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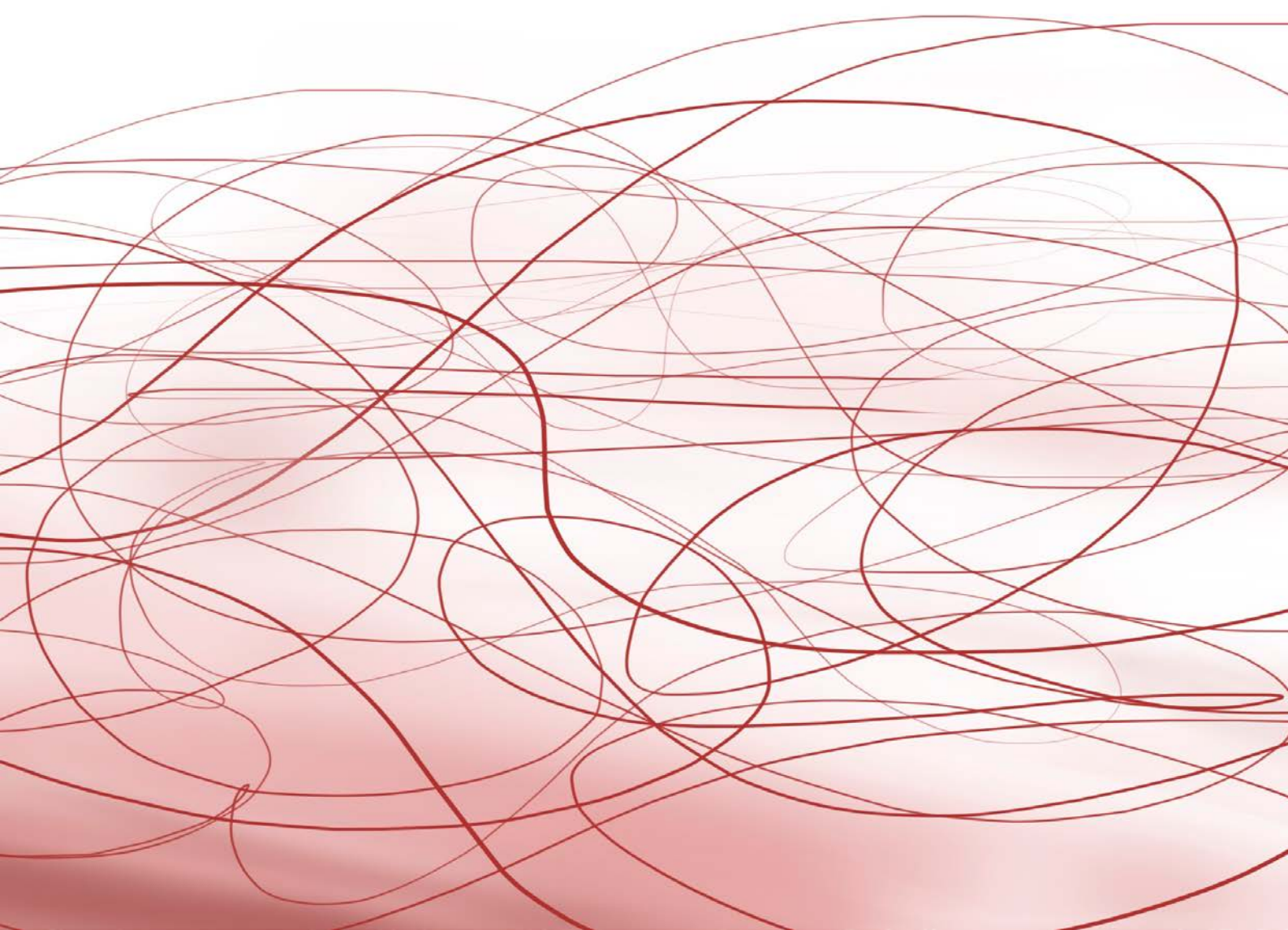
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THE DEVELOPING DEFINITION OF UNIVERSAL DESIGN

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Abstract: A review of scholarly work indicates a shift in the definition of universal design. Originally, the focus was placed on physical access to the built environment through design innovations that, while small in scale, resulted in significantly improved outcomes. This has developed to a more contemporary vision that addresses issues of social justice across multiple strata. This development is an indicator of the evolution of the field and has significant implications for those teaching universal design.

In 2018, educators teaching in interior design programs accredited by the Council for Interior Design Accreditation (CIDA) in the United States were surveyed about the infusion of universal design content within their curricula. As part of the survey, participants were presented with four definitions and asked to assess their appropriateness in defining the term universal design. Responses revealed a generally high level of understanding regarding the definition of universal design. This article investigates the evolution of the definition of universal design, presenting each of the definitions in their historical context, presents the survey results of interior design educators' perceptions of these definitions, and concludes with implications for universal design, particularly in the interior design discipline.

Keywords: universal design, interior design, human-centred design

Introduction

Educators of interior design, particularly those within programs accredited by the Council for Interior Design Accreditation (CIDA), are responsible to address

a wide variety of topics designed to ensure students are prepared to enter the profession. CIDA makes this responsibility plain in the Preamble to their Professional Standards, stating that “a sound curriculum for professional interior design education must provide a balance between the broad cultural aspects of education, on the one hand, and the specialized practical content integral to the profession, on the other.” (Council for Interior Design Accreditation, 2018)

Consistent with their stated commitment to “the ongoing enrichment of the interior design profession through identifying, developing and promoting quality standards for the education of entry-level interior designers”, CIDA requires that accredited programs of interior design successfully address 118 topics across sixteen standards. (Council for Interior Design Accreditation, About CIDA, n.d.) Among these standards, the universal design is addressed in standard 7e: “Student work demonstrates the ability to apply human factors, ergonomics, and universal design principles to design solutions.” (Council for Interior Design Accreditation, 2018) Footnoted reference of this standard makes reference to the following definition of universal design attributed to Ronald Mace at North Carolina State University Center for Universal Design: “the design of products and environments to be useable by all people to the greatest extent possible, without the need for adaptation or specialized design.” It is worth noting that this footnote includes specific differentiation of universal design from accessibility standards in the United States and Canada. (Council for Interior Design Accreditation, 2018)

Interior design generally, and CIDA in particular, has a well-established historical connection to universal design as a concept, even before the term “universal design” had become definitively understood. As will be discussed in the next section, the earliest use of universal design as a defined term occurred in 1985 by Ronald Mace, although at that time, the term had not gained widespread adoption beyond its origins in disability advocacy (Mace, 1985). Even so, the Foundation for Interior Design Education and Research (FIDER), as the predecessor of CIDA, included “design for special populations including persons with disabilities” as a core competency required of students educated in interior design as early as 1988 (Maisel, Steinfeld, et al., 2018; Foundation for Interior Design Education and Research, 1996). In subsequent

iterations of the FIDER professional standards, terminology shifted toward the use of “universal accessibility,” placing interior design educators among the earliest adopters of this concept. FIDER accreditation standards have included the term “universal design” since the publication of Professional Standards 2000 (Council for Interior Design Accreditation, 2000). This shift in terminology can be attributed to the then-recently published Seven Principles of Universal Design in 1997 (Connell et al., 1997). FIDER would change their name to CIDA in 2006 (Council for Interior Design Accreditation, Our Story, n.d.)

In the intervening years, through the work of several scholars, attempts have been made to fully capture the essence of universal design, resulting in no fewer than six different definitions of the term. Far from being a detriment to the study of this field, the multiplicity of definitions is, in fact, a sign of a healthy, growing concept. In the *Handbook of Universal Design* (2001), contributor Molly Story indicates that:

Differing terminology is a sign of healthy engagement with the concept, of practitioners seeking wording that is useful for a variety of specific purposes. Regardless of wording, the goal is profound: we can and should make our human-made world as accessible and usable as possible for as diverse a user population as possible. (W. F. E. Preiser & Smith, 2011)

Background

Evolving Definitions of Universal Design

Globally, the concepts contained within universal design have been included under different terms. In the UK, for example, the term “inclusive design” is more commonly used than universal design (Clarkson & Coleman, 2015). “Design for all” is the preferred term by the Council for Europe and the European Commission, particularly in their centres of excellence initiatives (Ormerod & Newton, 2005). While there are regional differences in the terminology, the basic underlying concepts agree. Of the terms considered, universal design has the longest history and, therefore, the greatest

development in clarifying the language of the definition. Furthermore, universal design has the greatest adoption in the United States (W. F. E. Preiser & Smith, 2011), and this term has been incorporated into the accreditation standards of interior design, the specific field studied in this survey. Moreover, as this study was limited to CIDA accredited programs in the United States, exploration was focused on the specific term universal design.

In the United States, the earliest use of the concept that would become known as universal design is attributed to the work of Ronald L. Mace at the Center for Universal Design at North Carolina State University. The first official definition of universal design emerged in 1985 as follows:

Universal Design is the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design. (Mace, 1985)

Mace's definition refers broadly to the design of both industrial products and architectural space. Mace, though an architect, understood from the outset that the concept of universal design needed to embrace more than simply architectural space. This definition was later included in the 2006 UN Convention on the Rights of Persons with Disabilities (Sieberns, 2018).

In 1991, Mace, Hardie, & Place published a revised definition as follows:

designing all products, buildings and exterior spaces to be usable by all people to the greatest extent possible. (Mace et al., 1991)

To assist with the implementation and dissemination of the concept of universal design, ten cross-disciplinary researchers were assembled to establish an agreed-upon set of principles by which universal design could be assessed. The Seven Principles of Universal Design resulting from their work were published in 1997. (Connell et al., 1997)

Among the authors of the Principles of Universal Design was Gregg Vanderheiden, PhD. Shortly after the publication of the principles, Vanderheiden offered the following definition of universal design:

A process of creating products (devices, environments, systems, and processes) which are usable by people with the widest possible range of abilities, operating within the widest possible range of situations (environments, conditions, and circumstances), as is commercially practical. (Vanderheiden & Tobias, 1998)

Whereas Mace viewed the role of universal design primarily through an architectural lens, Vanderheiden considered a different perspective as an expert in systems and user-interface design. It is therefore made clear in his definition that the concept of universal design applies not only to the built environment but also to “systems and processes.”

The mission and message of universal design continued to be refined in the following years. In 2001, Elaine Ostroff of the then-Adaptive Environments Center (now the Institute for Human Centered Design) published the *Handbook for Universal Design*, in which she presented the following definition:

Universal design is an approach to design that honors human diversity, addressing the right for everyone--from childhood into the oldest years--to use all space, products, and information in an independent, inclusive, and equal way. Further, the universal design process invites designers to go beyond building or access code compliance to create excellent, human-centered design. (W. F. E. Preiser & Smith, 2011)

It is clear from these definitions that the focus of universal design had already begun its evolution beyond a concept focused on specific design interventions and toward one focused on the needs of a diverse group of users.

Concurrently, researchers in the UK were evaluating the terminology and fitness of the various terms of universal design, inclusive design, and design-for-all. In 2005, Ormerod argued that the terms could be considered as interchangeable and offered a definition that sought to resolve these disparate terms into one definition:

Inclusive design is way of designing products and environments so that they are usable and appealing to everyone regardless of age, ability or circumstance, by working with users to remove barriers in the social,

technical, political and economic processes underpinning building and design. (Ormerod & Newton, 2005)

This definition would proceed to be adapted by the United Kingdom Design Council, where it was officially adopted in 2008.

[Inclusive design] is a general approach to designing in which designers ensure that their products and services address the needs of the widest possible audience, irrespective of age or ability. Two major trends have driven the growth of Inclusive Design (also known [in Europe] as Design for All and as Universal Design in the USA) - population ageing and the growing movement to integrate disabled people into mainstream society. (Design Council, 2008, referenced in Clarkson & Coleman, 2015)

It is notable that while the Ormerod & Newton definition clearly continues the trend of considering a human-centred design approach, the official UK Design Council definition, though published afterwards, maintains language consistent with a disability-focused agenda. This can be contrasted with the following definition published the same year by Beth Tauke, professor and researcher at the University at Buffalo School of Architecture and Planning:

Inclusive design is socially focused and grounded in democratic values of non-discrimination, equal opportunity, and personal empowerment. (Tauke, 2008)

Here Tauke removes traditional explicit references to the built environment, products, systems, and processes, that figure prominently in previous definitions, and opts instead for a values-based approach. If a design process of any variety is socially focused, non-discriminatory, and addresses equality of opportunity and personal empowerment, Tauke argues, it should be considered inclusive (or universal) design. Contrasting this approach with the initial Mace definition from two decades prior, it is evident that the movement of universal design has transitioned beyond the responsibility of designers of the built environment to a much wider set of designers, thinkers, and practitioners.

