ways contributing to safer and more usable pedestrian environments for sight impaired.

3.2 *Methods*

Several complementary approaches are applied in order to gather relevant data: Literature studies, Documents studies; Interviews with relevant actors; Stakeholder seminars; and a Case study.

The literature review compiles a large body of research literature concerning facilitation for the visually impaired. In the documents studies, standards, handbooks and guidelines produced by Norwegian national and municipal authorities and by user organisations

were reviewed, as well as similar documents from Sweden, Denmark, UK, and international bodies. In total, 36 such documents were reviewed.

Semi-structured in-depth interviews were made with authorities responsible for developing standards, organisations representing visually impaired, and practitioners involved in planning, designing, building and maintaining built environments. All together, 20 persons were interviewed. Two seminars with relevant stakeholders involved in or working with facilitation for visually impaired were conducted. In the first seminar (with 26 participants) we asked for input and contributions to preliminary findings, while the second seminar (21 participants) served as a quality control of findings and conclusions, and helped to better interpret and understand our findings.

Finally, a case study was conducted, where the aim was to examine whether and how the mechanisms disclosed through the previous work play out in a specific bus terminal project. More details about the methods are to be found in the project report (Tennøy et al, 2013).

4 Findings

4.1 Scientific knowledge

The literature review revealed that research focuses more on tactile paving (e.g. Ståhl and Almén, 2007; Ståhl et al, 2004; Ståhl et al, 2010; Øvstedal et al, 2005) than on how the built environment should be organised and designed in order for people with sight loss to navigate and find their way. One important exception is Atkin (2010), presenting results of empirical studies regarding how people with different grades of sight loss and

different assistive devices make use of natural cues and standardised tactile paving. Atkin (2010) stresses that visually impaired will have the best premise for safe orientation if the built environment is predictable, with even surfaces and unobstructed paths. Storliløkken et al (2012) describe how visually impaired train to be able to manage daily tasks, including daily journeys, with a (often newly received) loss of sight. Their book is based on experience-based knowledge, gained during their years as mobility trainers which, whilst providing valuable insights and understanding, does not represent systematic research-based evidence. Ståhl and Almén (2007) found that natural guiding elements are superior to specialized tactile paving when it comes to orientation and wayfinding. It is, however, crucial that these natural elements are designed so that gaps are avoided, as this will break the continuous line visually impaired need in order to orient.

4.2 Standards, handbooks and guidelines

Studies of standards, handbooks and guidelines from Norway, Sweden, Denmark, UK and international bodies revealed that the ideals of universal design are more or less similar in these countries (Norwegian Building Authority, 2010; Norwegian Public Roads Administration, 2011; Norwegian Ministry of Environment, 1999; Standards Norway, 2011; International Standard, 2010; Swedish Transport Administration, 2012; Danish Road Directorate, 2012; UK Department For Transport, 2005). They all recommend or take for granted that natural lead lines are the first choice and best solution, and they stress that standardised tactile paving should be used only if it is hard to achieve adequate lead lines with the help of natural elements alone and where warning is required (especially to warn against crossings and stairs).

Still, standards are not very detailed and specific in their recommendations on how built environments should be designed so that usability, accessibility and safety are achieved with natural leading elements. There is a general lack of descriptions, examples and illustrations of facilitation addressing these issues. The NPRA's (2011) handbook mentions the use of natural guiding elements specifically in one page, while the use of standardised tactile paving has its own subchapter consisting of six pages. Tactile paving is mentioned throughout the handbook in various settings, while natural lead lines are not. The ISO-standard (International Standard, 2010) has one sentence regarding natural lead lines, while the remainder of the standard is dedicated to tactile paving.

Guidance with respect to tactile paving is described in much more detail and with many examples in the standards. Recommendations on when tactile paving should and should not be implemented are often diffuse, or missing. A reader could understand the standards to recommend use of tactile paving in numerous situations where expert and practice interviewees stressed that natural leading elements should be the first choice. Even though tactile paving is described in much detail, these descriptions represent mainly simple and ideal situations. The standards do not address the many complex situations present in real life. This was emphasized as a problem during interviews with practitioners.

The Norwegian and Nordic standards are relatively coherent when it comes to the physical design of the tactile paving, and what the different patterns, i.e. guiding path surfaces, warning surfaces and information surfaces, indicate (Norwegian Building Authority, 2010; Norwegian Public Roads Administration, 2011; Norwegian Ministry of Environment, 1999; Standards Norway, 2011; Swedish Transport Administration, 2012;

Danish Road Directorate, 2012). There are some minor differences in details. This differs from the UK, where no less than seven different tactile patterns, indicating different hazardous situations, guidance and information, are in use (UK Department for Transport and the Scottish Executive, 2005). This may add to the potential for confusion and misinterpretation of the standards (Atkin 2010).

Further, recommended solutions are rarely sufficiently justified and explained. For instance, concerning pedestrian crossings, it is especially critical that the standards are clear, and that practitioners understand the risks of deviating from the norm. It was found that standards are not clear on the fact that crossings should be placed perpendicular to the kerb. Neither do they explain why: Blind people often orient themselves in crossings by place both feet on the kerb to identify the direction over the crossing (Storliløkken et al, 2012). If the crossing is placed at a curve, a blind person may end up walking obliquely over the crossing and end up in the middle of the intersection not knowing where the sidewalk is (Scott et al, 2011). Needless to say, this is dangerous but is hardly mentioned in guidelines.

Based on these observations, it was concluded that current standards, handbooks and guidelines are not sufficient to encourage practitioners to emphasise natural lead lines as the preferred solution or to ensure consistency in tactile paving systems.

4.3 *Practice*

Even though standards have their shortcomings, the performance of those planning, designing, constructing, operating and maintaining the built environment also play a

large part in the level of usability achieved for visually impaired. In general, the practitioners interviewed for the study demonstrated good knowledge of the basic principles in universal design, and they regard it as a part of their professional knowledge base. However, they claim that most people working in this field do not have the same level of knowledge with respect to universal design and facilitating for visually impaired persons.

All practitioners agreed that tactile paving is used too frequently and that specialized paving mainly should be used to warn danger. Practitioners explain that they would rather try to facilitate the environment without use of tactile paving. Still, they admit to often using tactile paving as the solution when upgrading or building new environments. The explanations for this are often related to the complexity of the situation, and problems of finding good solutions by using natural leading elements. They report that they mainly use standards for double-checking specific requirements, such as minimum and maximum heights of dropped kerbs.

Practitioners explain that they frequently encounter difficult and complex situations where implementing optimal facilitation might be hard, or even impossible. They complain that standards and the like often are not very helpful in these situations, since they mainly present examples and recommendations fitted for ideal and simple situations. Hence, they often need to develop solutions fitted for the specific context, and without guidance from standards.

Another problem, causing non-optimal solutions, is that considerations regarding universal design in general are considered too late in the planning and design processes.

Many decisions are made in zoning plan processes. When designers later in the process aim at universal design, they find that earlier decisions strongly hamper the possibilities for designing safe and usable streetscapes. Further, the practitioners stress that there are always many considerations to take into account in a project, meaning that there is a constant struggle regarding prioritisation between groups, values and objectives.

Practitioners find that user consultations are necessary, often useful, and in many ways a good thing altogether. Still, many also found that such processes may be frustrating, in various ways. Some designers treat local users as experts in universal design, and lean on them for advice when dealing with complex design problems. Users are, however, normally not experts in this field, and may give advice that leads to solutions that designers are later criticized for. Several of the practitioners claimed that users involved push for tactile paving in situations when the practitioners found this to be un-necessary or not the best solution. Others had experienced that local users complained to the press or to politicians when they did not get their will through, for instance regarding tactile paving. In the stakeholder seminars, it was concluded that these experiences demonstrate the need to clarify the role of users and user consultations in such processes. It was emphasised that designers should not expect users to be experts or to behave as professionals, since this is not in accordance with their role.