A final recent notable definition continues the trend of addressing issues of diversity and personal empowerment as foundational components of the concept of universal design.

A design process that enables and empowers a diverse population by improving human performance, health and wellness, and social participation. (Steinfeld & Maisel, 2012)

This definition, consistent with its predecessors in emphasizing design as a process, also emphasizes the importance of the outcomes of this process. This suggests the possibility of an assessment tool that can evaluate the outcomes in areas of human performance, health and wellness, and social participation, which will indicate the relative success of a universally designed process. From this definition, it can therefore be asserted that if a design does not sufficiently improve human performance, health, wellness, and social participation, it is not considered universal.

A trend is evident in the development of these definitions, which expands from specific design intervention as exemplified by Mace's 1985 definition toward an approach that inspires more empathy on the part of the designer. The trend invites this question: Is the role of the universal design practitioner to suggest modest and incremental improvements to the built environment, or is it instead to replace the process that results in traditional designs and built works with one that starts with embracing human diversity and wellbeing?

Universal Design in Interior Design Education

The development of the definition of universal design has occurred in parallel with the development of the professional standards by which interior designers in CIDA-accredited programs are trained. Interior design educators have been working to include universal design content in their curricula from the earliest days of the concept. This is due in large part to the influence that accreditation standards have played. FIDER and later CIDA have both included requirements for programs seeking accreditation to address the concepts of universal design in varying forms and under multiple terms.

Professional Standards 2000 (Council for Interior Design Accreditation, 2000)
Standard 6l consisted of the following language:

Student work **MUST** demonstrate understanding of universal design concepts and principles. (Council for Interior Design Accreditation, 2000)

While this was the first time that direct reference to the specific term “universal design” was included in the interior design accreditation standards, the standards in force immediately prior were FIDER 402R, dated January 1996. While 402R did not include the language of universal design, it is evident that the authors were aware of the movement as the standard includes “universal accessibility guidelines” in standard S2.11.3 as an example of standards and regulations with which students must be familiar (Foundation for Interior Design Education and Research, 1996, p.9).

In contrast, interior design’s most closely allied field, architecture, is accredited by the National Architectural Accreditation Board (NAAB). To date, NAAB has not included language indicating the importance of inclusive or universal solutions in their published Procedures for Accreditation, even as recently as 2015. Standard B.2 of this document, titled Accessibility, indicates that students must demonstrate the

Ability to design sites, facilities, and systems to provide independent and integrated use by individuals with physical (including mobility), sensory, and cognitive disabilities. (National Architectural Accreditation Board, 2015)

While this embraces the partial spirit of universal design, the focus of this standard is explicitly placed on disabilities. In concept, this is most closely aligned with a code-based minimum requirement definition. Absent is the concept of design for all.

Methodology

Survey Responses to Definitions of Universal Design

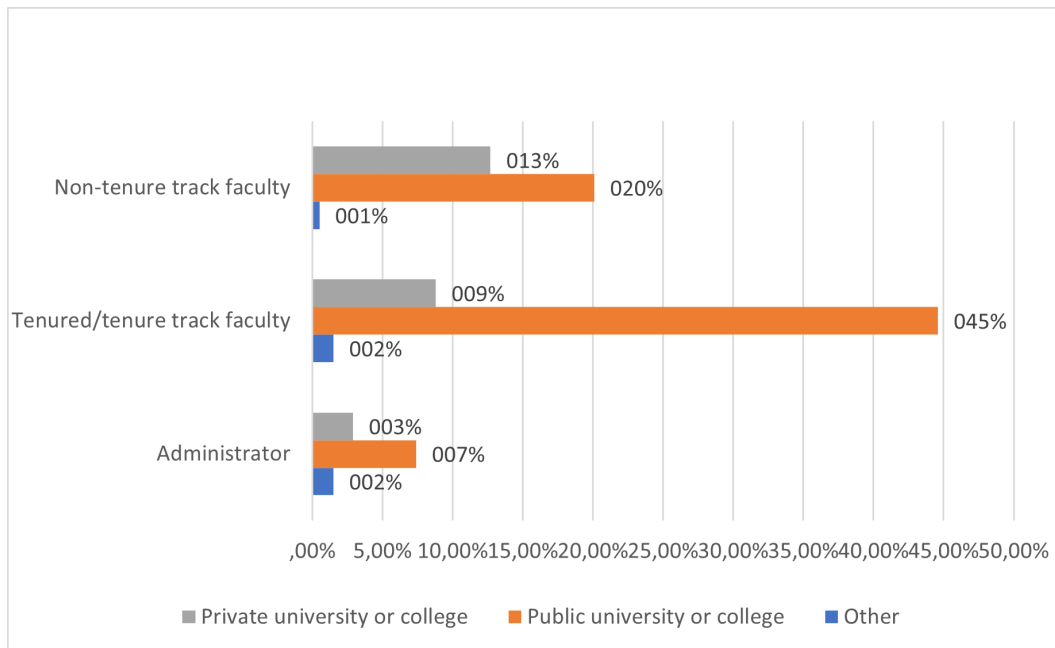
Because of the extended history of interior design with universal design, researchers were interested in the degree to which accredited interior design programs in the United States were achieving the CIDA-prescribed requirement. This was investigated through an online survey distributed to faculty and administrators in 158 CIDA accredited interior design programs throughout the United States in 2018. The survey procedures and content were similar to a previous survey sent to accredited Architecture programs (Tauke et al., 2016). The survey sought both quantitative and qualitative information, which asked about the understanding, attitudes, and incorporation of universal design in their curriculum. The following information provides additional information about the respondents.

Fig 1. Respondents who identified their school represented all five regions identified by the Interior Design Educators Council (IDEC).

<i>IDEC Region</i>	East	Midwest	Pacific West	South	Southwest	Region not provided	Total n
Sample size	24	45	22	42	27	93	253

Respondents were also asked to describe their primary title within their department and the type of institution in which the CIDA accredited program resides. Figure 2 below shows the responses provided by the 204 respondents who provided both title and institution type.

Fig 2. Respondent's Title and Institution Type: Percentage of the total sample (n=204)



Among the many topics related to universal design that were investigated through this survey, researchers were interested in examining faculty understanding of the concept of universal design. The findings of this topic are the particular focus of this paper and are expanded below.

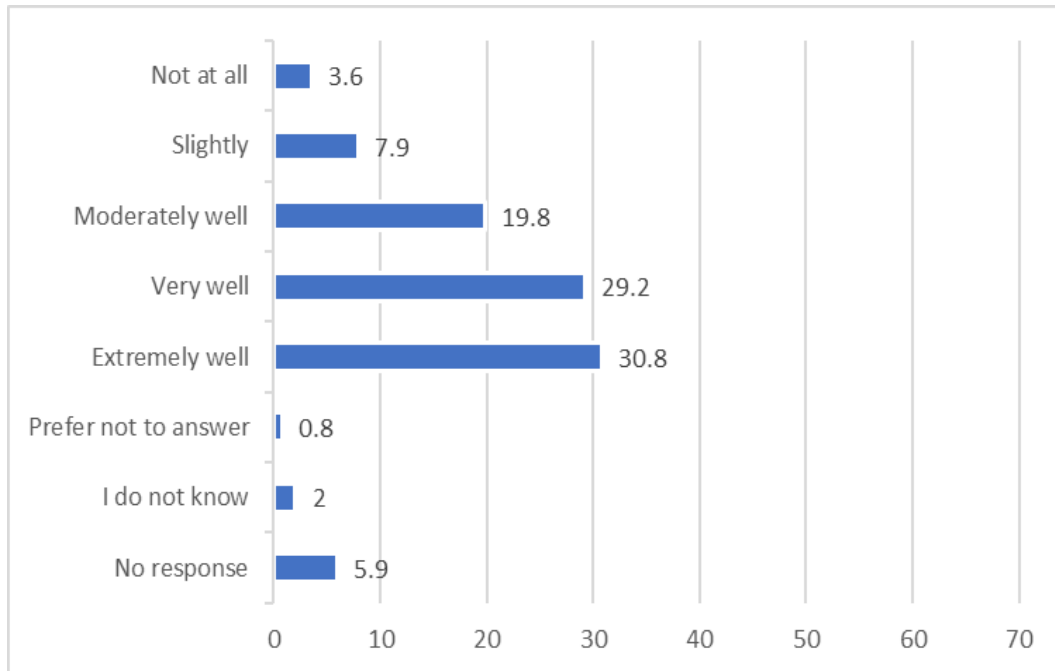
Survey respondents were presented with four definitions and asked “How well does this statement describe the term ‘universal design?’” Definitions 1, 3, and 4 were drawn from a historical context within the universal design movement, as discussed previously, whereas definition 2 was presented as a foil. All definitions were presented without context; survey participants were not provided with any background information for each definition.

Definition 1 as presented in the survey was the 2008 definition by Tauke

Inclusive design is socially focused and grounded in democratic values of non-discrimination, equal opportunity, and personal empowerment.

The responses to this definition by Tauke (2008) (Fig 3) indicate that faculty believe this definition to be an adequate definition of universal design. Sixty percent of respondents indicated that this definition fits the concept very well or extremely well, with only 11.5% indicating that it met the definition slightly or not at all.

Fig 3. Definition 1: A socially focused design process grounded in democratic values: Percent agreement (n=253)



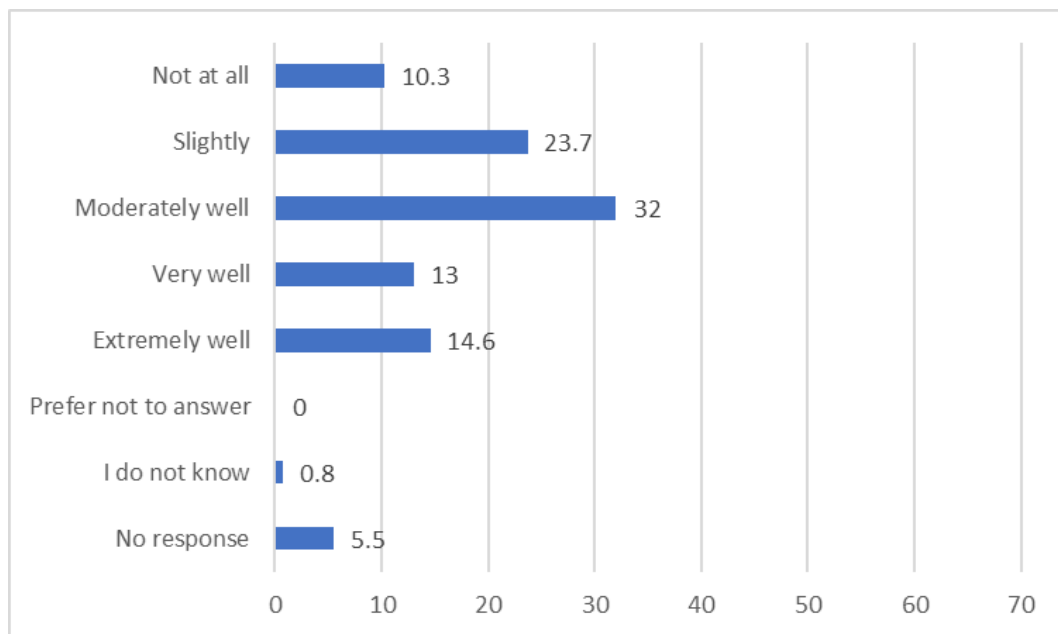
Definition 2 presented in the survey was adapted by the researchers from the 2010 Standards for Accessible Design by the United States Department of Justice. The definition published in the standards reads as follows: “minimum requirements - both scoping and technical - for newly designed and constructed or altered state and local government facilities, public accommodations, and commercial facilities to be readily accessible to and usable by individuals with disabilities.” (United States Department of Justice, 2010). The definition presented in the survey distilled the essential concepts and presented the following adapted definition

The design of interior and exterior environments to meet prescribed requirements for people with disabilities.