Experts interviewed suggested that inconsistencies in tactile paving could be due to poor construction work. One practitioner explained that those doing the actual construction of streetscapes lack the knowledge to understand why tactile paving needs to be laid as described in plans and drawings. Hence, extensive supervision during the construction phase is necessary. Most interviewees were, however, more concerned about lack of

knowledge among those responsible for maintenance. They felt that poor maintenance and faults made during reparations contribute to less usable and safe streetscapes for visually impaired.

4.4 Experiences from the case study

Finally, the case study of a developer with high ambitions regarding universal design revealed that focus on universal design from the start, involvement of competent and confident professionals during design and construction, as well as knowledgeable supervision throughout the project, increases the chances of arriving at built environments that are usable for visually impaired persons.

Still, the case study demonstrated how even projects with the best possible basis for universal design also may include solutions that are not optimal. This could be illustrated by two examples. One is the use of tactile paving leading towards a revolving door, which can be a difficult object to pass for visually impaired. The designers saw, in retrospect, that this is not an optimal solution (that is why alternative doors are required), but explained that standards did not address this issue and that they had not considered whether this was a good solution. Another example regards a pedestrian crossing with different tactile paving design on each side. The explanation for this was that one side of the crossing was completed years prior as part of another project, and the design was based on older recommendations. This underlines the fact that cities are continuously built and developed, according to varying requirements. The edges of a project always meet the edges of other (previous) projects. Solutions chosen in other project areas might affect the usability altogether. Sometimes it might not be difficult to merge the natural

reference points or tactile paving. In other situations, the solutions chosen in other project areas can greatly disturb the usability for the visually impaired.

5 Discussion

An aim of this research was to assess how and why qualities of current standards and characteristics of practices contribute to tactile paving being used in situations where natural leading elements would be a better solution, and why there is a lack of consistency in tactile paving systems.

5.1 How and why is tactile paving used where natural leading elements would be a better solution?

Seen from the point of view of practitioners, they often face complex situations where several considerations need to be taken into account, and they seek to solve the situations in the best way they can. They may face situations where they introduce changes of elements in already existing streetscapes, or they may be presented a zoning plan where non-optimal schemes (with respect to universal design) has already been decided upon. The practitioners might anyhow aim at using natural elements to form lead lines that are usable and safe. They rely on their education, previous experiences, and discussions with knowledgeable colleagues, and they consult standards, guidelines and handbooks. When turning to such documents, they find thorough descriptions on tactile paving, but only brief and vague descriptions on how to solve the situation with the help of natural leading elements. This is one reason why they choose standardised tactile paving.

Practitioners do also encounter local users participating in the design processes pushing for tactile paving. When designers turn to the standards, they are vague and not a good

tool for convincing the users that natural leading elements are a better solution in the specific case. If conscientious practitioners turn to scientific literature for help, they will not find compelling evidence there either. Knowing that users may complain to press or to politicians, and lacking documented evidence or clear recommendations for using natural leading elements, practitioners may choose tactile paving even though they do not find this to be the better solution.

These mechanisms seem, from our studies, to be important parts of the explanations of how and why tactile paving is used more frequently than most of those interviewed find optimal. Another relevant explanation is that many practitioners are not very knowledgeable with respect to these issues, and believe that tactile paving is the better solution. If they turn to available standards, guidelines and handbooks, such beliefs might be affirmed.

5.2 Why do inconsistencies in systems of tactile paving occur?

Turning to the problem of lack of consistency with respect to tactile paving, many of the same elements play a part. Practitioners face complex situations where many considerations need to be made. When turning to standards and the like, they find recommendations and examples from simple and ideal situations, which are not helpful. Hence, they need to figure out how to solve the situation on their own. If they are of a conscientious kind, they may read the standards carefully, or they may turn to research literature in order to figure out how visually impaired orient and what needs to be emphasised when doing local adjustments. As found in our studies, this will not be helpful. Hence, the practitioners need to develop on the spot solutions based on their

personal understanding of how people with sight loss orient and find their way, and how the built environment should be designed in order to be usable for them. Unsurprisingly, the results are deviating designs and hence inconsistent systems of tactile paving. Further, as demonstrated by the case study, streetscapes are built continuously, and both standards and ideas of what are good solutions vary over time. This is also an important part of the explanation.