This definition was included as a foil. It places emphasis on access for people with disabilities which, as discussed above, is an incomplete perspective from the standpoint of universal design. Interior design educators predominantly recognized this, with 27.6% indicating that this definition described universal design very well or extremely well, 32% indicated a moderate response, and 34% indicated slightly or poorly (Fig 4). Researchers were interested in investigating some possible reasons that the responses were not skewed even more dramatically and so cross-referenced the responses with demographic

questions. Those responses indicating that definition 2 fit the concept very well or extremely well were predominantly part-time instructors. Possible reasons were discussed amongst researchers for this, including professionals who are daily steeped in building code language or a lack of professional sensitivity to the development of the definition of universal design. The collected data did not indicate any further depth on this issue, and it remains an open question for further study.

Fig 4. Definition 2: Design of environments to meet requirements for people with disabilities. Percent agreement. (n=253)



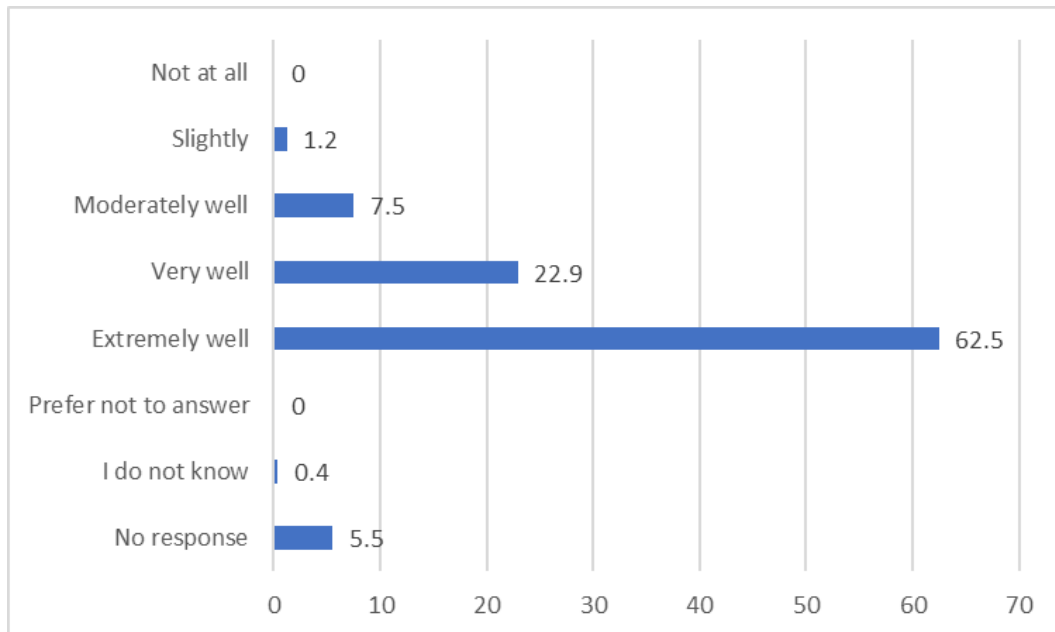
Definition 3, as presented to respondents, was an adaptation of the 1991 Mace definition discussed above. As published by Mace, this definition reads as follows: “designing all products, buildings and exterior spaces to be usable by all people to the greatest extent possible.” (Mace et al., 1991). The adapted definition as presented in the survey read as follows

The design of products, information, environments, and systems to be usable to the greatest extent possible by people of all ages and abilities.

Considered a classic definition in the field, researchers anticipated that many respondents would find this definition a strong fit to the concept. As expected, respondents strongly indicated that this definition represents the term universal design, with 85.4% indicating that it describes the term very

well or extremely well. Only 1.2% indicated that this definition slightly describes the term universal design, and no respondents indicated that this definition was fully unfit to describe the concept (Fig 5).

Fig 5. Definition 3: Design of products, information, environments to be usable by all. Percent agreement. (n=253)

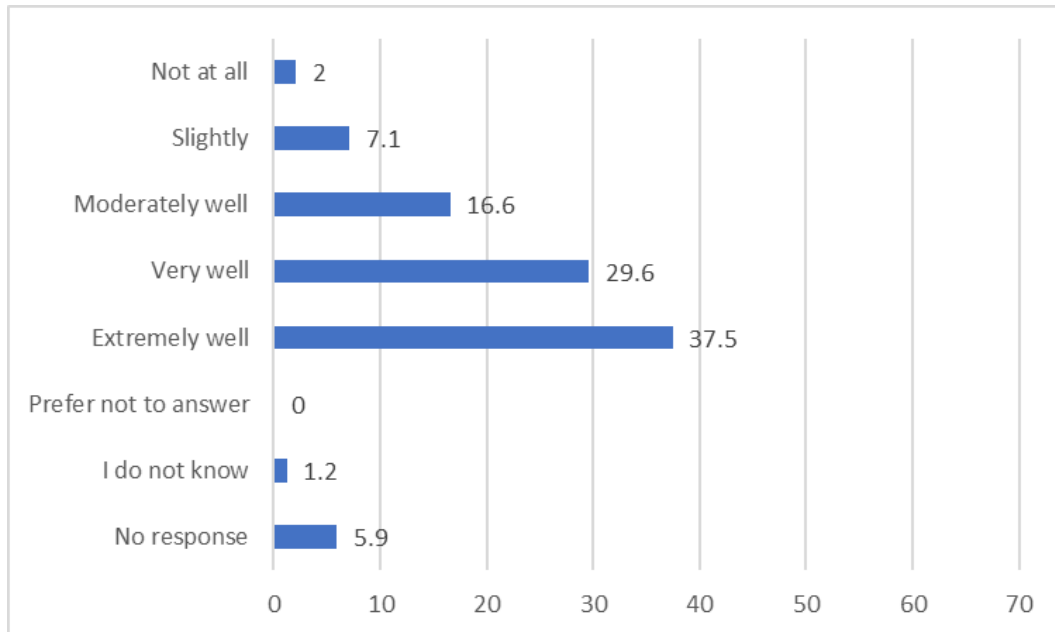


Definition 4 presented in the survey was published by Steinfeld and Maisel in 2012, making it the most recently published definition. The definition as presented in the survey reads as follows:

A design process that enables and empowers a diverse population by improving human performance, health and wellness, and social participation.

Respondents generally agreed that this definition represents the concept of universal design, as 67.1% of respondents indicated that this definition describes the term universal design very well or extremely well. Only 9.1% indicated slightly or not at all (Fig 6).

Fig 6. Definition 4: A design process that enables and empowers a diverse population. Percent agreement. (n=253)



Conclusion

A key finding resulting from this investigation is that interior design educators have a good understanding of the term ‘universal design.’ Of the definitions provided, respondents accurately identified the three that are part of the developing definition of universal design as discussed previously, though there remains some concern as to the ambiguous responses received for the disability-focused definition 2 (Fig 4). This could be an indication that further instructor education in this area is needed. Further study of this issue should be undertaken. Among the definitions that are included in the developing definition of universal design, more recent definitions 1 (Fig 3) and 4 (Fig 6) do not yet appear to be as readily recognizable to educators as is definition 3 (Fig 5), which is acknowledged to be a classic in the field. This may be a result of educators understandably relying on tried-and-true course materials, but may also indicate a need to update curricular offerings.

Although it is not possible with this data to ascertain the degree to which CIDA accreditation standards have influenced the high level of faculty familiarity with the concepts of universal design, it is likely that requiring this content in the documentation for programs seeking accreditation is a contributing factor.

In contrast, faculty in a similar study of NAAB accredited architecture programs showed a lower general understanding of the topic (Tauke et al., 2016).

The continuing evolution and development of the concepts surrounding universal design indicate that the importance of access and human dignity promoted by universal design are enduring concerns of the built environment. Far from a settled discussion, universal design is an evolving concept which should be tested and refined in its application to endeavours in both academy and practice. As concluded by Mace in 1991 “For the technologies of universal design to fully develop, universal design concepts and methods must be taught in university design programs.”(Mace et al., 1991) It appears from this data that instructors in interior design have embraced this message.

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MEASURING ECONOMIC BENEFITS OF ACCESSIBLE SPACES TO ACHIEVE ‘MEANINGFUL ACCESS’ IN THE BUILT ENVIRONMENT: A REVIEW OF RECENT LITERATURE

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Abstract: The level of accessibility in the built environment in most cities is still far from optimal. To enable people with a wide range of abilities to fully participate in social and economic activities, a more holistic change is needed in all spaces in which people interact on a daily basis. Building industries—developers, construction companies, and building owners—play a crucial role in accelerating this change. However, without a way to benchmark clear, more direct, and comprehensive economic benefits for these industry stakeholders, the effort of making our built environment more ‘meaningfully accessible’ will not get far. The purpose of this paper, therefore, was to learn how economic benefits of accessibility-related to the built environment has been conceptualized and measured in the empirical literature. Building on the findings, a clearer cost-benefit analytic framework for creating accessible buildings and outdoor spaces may be formulated. Our literature scan of studies published in the last two decades yielded 19 papers, all but two of which are from tourism and transportation research. We found three main approaches to conceptualizing economic benefits: 1) as market potential of accessible sites and services projected at the population-level (mainly in tourism); 2) as cost saved from having accessible infrastructure (mainly in transportation); and 3) as hypothetical return of creating accessible spaces (transportation, housing and urban design) based on users’ willingness-to-pay. The papers ubiquitously agree that there are far-reaching overall benefits of making

products and services more accessible for society. But many also acknowledged the data and methodological limitations in current cost-benefit analysis frameworks. Efforts of improving data availability and methodology through cross-disciplinary dialogues are strongly desired. Similarly, a strong voice of public demand for change in the built environment will be critical in fostering the dialogues.

Keywords: economic benefits, built environment, meaningful access, cost-benefit analysis framework.

Introduction

A WHO report in 2011 showed that about 15% of the world's population is said to have some type of disability, which is well over a billion people. Newer reports estimate that possibly 2 billion people have some type of disability (Wagner, 2019). Many countries are also experiencing rapid population ageing, and persons with disability will increase at an accelerating rate. As individuals age, they will have reduced physical strengths and dexterity, limiting their ability to live an independent life and participate in civic activities as members of society. Our built environment—generally understood as human-made spaces in which people live, work, and play (Glanz et al., 2016)—needs to adapt to such population change.

However, the level of accessibility in the built environment in most cities is still far from optimal. To achieve accessibility that enables people with a wide range of abilities to fully participate in social and economic activities across private and public spheres, a more holistic change in the built environment is necessary. Such an ambitious aim can only be achieved if both public and private sectors work together to increase spaces in the private (home) as well as public realms (outside of home). The public realms span across streets, parks and recreational spaces, and commercial and institutional buildings.

Despite the crucial role of private sectors (particularly building industries such as developers, construction companies, and building owners), few benchmarking frameworks exist for the industries to gauge a broader range of costs and benefits in incorporating designs beyond minimum guidelines for

accessibility in buildings and surrounding outdoor spaces. In particular, there is a dearth of evidence that demonstrates tangible benefits to the building industries in achieving accessibility beyond minimum standards. Without a clear benchmarking framework, there can continue to be limited buy-ins from the industries to create beyond minimally accessible buildings and spaces that meet the standards, as it is difficult to gauge their financial risks and benefits.

Therefore, the purpose of this paper is to learn from empirical literature how an analytic framework for the economic benefits of creating accessible buildings and other spaces may be formulated. In particular, this paper asked: 1) how are the economic benefits of accessibility conceptualized and measured in empirical studies? and 2) what conclusions were drawn from these studies about the economic benefits of accessibility?

Background

Accessibility, universal design and meaningful access

Accessibility means different things to different people. As for the accessibility concept specifically related to the built environment, Iwarsson and Stahl (2003, 58) define it as “the simplicity with which activities in the society can be reached, including needs of citizens, trade, industries and public services”. Winance (2014, 1334) conceptualizes accessibility as “a process of adjustment and practical arrangements between the persons and her/his environment”. Similarly, Andersson and Skehan (2016, 102) consider it as “the meticulous work of adjusting every detail of the built space to a large and varied group of potential users, with a focus on details of importance in relation to cognitive, physical and sensory abilities”.

The term Universal Design (Story, Mueller, & Mace, 1998) has probably had the largest traction in the recent accessibility discourse, helping promote understanding of the need for a built environment inclusive of populations with a wide range of physical, cognitive, and mental abilities. Universal Design is sometimes coined with another term, Design for All (Aslaksen, Steinar, Rand, & Edel, 1997; Barnes, 2011). To a certain extent, the term universal has also helped reduce the sense of stigma for any specific group. However, there

is still a perception that Universal Design is another, less stigmatizing term for an effort to increase accessibility for only a small segment of society in a severe end of the ability spectrum (Odeck, Hagen, & Fearnley, 2010).

Notwithstanding, Raviselvam, Wood, Hölttä-Otto, Tam, and Nagarajan (2016, 131) define Universal Design as “designs that enable the users and not disable them irrespective of their age or ability.” They further state, “(A) good design accommodates a user’s existing abilities rather than highlighting what they lack; designs that fail to fulfil this requirement leave the user feel disabled” (Raviselvam et al., 2016, 132). The functionality of space by people is not solely determined by individuals’ characteristics associated with disabilities but also their life stage (e.g., children, older adults) and circumstances (e.g., carrying luggage, a stroller, being pregnant) (Bringolf, 2011). In other words, Universal Design aims to cater to the widest range of groups possible, and considers equity among them in a more holistic way (Odeck et al., 2010).

Increasingly, questions on accessibility in the built environment in research has shifted from whether different types of spaces meet regulatory requirements addressing a few, more visible types of disability needs, to whether they are ‘meaningfully accessible’ (Rick Hansen Foundation, 2017). Meaningful accessibility is a concept that views accessibility as not just about physical features of buildings and spaces, but about how the built environment enables people of all ages and abilities “to participate equally in social and economic life while creating healthy and socially sustainable communities” (Rick Hansen Foundation, 2017). As such, meaningful accessibility and universal design go hand in hand—meaningful accessibility is a goal of universal design.

Benefits of creating meaningfully accessible spaces

Meaningful accessibility is achievable only when a larger portion of the built environment, beyond homes, is made accessible. Some benefits of making accessible public spaces are apparent, though not easily quantifiable. For example, it will reduce barriers to using services and amenities, increase the range of day-to-day activities persons can conduct more independently (Carr, Weir, Azar, & Azar, 2013; Joines, 2009; MacLachlan et al., 2018), and enhance users’ health and well-being through increased physical activity-level. A

higher degree of accessibility in public spaces facilitates a greater level of participation in society (Darcy et al., 2008; Hartje, 2017; Kadir & Jamaludin, 2013; Lyche & Hervik, 2002; Maynard, 2009; Aslaksen, 2016), which can lead to greater social equity. These benefits are also discussed as factors that lead to better mental health (Demiris & Hensel, 2008; Joines, 2009; MacLachlan et al., 2018).

However, what has not been well understood is the kind of benefits accessible buildings and public spaces may bring to the very industries that create them. A few pieces of information regarding the potential benefits of Universal Design for the building industry exist. For example, the Global Universal Design Commission in New York State (in Steinfeld & Smith, 2012) claims that creating spaces according to Universal Design principles increases a consumer base and customer loyalty, reduces operating and renovation costs, and increases tenants' productivity. The Commission also stated that developers and building owners will benefit from user satisfaction and increased productivity resulting in higher rates of visitors, social branding opportunities, broadening markets, and lower renovation and operation costs (ibid.).

The National Disability Authority in Ireland also adds that the businesses located in the buildings can retain customers and enhance a positive public image (Centre of Excellence in Universal Design and Ireland National Disability Authority, 2014). Siperstein's (2006) survey of consumer attitudes towards companies that hire employees with disabilities also supports the idea that a company's public image as accessibility-friendly is likely to lead to greater loyalty and patronage by consumers, leading to higher profits.

These claims are consistent with a contemporary corporate social responsibility theory (Pirsch, Shruti, & Grau, 2007) that posits co-dependency between profit maximization and quality of stakeholder relations (Jensen, 2002) or "what is good for business is also good for society and vice versa" (Loosemore & Lim, 2017, 93; Porter & Kramer, 2011). Some studies also suggest that early adoption of practices associated with social responsibility could prevent the creation of harsher regulations that would be more costly (Hirose, Lee, & Matsumura, 2017).

Need for a benchmarking framework

However, these claims are not always substantiated by evidence via empirical studies. Much of the space in which people interact through day-to-day life—streets, parks, buildings containing services such as shops, schools, and healthcare services—are public goods, built, owned and managed by private sectors. As such, the building industry plays a vital role in increasing meaningfully accessible spaces in a community. Despite this, the role of the building industry in creating accessible spaces in the built environment is often overlooked, and “(f)ew efforts have been made to quantify benefits of universal design in public buildings and outdoor areas” (Aslaksen, 2016, 654). To date, it is unclear how the actual costs and benefits attainable from building and maintaining accessible buildings and other spaces can be compared, resulting in discouraging interest from the building industry in investing its resources to create spaces beyond complying with minimum design standards. Lack of measures quantifying benefits for the building industry has also prevented governments from being able to determine strategies to increase meaningfully accessible buildings and public spaces in a community.

Methodology

We conducted a scoping review of academic literature as well as reports and working papers by governmental and non-governmental organizations that were published in the last two decades (2000-2019). We used Dalhousie University’s Library database to collect academic journals using sets of the following keywords: “accessibility”, “accessible”, “universal design”, “barriers”, “barrier-free”, “inclusive design”, “access for all”, “disability”, “disabling”, “built environment” and “benchmarking” in combination with terms including “evaluation framework”, “valuation”, “benefits”, “measure”, “assessment”, and “cost-benefit analysis”. Other types of literature were collected through the Google engine using the same keywords.

Our screening of titles and abstracts resulted in 19 papers, which were found to inform our interests—how economic benefits of accessibility in the built environment were conceptualized and measured. Many papers initially

collected were excluded because they focused on the design of devices, assistive technologies, or visual materials rather than accessible features in the built environment. Papers were also not included if the type of accessibility they were referring to was not accessibility for persons experiencing impairments. For instance, the spatial accessibility of a pedestrian or transit network refers to the time and space travelled to reach destinations rather than what barriers may impede someone's navigation to a destination. There was also a myriad of papers that measured the level of accessibility of services and amenities themselves (e.g., accessibility design audits). These were excluded. Finally, papers that solely looked at user benefits for accessible spaces, instead of industry benefits, were not included. Some of these were used to understand the context of the findings and included in Discussion.

Results

The results from our literature search confirmed that there is a dearth of evidence for benefits to building accessible spaces, particularly that of economic benefits. The search terms used yielded many papers from various fields, but only a small percentage informed measures of economic or non-economic benefits. A majority of the 19 papers come from transportation (10) and tourism (7) fields. Of the two other articles, one was from housing, and another was from urban design discussing costs and potential benefits of design features in and outside of buildings. Most (15) of the articles found have been published in the last decade (2009-2019). There were eight sources from Europe, four from Australia and New Zealand, three from Norway, one from South America, and one from South Korea. The remaining two sources took an international perspective. Table 1 shows the summary of the 19 papers reviewed. The numbers below refer to the identification numbers of the papers in the table.

According to these papers, economic benefits of accessibility have been largely conceptualized in three ways: 1) as market potential of accessible sites and services projected at the population-level (mainly in tourism) ^{3, 4, 7, 8, 17}; 2) as cost saved from having accessible infrastructure (mainly in

transportation)^{5, 12, 14, 15}; and 3) as hypothetical return of creating accessible spaces (transportation, housing and urban design) based on users' willingness-to-pay^{1, 2, 6, 9, 11, 13, 15, 16, 18}. There were a few papers that employed hybrid approaches.

1. Benefits as market potential of accessible sites and services

One of the most common research areas investigating the economic benefits of accessibility is tourism^{3, 4, 7, 8, 9, 17, 19}. Five papers^{3, 4, 7, 8, 17} included in this review estimated the market potential of attracting tourists with accessibility needs. For example, Darcy et al. (2008) calculated the gross economic contribution of persons with disability to tourism in Australia using data from Australia's National Visitor Survey, which reports on the number of inbound and outbound tourists with disabilities and their estimated spending. They summarised patterns of consumption from overnight trips and day trips, finding that the total expenditure by tourists with accessibility needs for the year 2003-04 was between \$8 and \$11 billion overall, resulting in \$3 - \$4.5 billion in gross value added to Australia's tourism market. Pavkovic, Lawrie, Farrell, Huuskes, and Ryan's (2017) report similarly outlined economic incentives for tourism businesses that offer accessible services and environments in New South Wales enumerating the "untapped market" (Pavkovic et al., 2017, 31) of persons with disabilities, older people, and young families using demographic data. Based on the estimation using recent travel data (i.e. how often trips are taken by those groups) and expenditure data showing how much was spent by those groups on tourism services, they concluded that spending by persons with disabilities accounted for 17% of the overall expenditure of the Australia tourism sector (\$3.3 billion over the first quarter of 2017). Similarly, Bowtell's (2015) study forecasted potential revenue from implementing accessible tourism standards to the year 2025, using 2005 data on numbers of consumers with disabilities and recorded spending by travellers with accessibility needs. He found that an estimated market potential of €88.6 billion could be anticipated for companies in the tourism industry over the next two decades, representing a 65% increase in revenue from 2005. These studies all conclude that there is substantial economic growth potential by making tourism sites and services accessible for persons with disabilities.

2. Benefits as cost saved

A second type of economic benefit looked at cost saved for users and service providers from implementing accessible facilities ^{5, 12, 14, 15}, rather than suggesting potential revenue of accessible services. Burdett, Locke, and Scrimgeour (2017) investigated the cost saved for pedestrians who gained mobility access through an improved crosswalk. Their study compared counts of the number of pedestrians using a mobility aid (e.g. walking stick, wheelchair, back or leg brace) who crossed an intersection before and after accessibility improvements to the crosswalk were implemented. They saw an estimated 147% increase in trips by persons using mobility aids through the improved site. Then, they estimated the cost saved for these users from not having to use an alternate means of reaching their destination, such as by taking a taxi, which they may have done if the accessibility features were not in place to allow them to cross the intersection. Using estimates for trip costs and the number of additional trips enabled by improvements, Burdett et al. (2017) propose that the net value of the cost saved from this project is \$1.27 million.

Instead of direct cost savings, some studies calculated the time saved from the implementation of accessibility infrastructure, and then the time was converted to some monetary value. These papers typically come from transportation research, including Burdett et al.(2017), where reduced time spent for travel was converted into an amount of currency, based on a standard value typically derived from average employment income of service users, established and available from other empirical studies. For example, Karekla, Fujiyama, and Tyler (2011) considered a scenario of two improvements to a line in London's Underground rail system: widening all train doors to 1800mm and raising all platforms to be level with the train. By doing so, they suggested that dwell-time (i.e. the amount of time a train waits at a platform for passengers to get on and off) would be reduced by an average of 6 seconds for southbound trips and 5 seconds for northbound trips. It was assumed that all passengers would receive this time-saving benefit. Based on an empirical standard of time-currency conversion at the time of the study (Transport for London, 2010 in Karekla et al., 2011), they estimated that the time saved equalled £2,215,000 in savings. They also proposed that reduced

dwell time and, therefore, total journey time, would have economic implications for transportation operators, such as the frequency of train operation and maintenance. These factors, estimated over a 25-year project timeline, resulted in £52,162,000 in total estimated benefit.