All standards and all interviewees agreed that tactile paving should be used to warn against stairs and crossings. Our study revealed quite a severe problem - that the practice of using warning surfaces to demarcate dropped kerbs at crossings anyhow varies strongly. There are variations in designs, and in many cases warning surfaces are missing. In one example, a stretch of an urban street was re-built with warning surfaces demarcating some crossings but not others. In another example, warning surfaces were missing in connection with a regulated pedestrian crossing being part of the main pedestrian street, rebuilt only five years ago. One explanation for this, we were told in interviews, was that the responsible authorities did not believe that visually impaired people are able to detect these warning surfaces, or that “they do not use them”. Another suggestion was “sloppy work and project management in the construction phase”. Unfortunately, the responsible authorities were not available for interviews.

6 Main recommendations

The second aim of the study was to arrive at recommendations for how to improve the current situation, through changing standards and/ or practices. An important finding in this work is a lack of systematic and research-based knowledge on how people with sight

loss actually orient and find their way in complex pedestrian environments, how they use elements of the physical environment in these processes, and hence how the built environment ought to be designed in order to be usable for people with sight losses. The strongest recommendation is hence that more systematic research on these issues should be conducted, and to make this knowledge available to those developing standards, guidelines and handbooks, as well as to practitioners. Institutions engaged in mobility training for the blind and visually impaired may be useful partners in such work.

Standards, guidelines and handbooks should present more comprehensive and specific descriptions on how to design usable built environments, allowing easy and safe wayfinding for the visually impaired. Further, how use of natural leading elements could be used to reinforce this. The balance between tactile paving and natural leading elements should be shifted towards natural leading elements.

The standards should contain more, better and concrete discussions, examples, and illustrations of good facilitation. Further, they need to explain and justify recommended solutions. Otherwise, planners and designers may ignore details that are important for visually impaired, or misunderstand the intentions of recommendations. There is thus a particular need for clarification and explanations regarding recommendations for crossings.

Most practitioners requested better guidance for complex situations. The standards should also contain guidance on how visually impaired people orient and find their way, and how the built environment can be design to help and support them on their everyday journeys, with and without the use of tactile paving. Knowing how visually impaired

persons orient, it may be easier for practitioners to familiarize themselves with their situation and hence facilitate a better and more usable environment.

The national efforts to harmonize different standards, handbooks and guidelines should continue. This is especially important when it regards warning of hazards. Readings of standards from different countries disclosed significant deviations. This calls for international harmonization, for instance by strengthening the influence of ISO-standards.

Norwegian authorities discuss how to deal with the shared space concept when revising their standards. They are recommended to learn from experiences in the UK, where removal of the traditional kerb in shared spaces been recognised to increase risk for sight impaired and to reduce their ability to navigate in such spaces (Child et al, 2009; Norgate, 2012; Thomas 2008, 2011).

Another recommendation regards improving the knowledge of practitioners involved in planning, designing, constructing, operating and maintaining the built environment. This could be done through training programs mandatory for those involved in facilitation, and with recurring courses on a frequent basis. Further, there is a need for highly qualified experts in this field. Another approach could be to put in place a system for certifying professional mobility consultants, which have received special training, as is already done in the UK.

Recommendations concerning processes include that universal design is considered early in processes, in order to prevent non-optimal frames with respect to usable solutions.

Another lesson learnt is that the role of users participating in planning- and design processes needs to be clarified. Finally, deeper and more thorough research than that presented here is needed regarding how planning- and design-processes proceed, to clarify the mechanisms contributing to the built environment being designed in ways that are usable and safe for visually impaired persons.

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