3. Benefits as hypothetical return of creating accessible spaces

The third approach to measuring potential economic benefits of accessibility seen in the literature is directly asking people the monetary values they place, such as having some accessible features and services ^{1, 2, 6, 9, 11, 13, 15, 16, 18}. Most of the papers using this approach used a contingent valuation method (CVM), assessing potential users' willingness-to-pay for the hypothetical 'goods'. Willingness-to-pay is usually derived from responses from a survey asking participants what they feel is fair to pay in exchange for benefits they would receive. Surveys typically include a suite of monetary value choices accompanied by a description of accessible spaces—often with images—from which respondents will choose their most preferred option. Their choice will be the 'stated preference', hence this type of survey is also called a stated preference survey (Fearnley, Flugel & Ramjerdi, 2011). In a study by Fearnley et al. (2011), passengers of three Norwegian city transport lines were asked to choose between trip scenarios, each with different accessibility and cost attributes (e.g., choice between a transit stop without a shelter and with a lower ticket price, and a transit stop with a shelter and a higher ticket price). Using this method, Fearnley et al. (2011) found that respondents were willing to pay more (approximately 3.12 NOK) for transit stops with shelters and even more (approximately 5.10 NOK) for transit stops with shelters where seating is provided. Similarly, Aslaksen (2016) performed a stated preference survey of Norwegian citizens to identify the benefits of different Universal Design (UD) measures such as visual and tactile marking, automatic entrance doors, and ramps. Respondents were asked to answer a series of multiple-choice questions presenting accessible design options for various locations, such as entering a swimming pool or a movie theatre, and the cost of entry for each scenario. His study found that respondents were willing to pay the most for indoor and outdoor lighting improvements (17 NOK on average), visual and tactile markings of walkways (9 NOK on average), and handrails on stairways (7 NOK on average). Aslaksen (2016) also presented an example calculation of

potential benefits against the costs for installing an automatic door in the city hall based on the study's valuations and estimated there would be about 24% in net benefits. Alonso's (2002) willingness-to-pay survey represents one of a very few studies on the economic benefits of accessible housing, asking 1,104 homeowners in Madrid and Barcelona what they would pay for conventional, adaptable, and barrier-free housing. On average, respondents were willing to pay 12.5% more for adaptable and barrier-free dwellings than for conventional housing. By applying these numbers to Spain's housing market, Alonso (2002) suggested that building homes with greater accessibility could account for €6.3 to €8.3 billion in annual value-added.

Hybrid approaches

A few studies employed hybrid approaches. One such study by Pena Cepeda, Galilea and Raveau (2018) in Santiago, Chile, used extra travel time survey participants were willing to spend as the currency value equivalent, rather than currency value equivalent for time saved through implementation of accessible services. The survey presented sets of two bus stops, each with different accessibility attributes such as elevated floors at bus stops, access ramps, and audio-visual stop displays for the visually impaired, accompanied by associated travel times. They found that travellers were willing to lengthen their travel time in order to use these accessibility attributes. Then, the authors translated the extra time into US dollars considered as equal worth. For example, the US dollar equivalent of being able to use elevated floors at bus stop despite the additional length of time to get to them was an average of \$0.44 per person. Maynard (2007) combined time as a component in her survey, asking their stated preferences for a combination of a rail ticket and the length of travel time between given accessibility design choices. In her study, respondents were willing to pay more for the ticket for the option of a lift with stairs (£0.48 per person) and ramps with stairs (£0.15 per person) at rail stations. However, her study used the travel time component as a way to assess if the monetary value choices aligned with established measure of currency equivalent for the time period, rather than to calculate the currency equivalent for the time chosen.

#	Citation [Field of Study] and Location	Purpose	Indicators of Benefits	Method of Measurement	Findings
1	Alonso, F. (2002) The benefits of building barrier-free: A contingent valuation of accessibility as an attribute of housing [Housing Policy] Spain	To demonstrate potential economic profitability of barrier-free residential dwellings	Added economic value in euros (€) of barrier-free dwelling design measured by willingness to pay for accessible, adaptable, and conventional homes	A double-bounded contingent valuation survey was distributed to 1,104 households in Barcelona and Madrid asking what price they would be willing to pay for the three types of dwellings	Respondents are willing to pay 12.5% more on average for adaptable and accessible housing compared to housing with barriers. The value added by improved accessibility to the annual production of housing in Spain is estimated to possibly reach €6.3 to €8.3 billion

#	Citation [Field of Study] and Location	Purpose	Indicators of Benefits	Method of Measurement	Findings
2	Aslaksen, F. (2016) Upgrading existing buildings to universal design: What cost-benefit analysis can tell us [Urban Design] Norway	To identify differential monetary benefits for select UD measures perceived by users with and without disability, and to suggest how the information can be used to generally support planning and implementation of UD measures, while prioritize different UD features	Economic value (in NOK) of the presence of universal design features in buildings as stated by survey respondents with and without disability	Stated-preference surveys to assess willingness to pay for entrance to public facilities with certain accessible design features; results were compared with cost of implementing universal design features derived from public sector database of accessible projects	Most UD features had some value for all users, while their value for the target group (persons with accessibility needs) was higher. For example, improved indoor and outdoor lighting were valued most highly on average at 17 NOK each, the target group valued them at nearly double the average. An example calculation is provided for installing at automatic door to city hall, where the valuation is 1 NOK per visitor over 25 years compared to installation cost, finding about 24% in net benefits.

#	Citation [Field of Study] and Location	Purpose	Indicators of Benefits	Method of Measurement	Findings
3	Bah, Y.M. (2016) Economic incentive of a non-handicapping built environment [Tourism] Sweden	To demonstrate market potential for tourism targeting clientele with disabilities	Occupancy rates of places with accessible accommodations [indirect]	Questionnaires distributed to site owners and managers to obtain occupancy rates and information on what accessible facilities are offered at their tourism sites	There was general agreement that there is increased demand for accessible tourism sites
4	Bowtell, J. (2015) Assessing the value and market attractiveness of the accessible tourism industry in Europe: a focus on major travel and leisure companies [Tourism] Europe	To present market potential in targeting clientele with disabilities over time	Estimated revenue (in €) per consumer for accessible tourism services based on projection of number of disabled customers and per customer revenue	Revenue in 2025 was projected based on market analysis using 2005 data for per customer revenue and demographic forecasting	Potential revenue of tourism for 2025 is estimated to be €88.6B, 65% increase from 2005

#	Citation [Field of Study] and Location	Purpose	Indicators of Benefits	Method of Measurement	Findings
5	Burdett, B., Locke, S., & Scrimgeour, F. (2017) The economics of enhancing accessibility: Estimating the benefits and costs of participation [Transportation] New Zealand	To demonstrate potential economic net value of investment in accessible pedestrian and transit infrastructure	Cost saved for pedestrians with mobility challenges by not having to opt for an alternate means of transportation	The paper compared the counts of pedestrians using a mobility aid crossing the intersection before and after the improvements were made, then estimated total economic benefit by summarizing the trip costs saved by the counts increased	Found increased pedestrian use of street crossing after accessibility improvements, with the number of trips for persons with mobility aids per year estimated to increase by 147% and 12% for persons without mobility aids. The net value of cost saved from the investment is estimated to be \$1.27 million

#	Citation [Field of Study] and Location	Purpose	Indicators of Benefits	Method of Measurement	Findings
6	Chang, I. (2019). Policy-feasibility study of vertical/horizontal moving assistant systems for the mobility-disabled using a contingent valuation method [Transportation] South Korea	To help policy-makers understand the benefits of a new vertical/horizontal moving-assistant system in subway stations by evaluating its economic value	Subway users' willingness to pay (in USD) in tax	One-on-one surveys, using a double-bounded question structure, asked subway users to respond 'yes' or 'no' to proposed tax amounts to pay for the installation of a vertical/horizontal moving-assistant system. This determined the minimum and maximum amounts users were willing to pay for the system. Responses from general users and users with mobility disability were examined	Most respondents (32.3%) opted to pay \$1.67, while 30.3% were not willing to pay any amount. Average willingness to pay (WTP) was higher for general users, at USD 1.15, than for mobility-disabled users, at USD 1.04. Using statistically significant sociodemographic data on respondents (age, education level, income, etc.), WTP was modelled for a wider population of potential subway users, estimating total benefits ranging between \$69.81 and \$200.32 million

#	Citation [Field of Study] and Location	Purpose	Indicators of Benefits	Method of Measurement	Findings
7	Darcy, S., & Dickson, T.J. (2009) A whole-of-life approach to tourism: The case for accessible tourism experiences. [Tourism] Australia ACA	To make a case for accessible tourism in Australia	Demand measured by the numbers of customers with disabilities, ageing persons, and young families [indirect]	Uses demographic data to determine the population of Australians (potential customers) with accessibility needs	Suggests that potential economic benefits can be calculated by applying spending estimates to demographic data based on existing studies
8	Darcy et al. (2008) Chapter 4 of Visitor Accessibility in Urban Centres [Tourism] Australia	To estimate the economic contribution of the accessible tourism market in Australia	Added economic potential for places and businesses in the tourism industry and its estimated contribution to GDP in Australia	Uses demographic data on persons with disabilities in Australia with Tourism Research Australia's statistics on average travel spending by persons with disabilities	The economic contribution of tourists with disabilities to tourism GDP in 2003-04 was between \$8 and \$11 billion. Revenue demonstrates the importance of making tourism more accessible

#	Citation [Field of Study] and Location	Purpose	Indicators of Benefits	Method of Measurement	Findings
9	Fearnley, N., Flugel, S., & Ramjerdi, F. (2011) Passengers valuations of universal design measures in public transport [Transportation] Norway	To demonstrate the potential economic benefit of accessible improvements to public transit systems in order to integrate them into project appraisals	Reported willingness to pay (in NOK) by transport passengers for different trip scenarios including 13 different accessibility measures	Passengers of three transport lines in Norwegian cities were presented with a stated preference questionnaire with a contingent valuation question; respondents selected their preferences between trip scenarios with varying accessibility measures and trade-offs of access and costs	UD measures were valued highly by passengers, producing positive net values exceeding costs substantially with 2500 passengers or more per year. E.g. Estimated willingness to pay for bus stop shelters was 3.12 NOK while bus stop shelters with seating were valued higher, at 5.10 NOK. The results make a strong case for prioritizing investment in accessibility measures to improve public transport

#	Citation [Field of Study] and Location	Purpose	Indicators of Benefits	Method of Measurement	Findings
10	Federling, D., & Lewis, D. (2017) Towards a framework for identifying and measuring the benefits of accessibility [Transportation] International	To propose a comprehensive framework for quantifying the holistic benefits of accessibility to apply in cost-benefit analysis	Discusses economic and social benefits that can be monetized including those for the agency (worker safety), users (mobility, quality of life, safety) non-users (cross-sector economic benefits, option value, and existence value) and values of increased capability with people with disabilities	Lists a variety of methods including demand analysis, input-output analysis, stated preference analysis, in combination of willingness to pay, quality-adjusted life years, value of time, saving, and productivity (income) as potential methods to monetize the indicators; none was actually measured	The framework is proposed as a narrative tool to incorporate quantification of a wide range of non-economic benefits, to make more robust estimates of overall benefits of accessibility. The framework is key to triggering self-sustaining investment in accessible technology and design

#	Citation [Field of Study] and Location	Purpose	Indicators of Benefits	Method of Measurement	Findings
11	Gassiot Melian, A., Prats, L., & Coromina, L. (2016) The perceived value of accessibility in religious sites - do disabled and non-disabled travellers behave differently? [Tourism] France	To demonstrate the potential economic benefit for the tourism industry in France through enhancement of accessibility in religious sites	Degree of satisfaction for accessible elements of a religious site as a proxy for potential economic benefit for the tourism industry	Structural equation modelling to test the hypothesized relationships between perceived value of accessibility and tourist satisfaction measured by levels of loyalty to the site, tourists' intention to recommend the site to others, and return to the site themselves based on survey responses by adult visitors to Lourdes, a well-known religious tourism site	Perceived value of accessibility has a higher positive effect on satisfaction for both disabled and non-disabled people. The disabled group makes up a broad market at religious sites, therefore it is important to take into account the fact that persons with disabilities place more satisfaction and loyalty on accessible religious sites

#	Citation [Field of Study] and Location	Purpose	Indicators of Benefits	Method of Measurement	Findings
12	Karekla, X., Fujiyama, T., & Tyler, N. (2011) Evaluating accessibility enhancements to public transport including indirect as well as direct benefits [Transportation] United Kingdom	To demonstrate an example method of comparison between the costs of implementing accessibility features at public transport stops with the economic benefits from travel-time reduction	Travel-time saved from reduction of the dwell-time of the train at platforms (i.e. more efficient loading of passengers), converted to a monetary value	Performed cost analysis of raising the platform of all stations along a line in London's Underground to be level with the train and widening all train doors, and compared it with the potential monetary saving from dwell-time reduction, based on empirical studies that assigned currency values to minutes	Average dwell time saved for southbound journeys was 6 seconds and 5 seconds for northbound journeys, resulting in about £2,215,000 in passenger time saving benefit per year. This, with the recommended discount rate, results in an estimated total of £52,162,000 over a 25-year infrastructure project, which is 1.16 times more than the general cost of constructing the proposed improvements

#	Citation [Field of Study] and Location	Purpose	Indicators of Benefits	Method of Measurement	Findings
13	Lyche, L., & Hervik, A. (2002) A cost-efficiency approach to universal access for public transport for disabled people [Transportation] International	To demonstrate types of economic benefits that can be compared with the cost of replacing old infrastructure to be accessible	Economic return of replacing old features in the public transport system measured by fees from additional ridership, willingness to pay more by existing riders, value of having travel options, reduced travel by family and friends to drive persons with accessibility needs, and increased labour participation [indirect/partial]	Hypothetical calculation of returns in the indicators suggested	It is difficult to monetize many benefits of making public transport accessible. Costs will likely exceed benefits. However, it is found to be more cost-effective to invest in new construction that is accessible, rather than to retrofit existing public transit infrastructure

#	Citation [Field of Study] and Location	Purpose	Indicators of Benefits	Method of Measurement	Findings
14	Maynard, A. (2009) Can measuring the benefits of accessible transport enable a seamless journey? [Transportation] United Kingdom	To demonstrate the importance of quantifying benefits of accessible features throughout a journey into monetary units using an example of her previous study	Monetary value of time saved by being able to use an accessible feature in a railway station [indirect/partial]	Summary of monetary values assigned for saving time per person using an established standard of currency values per given time period in transportation economics	Lack of information on how to appraise cost-benefits for accessible public transit is limiting attention to the need of making it accessible by the transport sector. Calculation of the holistic benefits of making a door-to-door journey accessible will require assessments of other benefits such as reduced private vehicle use, social inclusion, reduced negative environmental impacts, improved health, and land-use efficiency

#	Citation [Field of Study] and Location	Purpose	Indicators of Benefits	Method of Measurement	Findings
15	Maynard, A. (2007) Monetising the benefits of disabled access in transport appraisal [Transportation Economics] United Kingdom	To determine monetary benefits of accessibility improvements to public transportation	Willingness to pay (in £) for ticket prices for rail transport with different accessible features hypothetically applied to rail stations	Stated preference survey using discrete choice modelling asking passengers to choose willingness to pay rates of ticket prices for combinations of mobility accommodations to platforms of heavy rail stations	Results demonstrate that access by persons with mobility disability can be valued in a similar way to other non-market impacts. Willingness to pay for lift with stairs (£0.48 per person) and ramp with stairs (£0.15 per person) significantly increase the benefit-to-cost ratio.

#	Citation [Field of Study] and Location	Purpose	Indicators of Benefits	Method of Measurement	Findings
16	Odeck, J., Hagen, T., & Fearnley, N. (2010) Economic appraisal of universal design in transport: Experiences from Norway [Transportation Economics] Norway	To demonstrate what types of benefits and costs should be considered, and how they can be valued in monetary terms, in order to assess the economic merits of UD projects in transportation	Benefit-to-cost ratio	Monetary values of non-economic benefits estimated using data from other CV studies for transportation and costs of implementation and maintenance estimated from external data sources for three UD transport projects: low-floor bus, high curbstone at the bus stop, and enhanced lighting. Comparison of benefits against the cost of investment to estimate net value of UD projects over 25-year appraisal period	The inclusion of social benefit values of UD features in monetary appraisal of transportation projects demonstrates that UD projects are actually profitable. Projected benefit-to-cost ratio of three example projects examined range 0.31 (high curbs/tone at a bus stop) to 25 (enhanced lighting at bus stops)

#	Citation [Field of Study] and Location	Purpose	Indicators of Benefits	Method of Measurement	Findings
17	Pavkovic, I., Lawrie, A., Farrell, G., Huuskes, L., & Ryan, R. (2017) Inclusive Tourism: Economic Opportunities [Tourism] Australia	To make a business case for accessible tourism in New South Wales	Potential total spending by the numbers of tourists with disabilities, ageing persons, and families with young children	Average travel spending by persons with disabilities based on Tourism Research Australia's statistics was multiplied by the number of persons with disabilities from census and projections for an ageing population in Australia	Demonstrates sizable potential markets in Australia and internationally. For example, in the first quarter of 2017 in Australia, people with disabilities spent \$3.3 billion and account for 17% of overall expenditure in tourism, and seniors (60 and over), who make up 22% of total visitors to Australia, spent over \$15 billion on tourism activities

#	Citation [Field of Study] and Location	Purpose	Indicators of Benefits	Method of Measurement	Findings
18	Pena Cepeda, E., Galilea, P., & Raveau, S. (2018) How much do we value improvements on the accessibility to public transport for people with reduced mobility or disability? [Transportation Economics] Chile	To demonstrate the potential economic benefit from implementing accessibility improvements in public transport	Monetary value assigned to the extra time people are willing to spend on transit trips for the availability of accessible (UD) features	Asked persons with and without reduced mobility (including those with visual impairment) to answer a stated preference survey considering the following UD elements with discrete choices of travel time increases: audio-visual information at bus stops, elevation of stops, and buses' access ramps. Monetary value equivalent of travel time was then calculated based on another study	The attribute found to be valued the highest is the elevation of floors at bus stops: USD \$0.44 for all people, \$0.73 for people with reduced mobility and \$0.35 for people without reduced mobility. The study demonstrates the increased time spent for accessible features as an alternative to willingness to pay in the form of fees to use for economic valuation.

#	Citation [Field of Study] and Location	Purpose	Indicators of Benefits	Method of Measurement	Findings
19	Rebstock, M. (2017) Economic Benefits of Improved Accessibility to Transport Systems and the Role of Transport in Fostering Tourism for All [Tourism] Europe	To outline possible economic and non-economic benefits of improved accessibility to transport systems in general and for the tourism sector	Psychological effects of "getting out and about", exercise benefits, community cohesion through building local support networks, greater number of and flexibility of trips and destinations, economic value from increased ridership of transit, and from greater number of tourism consumers [indirect]	None empirically measured	Accessible tourism has a big impact on the tourism market and the overall economy. It posits increased ridership, greater variation in destination, and comfort for all users and not just persons with disabilities

Discussion

Current state of research

The purpose of this study was to understand how the economic benefits of accessible space designs have been conceptualized and empirically assessed in order to establish a more comprehensive cost-benefit assessment framework for creating ‘meaningfully accessible’ built environments. The literature presented in this study does not comprise an exhaustive list. However, multiple research database search did not yield more papers that inform new insights or methodologies, and even those we did find tended to be either authored by the same group of researchers or compilations of some of the papers included in our study.

It is not surprising that studies attempting to measure the economic benefits of accessibility are more prevalent in tourism, given that the return of the service provided is relatively easy to quantify by using consumer spending data. In transportation research, methodologies to evaluate economic return on investment in infrastructure renewal and repair are more advanced. It is also understandable as the transportation sector is accountable to the public, and the scale of investment coming from public funding is substantial. Transportation research has long utilized standardized algorithms to convert time saved by providing efficient services, or time as cost incurred from disruption of services, into some monetary value, typically using the average income of full-time employees in the region or country (US Department of Transportation, 2014).

In the 19 papers we reviewed, only two attempted to measure the economic benefits of accessibility in buildings and adjacent features, though studies on accessible transportation infrastructure have some overlaps. For example, costs saved for building users through the implementation of elevators or automatic doors can be calculated using the standardized algorithm of time-money conversion used in transportation research.

Many papers reviewed recognize the challenges of measuring broader economic benefits of investment in accessible infrastructure and services—

whether the recipients of the benefits are the industry that provides the service, individual users with (or without) disabilities, or the society as a whole. A range of non-monetary benefits of accessible buildings that could potentially be expressed in monetary forms discussed in the reviewed papers includes independence and dignity for persons with disabilities, option value (the value of having multiple destinations or methods of travel to choose from), and health and wellness, particularly from avoiding injury (Federing & Lewis, 2017; Gassiot Melian, Prats & Coromina, L., 2016; Lyche & Hervik, 2002). In fact, the very objectives of some of the papers were to advocate for advancing the methodologies to include these hard-to-measure variables in the cost-benefit analysis frameworks (Fearnley et al., 2011; Maynard, 2009, for example). While these papers demonstrate, conceptually, how a few of these benefits could be calculated, they were clearly faced with the challenge of data availability.

Parallel with the green building literature

While there is a dearth of literature demonstrating the industry benefits of creating accessible buildings and spaces, there are some parallels that can be drawn from green building research. Green building research has investigated the benefits (and costs) of building to enhance environmental sustainability via the promotion of green buildings. For example, a study on the impact of the LEED program on real estate market trends (Fuerst & McAllister, 2011) has shown that LEED-certified buildings had 5% higher rent and 25% higher sales prices than non-certified buildings. Another study (Devine & Kok, 2015, 162) demonstrated that green-certified buildings were statistically associated with “higher levels of tenant satisfaction and increased probability of lease renewals, and decreased tenant rent concessions.” Liu, Guo, and Feiling’s (2014) financial analysis of green buildings in China calculated savings of incremental costs (including materials and energy savings), finding that these buildings likely have both incremental financial and environmental benefits enough to attract private investment. A cost-benefit analysis of green buildings in Turkey (Uğur & Leblebici, 2018) revealed that the construction cost increases with gold and platinum LEED buildings was minimal (+7.43% and +9.43%) while the reduction in energy costs were 31% and 40%—finding that the return of capital investment could be substantial.

Many of these measures are relevant to the building industries considering accessible buildings. For example, rent charged, vacancy rates for accessible lease space, and overall property values can be compared with those buildings without accessible spaces or with only minimally accessible spaces. Monetary benefits of enhanced health and well-being could also be measured using counts of reduced absenteeism and saved workers' compensation for employees working in an accessibility enhanced building, and compared with those of conventional (minimally accessible) buildings. The number and costs of lawsuits for injuries occurring in accessible buildings could also be compared with those of only minimally accessible buildings. Few of these measures have been incorporated in the studies we reviewed, likely due to the lack of data that is readily available for researchers.

Conclusion

Critical theories around disability have long urged the discourse to move beyond the notion of disability as something that is outside of 'normality' and needing special accommodation (Hamraie, 2016). Disability research has attempted to break down the artificial notion of dichotomous existence in society where there are those 'able' majority and those who are not, while the physical, mental and cognitive abilities of all people, in fact, vary along a continuum of scale, with the 'disabled' making up the largest minority in the world (Akinici, 2013). However, the creation of an accessible environment is still largely perceived as stemming from an altruistic intention rather than a viable business choice for the industry. "What is good for business is also good for society and vice versa" (Loosemore & Lim, 2017, 93) largely remains rhetorical.

The studies we reviewed ubiquitously agree that there are far-reaching overall benefits of making products and services more accessible for the society. Many advocated for better cost-benefit analysis frameworks to make a case for pursuing accessibility that can accommodate the needs for as many people as possible. However, reduced material costs and energy saving from accessible buildings are unlikely as substantial as green buildings, and therefore meaningful accessibility is a *harder sell*. From a human rights perspective

(United Nations, 2016), meaningful accessibility should not be an option; rather it is a fundamental requirement regardless of possible economic return to those who create the buildings and other spaces. In that sense, the unfavourable cost-benefit ratios for building industries should not matter. At an operational level, however, the implication of such a hardline approach means more detailed and stringent regulations, which will certainly face the industry's resistance and will not be realized without strong support from the public. Demonstrating more tangible economic benefits seems to be an effective strategy to increase the incentives for building industries to create buildings and other spaces beyond complying with minimum standards. Governments will also be better able to formulate policies and intervention schemes if they can more clearly gauge the benefits against the tax dollars they have to be accountable in spending. This paper was motivated by the urgent need to draw attention to the critical gap in research, particularly among disciplines such as planning, urban design, and architecture that have been relatively reticent in the discourse. A strong voice of public demand for change in the built environment will also be critical in fostering the effort to develop a better framework of cost-benefit analysis for creating more meaningful built environments.

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THE SYMBOLISM OF THE DOOR KNOCKER "HAND OF FATIMA": A PROPOSAL OF SENSORY TOURIST EXPERIENCES IN THE CITY OF LAGOS

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Abstract: The advantages of applying a multi-sensorial approach to the experimentation of objects, historical sites and heritage practices have been widely discussed and applied, especially in the sphere of the sensory tourist experience. Expanding opportunities to understand the past through a broader sensorium is fundamental to awakening interest, encouraging tourists/visitors to use the five senses to explore the surrounding environment, facilitating the creation of memorable experiences and contributing to inclusive tourism. The vernacular architecture, as a cultural heritage of symbolic value and belonging to the imaginary of collective memory, is an important vector of the aesthetic values of urban landscapes. Therefore, there is a need to stimulate synergies between tourism and heritage to develop tourism products that help in the valorization and preservation of vernacular architecture in historical territories/centres. The "Hand of Fatima", the door knocker shaped as a closed-hand, is one of these decorative elements and part of the collective

cultural heritage, which, more than achieving a utilitarian function, has a symbolic and even superstitious role, for being considered by many as talismans of protection. This research investigates the perceived sensorial experiences in the city of Lagos, located in the Algarve region, south of Portugal, and the specific sensitive element of door knockers known as the "Hand of Fatima" at the historic centre of this city. Many of these objects are true works of art that allow inclusive sensory experiences for many people. Therefore, a qualitative and exploratory approach was adopted, and a Geographic Information System was used to compile and analyze the data. The research concludes that there are diverse sensory experiences. Concerning hand doors knockers, there is a great concentration in this urban area, which enable multiple sensory experiences, contributing to the understanding of the historic centre of Lagos as a living museum.

Keywords: Inclusive tourism; cultural tourism; vernacular heritage; sensory experiences; door knocker; Hand of Fatima.

Introduction

Until the second decade of the 21st century, tourism activity asserted itself as the world's leading economic sector, with uninterrupted and continuous growth, becoming one of the fastest-growing activities in the world, being very much integrated into the lifestyle of most of the modern society (UNWTO, 2015; 2017). It is estimated that four out of ten tourists choose their vacation destination based on its cultural offer (The European Commission, 2017).

The link between tourism and culture is intrinsic and inexorable. The historical-cultural manifestations of a travelling destination are considered one of the main motivations of a journey, just as travel itself generates culture, in a symbiotic relationship perpetuated over the centuries (Richards, 2018; Timothy, 2018).

In the field of cultural tourism, it is possible to observe a growing interest in the past, therefore reflected in the awareness of historical and cultural heritage, with positive impacts on its conservation, valorization and promotion, where the visit to historical sites is recognized as one of the main

elements of travel (Bonn, Mathews, Dai, Hayes & Cave, 2007; Timothy, 2018). Such dynamic is clearly reflected at a local scale with the increase of cultural activities in managing municipal demand for specific elements associated with patrimonial heritage.

All societies have culture, comprising a system of their symbols having distinct meanings and values (Barreto, 2007). Culture is something pertinent to every human being. As the result of the interaction between people, it is responsible for patterns and values, acquired and transmitted, in a learning process that can be accumulated, absorbed, and passed on to generations over time, a cultural heritage consisting of a set of oral and written traditions (Burns, 2002; Dias, 2006).

Since culture embraces what people think (attitude, beliefs, ideas and values), what they do (lifestyle and customs) and what they create (works of art, artefacts, cultural products), it is possible to consider the habits and customs of a local community, with their crafts, folklore, museums and architectural heritage as cultural resources of the tourist activity (Richards, 2016; Ignarra, 2003).

Therefore, it is necessary to value cultural assets to obtain a competitive advantage in the travel destinations and, concurrently, to raise a sense of uniqueness. This perception has led travelling destinations, at international, national, regional and local levels, to create and diversificate tourism products in order to encourage and promote, in a sustainable and inclusive way, artistic and cultural manifestations capable of transmitting the symbolism, identity and authenticity of the place, at the same time as providing enriching and memorable experiences (Bonn et al., 2007; Jelinčić & Senkić, 2017).

This framework is consensual with the cultural dimension of the sustainability paradigm that emphasizes the integrity and cultural diversity of territories (Rosa, 2018). In this context of sustainability, universal access to culture is a matter of social equity. According to this, accessibility “is the characteristic of an environment or object which enables everyone to enter into a relationship with, and make use of, that object or environment in a friendly, respectful and safe way” (Aragall & EuCAN members, 2003: 23).

In this context comes the accessible tourism, which according to Darcy & Dickson (2009:41) "is inclusive of all dimensions of access", as an increasingly important segment of tourism, where its main purpose is to promote tourist activities that are accessible to all people, with or without physical, mental, intellectual or sensory limitations. When based on the principles of universal design and equal opportunities, accessible and inclusive tourism can benefit everyone, tourists and residents (Rodrigues, Rosa & Rebelo, 2020).

So, nowadays, the concept of accessibility is being used in a determined move away from the focus on "disability". Thus, accessible tourism is now discussed, not as a segment, but as a quality attribute of the built environments, products, experiences and services associated with all typologies of tourism and enjoyed by all people.

Immersed in this scenario, the contemporary tourist/visitor, generally autonomous in planning his trips, is increasingly interested in developing experiences in the destination, starting from his interpretation (Branco, Vieira & Rodrigues, 2014). To do so, he looks for a complete experience, a source of unique sensations and emotions, through his involvement, effective participation and greater interaction with tourism products and services, including historical and cultural heritage (Panosso Netto & Gaeta, 2010; Rahman, Khalifah & Ismail, 2015).

When any individual explores a place, he does so through the senses combined with his thoughts, environment and previous experiences. The perception of the experienced moment is built in his mind and felt by his body (Kim & Fesenmaier, 2015). Sensory perceptions are the main signals that a person can capture from a place. Building an experience requires sensory embodiment, which permeates the perception of the environment through the senses and in real-time, creating lasting memories (Campelo, 2017).

Designing tourist experiences using the five senses as a tool can be a differentiating element in the process of interpretation, interaction and connection between tourists/visitors and the history of the place (Jelinčić & Senkić, 2017) and will improve inclusive tourism. Furthermore, as sensory involvement and emotions can be intimately connected (Schorch, 2014), offering cues and sensory stimuli to facilitate the reading of the space and its

historical understanding contributes to the increase of the perceived value, resulting in more complete, satisfactory and memorable experiences (Campelo, 2017; Lv, Li & McCabe, 2020).

Multisensory stimuli generate perceptions and create mental images related to the experiences lived by the individual (Mateiro, Kastenholz & Breda, 2017). Literature shows that exploring the sensory dimension can contribute both to the enrichment of the tourist experience and the protection of heritage resources, including people with disabilities (Cantoni, Dondi, Lombardi, Nugrahaningsih, Porta & Setti, 2018; Agapito & Chan, 2019). Furthermore, it contributes to well-being and happiness, as well. For example, studies have shown that people with disabilities feel satisfied after visiting natural environments and participating in wilderness activities (Jaquette, 2005; Zeller, 2008) related to these sensory experiences.

Within this framework of sustainability and social inclusion, it can be observed, in recent years, a diffusion in the implementation of tourist routes on a municipal scale, approached by various themes and dimensions, where cultural ones stand out. These are important tools for the promotion, conservation and protection of the cultural heritage, and also for the development and consolidation of tourism in those destinations interested in overcoming seasonality and maintaining their attractiveness when facing highly competitive tourist markets (Ramírez, 2011; Paiva, Seabra, Abrantes, Reis & Pereira, 2018; Rodrigues et al., 2020; Sabir, 2019).

In this context, elements associated with vernacular architecture could be better promoted. Vernacular architecture built with techniques and local materials represents a knowledge usually passed from generation to generation (Singh, Mahapatra, & Atreya, 2008).

The literature alluding to vernacular architecture has given, above all, emphasis to the constructive characteristics of the buildings. In this article, typical building decorative elements are promoted, which translate, as well, the cultural identity of the places. The research is focused on the door knockers, in particular emphasizing the "Hand of Fatima".

The door knockers constitute “a small asset of the collective estate” (Maçarico, 2009). They are objects of identity and symbolic value, which add value and uniqueness to the vernacular architectural heritage of a territory, and that, according to Maçarico (2011:9), they are elements related to the language of the door, integrating a “communicational code, linked to the passage from public to private space”.

Among these utilitarian pieces, perceived as heritage elements soaked in history and significance, the “Hand-Object” (the closed-handed knocker) became the “Symbolic Hand”, when recognized as the “Hand of Fatima”. However, in literature, there is no consensus on the true relationship between the (closed) hand and the Khamsa or Hamsa (the opened-handed, protective talisman), whereas various theories and representations amplify varied interpretations and the mystery that attracts and seduces so many people throughout the centuries (Maçarico, 2011).

Khamsa, the Arabic name for the number five, but also for “the five fingers of the hands,” or Hamza or Hamesh as it is called in Hebrew, is a symbol primarily recognized as a talisman of protection against the evil eye in the Islamic and Jewish cultures. In these two traditions the number five has a superstitious meaning. For Jews, five represents the five books of the Torah, while for Muslims it configures the Five Pillars of Islam (Sayed, 2016).

In fact, the forms representing the open right hand, stylized in different ways, have been documented, portrayed and adopted throughout history in different cultures, which, in addition to using them as a symbol of protection, have then employed various philosophical, religious and even prophylactic connotations to this anthropomorphic and apotropaic sign (Maçarico, 2011; Sayed, 2016).

Sayed (2016:23) states that *“The civilizations of the past captured the power of symbols and used them extensively through rituals, art, religions and myths”*. And such context is applied to this “Symbolic Hand”, which might have originated during the Phoenician civilization, in the worship of the Carthaginian goddess Tanit. Until today, it has strong relevance in the form of ancestral heritage, as well as in daily use, for the cultures and religions of the Middle East, North Africa and the Iberian Peninsula (Maçarico, 2011; Sayed, 2016).

The name "Hand of Fatima", widely used, refers to the youngest daughter of the prophet Mohammad, the spiritual leader of Islam. For the followers of Islam, Fatima was a sanctified woman, venerated as a devoted daughter, the only one who gave heirs to Mohammed, assuring the prophet's offspring. But it is important to point out that although the symbolism of Hansa is associated with the Islamic cultures, the law of the Quran has restrictions in the area of image worshipping and the use of amulets (Maçarico, 2011; Sayed, 2016, Beinhauer-Köhler, 2018).

Throughout history, the open hand is in fact, the talisman most used and rooted in numerous cultures and traditions. Many pointed out it as the representation of the "Hand of God" or "Hand of Allah", a symbol of an omnipotent Supreme Being who possesses the power to grant protection against evil and bless those he governs. It has various names, including "Hand of Myriam" for the Jews and "Hand of Ali" for the Shiites (Loewenthal, 1972; Maçarico, 2011; Beinhauer-Köhler, 2018).

When related to their prophylactic powers, healing attributes and protection against the "evil eye", these objects and their symbology are still frequently requested, even in the hospital environment, when family members resort to their superstitious beliefs to ask for spiritual and religious protection for their sick relatives (Lloreda-Garcia, 2017). Today, the Hamsa is popular as a protective talisman in Middle Eastern and Western cultures, incorporated into everyday life through jewellery, tapestries, pottery, keychains and other domestic and decorative elements, becoming a souvenir or a symbolic reminder (Swanson & Timothy, 2012) for tourists and visitors who want to take with them a memory of their travels (Maçarico, 2011; Sayed, 2016).

In Portugal, besides the usual contemporary use, the open hand or Khomsa (hand, in Arabic) is essentially associated with the Islamic ceramics found in archaeological works. In turn, the "Hand of Fatima" closed-handed door knocker is present in Portuguese doors from north to south. However, in the Alentejo and the Algarve regions, these hand-shaped decorative elements have the highest incidence. The most common theory is those door knockers (or "aldrabas" in Portuguese, from the Arabic *ad-dabbâ*), including the hand-shaped knocker, had their splendour of use, configuration and diffusion,

during the Al-Ândalus period, characterising the Islamic legacy in the Portuguese culture until today (Maçarico, 2008; Maçarico, 2011).

However, according to the hypothesis analyzed by Maçarico (2011), the ancestry of the "Hand of Fatima" - a door knocker shaped as a closed hand - could be a capitalization of an earlier symbol, in a folklorizing feature and an orientalist nature, fostered by the French colonialism. According to the author, there is a line of research, supported mainly by Portuguese and North African authors, stating that the hand-knocker appeared not earlier than the 19th century as an influence of the colonial architecture, and that the designation "Hand of Fatima" is the actual result of a misinterpretation and a consequence of the protectorate and orientalising, which originated an invented tradition that was romanticized and incorporated into the popular imagination (Maçarico, 2011).

This multiplicity of perspectives, the fact that there is a dispute between the "Hand as an object" and the "Hand as a symbol", and whether the "Hand of Fatima", an element that can still be found today as a decorative element in many doors, had its origin in the Islamic culture and tradition, or it is just an entanglement based on a reinvented tradition by orientalists (Maçarico, 2011), can further provoke the imaginary of tourists/visitors and residents, amplifying the mystification of these objects-signals that embody the culture and identity of territories, representing the materialization of the mystic, symbolic and folkloric.

These cast-iron objects are associated with Art Nouveau architecture that used many of the technological innovations of the last decades of the 19th century.

The possibility of moulding has made cast-iron a material widely used, and small works of rare beauty have been executed, like Fatima's hands as door knockers. In the first decades of the 20th century, the traditional art of cast iron was abandoned. The Art Nouveau movement opened up design to more sensual and feminine properties.

On the other hand, the door knockers correspond to objects that are easily accessible in the urban landscape and are, particularly, perceived by tourists

who utilize tact to understand the cultural products. In a building of vernacular and tourist interest, there may be architectural items whose 3D shape is particularly useful for the blind and people with intellectual disabilities. The construction of mental images of cultural products through tact translates into inclusive sensory experiences (Neumüller, Reichinger, Rist & Kern, 2018).

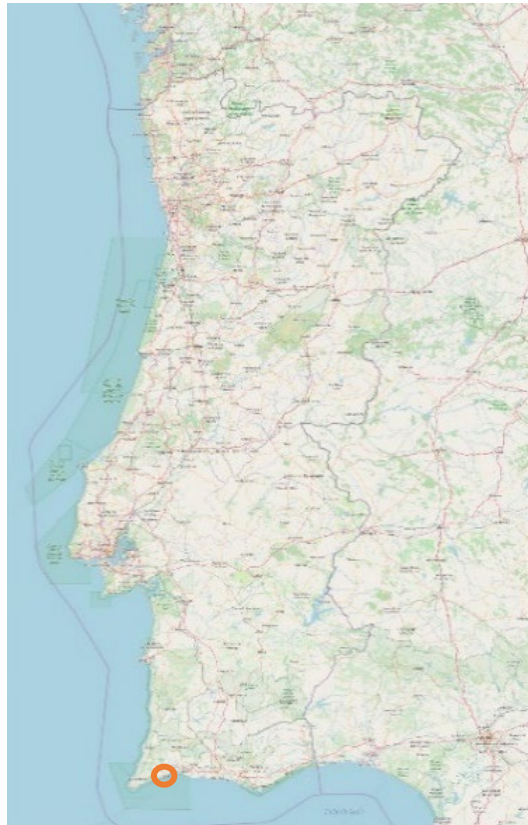
An alternative for a closer interaction between the individual and the vernacular architectural heritage of a destination, is the implementation of pedestrian cultural routes. By exploring a place on foot, it is possible to create more real and profound interaction with its historical narrative by potentiating the perception (physical and mental) of tourists/visitors on the cultural identity of the destination. The implementation of pedestrian cultural routes has been associated with urban regeneration (Rodrigues et al., 2020).

Lagos, located in the Algarve, south of Portugal (Figure 1), is strongly associated with Henry the Navigator (1394-1460), an important figure in the early Age of Discoveries in 15 century. He sponsored voyages down the coast of Africa, beginning the first process of globalization. The port of Lagos was the harbour from which these expeditions left, trips that are in the tourism imaginary. This city is known internationally as a sun and sea destination, and it is rich in history and culture (Câmara Municipal de Lagos, 2012).

The municipality has triggered urban rehabilitation processes for decades and assumed the design of the streets, giving space for the pedestrian. The municipal works to preserve and develop cultural and architectural identity, which is an important touristic product to complement the binomial sun and beach. The current strategy, developed in the last decade, presents, among a series of measures, the creation of thematic walking routes as an opportunity that can contribute to the diversification of the tourist offer, and the requalification and promotion of the built heritage of the municipality. Guided audio tours have already been implemented, promoting inclusive experiences increase (Câmara Municipal de Lagos, 2012).

Figure 1. Portugal map and the location of Lagos city (orange circle).

Source: Map data copyrighted by OpenStreetMap contributors. Available at: <https://www.openstreetmap.org>.



Considering this scenario, based on the data inventoried during the XXX project, the general objective of this work is to identify different types of sensorial experiences observed in the city of Lagos. The specific goal is to develop a spatial identification of the door knockers "Hands of Fatima" in the historic centre, as this is a specific element of vernacular architecture associated with cast-iron architecture. These traditional objects are true works of craftsmanship which could allowed inclusive sensory experiences in the city of Lagos.

Methodology

Data collection methods

Different research methodologies, such as qualitative approach, direct observation and field research were used.

A qualitative approach was adopted, developed from an exploratory investigation, based on a literature review and fieldwork, for the inventory of the buildings of Lagos's historical centre and their vernacular architecture elements, including the door knockers known as the "Hands of Fatima".

In the Summer of 2020, the researchers visited the city of Lagos as tourists to understand what kind of sensorial experiences this destiny guarantees, which include the sight and tact of door knockers. Selected random points in the city were: cliffs and caves of Ponta da Piedade, the beach of Porto de Mós, historic centre, marine of Lagos, stream of Bensafrim, Urban Park (green ring). The direct observations covered different day moments, during 30 minutes periods, and sensorial experiences were registered in an observation sheet. The data collection took place between August 23 and August 30.

Concerning the door knockers known as the "Hands of Fatima", three phases were considered in the methodological process to achieve the proposed objectives. The first stage of the research included the task of selecting the site of study, taking over the area corresponding to the historical centre of the city of Lagos, corresponding to the city within the walls. This was followed by intense fieldwork, where significant data on the building and its elements of vernacular architecture was collected. The data collection took place between August 15 and September 25, 2020.

Then the collected data were compiled, managed and analyzed using a Geographic Information System (GIS), namely ArcGIS Desktop 10.8.

Currently, GIS provides abilities that support the creation of spatial databases and the implementation of geoprocessing operations. It is possible to develop spatial analyses by relating the data of the different elements of vernacular architecture by their geographical positions.

Results and Discussion

Diversity in sensory experiences

The city of Lagos is a tourist destination that enhances multiple sensory experiences, both in the natural environment and built spaces. The city offers a myriad of sensory experiences that can be enhanced and better developed considering the five external human senses: sight, hearing, smell, taste and touch.

This kind of tourism that enhances the multisensory mode of appreciation provides a discovery that ends up being personalized and unique, as it might be influenced by the tourist age, gender, educational qualification and previous experiences (Agapito, Mendes e Valle, 2013). In addition, people with sensory disabilities tend to be more attentive to specific aspects of the environment or object targeted for their attention (Dye, Baril & Bavelier, 2010).

The senses make it possible to establish a relationship with the external environment, intrinsically and spontaneously, and contribute to the generation of meanings (Mateiro et al., 2017). Furthermore, the stimulus of the five senses results in human sensations, which act as triggers for the formation of perceptions and play an essential role in constructing experiences (Agapito et al., 2013).

In fact, Kim & Fesenmaier (2015) advocate that the sensory experience combines the senses with the cognitive and affective dimensions to produce interaction and integration between people, resources, places and environments. This conjunction enables the creation of a richer narrative about historical places and heritage sites, giving the ability to establish a personal connection with destiny, culture and the local community (Pan & Ryan, 2009; Davis & Thys-Senocak, 2017).

Through the direct observations was possible to verify that according to the hours of the day and the weather conditions, there are multiple and distinct routes to enjoy the landscape. This multi-sensorial experience leads to different ways of enjoying multiple sites.

Regarding vision, nature and the built environment combine to offer a wide variety of colours and shades: the blues of the sky that change with the luminosity, the dark blues of the Algarvian sea and the lightest of the caves at Ponta da Piedade, the blues of birds like the common kingfisher; the golden yellows of the sands in the beach of Porto de Mós, the cliffs (Figure 2) and the caves; the greens of the gardens and trees; the brown of the century-old walls and the doors of traditional houses; the white of traditional houses and churches, and storks; the diversity of colour of the doors and their knockers; and the sunrise and sunset guarantee a full conjugation of variations of orange colours and brightness.

Visiting the city can provide the hearing of an authentic collection of sounds: from nature, sounds and noises like the waves of the sea, the whistling of the wind, the singing of cicadas and the songs of birds, many of them with vulnerable status: Eurasian whimbrel, common redshank, sandwich tern, black-tailed godwit; the noises of trains, motorboats, car traffic and shouting in local markets; the sound of warning for the pedestrian to stop when the drawbridge is lifted to the entrance of the sailing boats to the marine; the sounds of the water pulls and laughter of children experiencing the water infrastructure in the centre of the square of Henry the Navigator; and in the evenings the sounds of joy, music and conversation in the historic centre and the marine.

And the smells coming from nature, from the sea and the stream, from the plants in the urban park. And the smells that come from restaurants, bakeries and pastry shops, with the barbecues and the food made with fragrant herbs, the bread freshly baked in the oven, the smell of sugar syrup and cinnamon, when the traditional sweets of Lagos “Dom Rodrigues” are made.

The varied and rich gastronomy, combined with the Mediterranean diet and other traditional foods, guarantees unique palates. Fish and seafood, olive oil and aromatic herbs that season, conventual sweets made from eggs, almonds and figs. The tasting of farm wines, belonging to the municipality of Lagos.

Figure 2. The blues of the sea and the golden colour of the cliffs on a beach of Lagos. Source: the authors.



With touch, distinguish shapes and textures can be experienced such as hot and cold, rough and soft. On the cliffs and beaches, the roughness of the sandstones can be felt, soft sand can be stepped and slid through the fingers; on the accessible beach of Porto de Mós, people with disabilities experience the salty sea on amphibious chairs, and have the perception of the temperature of the water and the movement of the waves; in the urban park the edges of the leaves of the trees, the roughness of the trunks can be touch, as well as the different textures of fruits, such as almond shells. All these examples make the city of Lagos a destination that enhances different sensory experiences.

Sensory experiences with door knockers "Hands of Fatima"

The focus was given to a particular object associated with traditional popular architecture, the closed-handed door knocker "Hand of Fatima". There are many of this kind of antique decorative elements in the historic centre of Lagos, and they can be integrated into the collective cultural heritage. In addition to compressing a utilitarian function, it has a symbolic and even

superstitious charge since they are considered by many protective talismans (Maçarico, 2011), and so, the associated sounds have a strong impact on tourists who perceived these dimensions.

Iron architecture appeared around the second half of the 19th century, associated with the industrial revolution, and in Portugal's case it took place later, in the transition from the 19th to the 20th century.

This temporality is consensual with the history of the city of Lagos. In 1755, an earthquake of great intensity occurred in Portugal, followed by a tsunami. These events had great consequences in Lagos, with the destruction of most of its buildings, as well as deep changes in its urban structure (Paula, 1992). Thus, a large part of the city's traditional buildings, mainly in terms of its historic centre, date back to the late 18th, 19th and 20th centuries. In the 60 hectares of the historical centre area, only 12% of the buildings were built before 1920, around 194 buildings (Câmara Municipal de Lagos, 2012).

Within the area inventoried in the scope of the TurAccess project, the historic centre of Lagos, 89 door knockers known as "Hand of Fatima" have been identified. The great incidence of these elements of vernacular architecture, made of cast-iron, can be justified due to the extensive architectural and urban development of the city from the middle of the 19th century, a period of great expansion of the use of iron in architecture (Mendes, 2000), and the re-establishment of the socio-economic structures of the city due to the expansion of the canning industry (Paula, 1992).

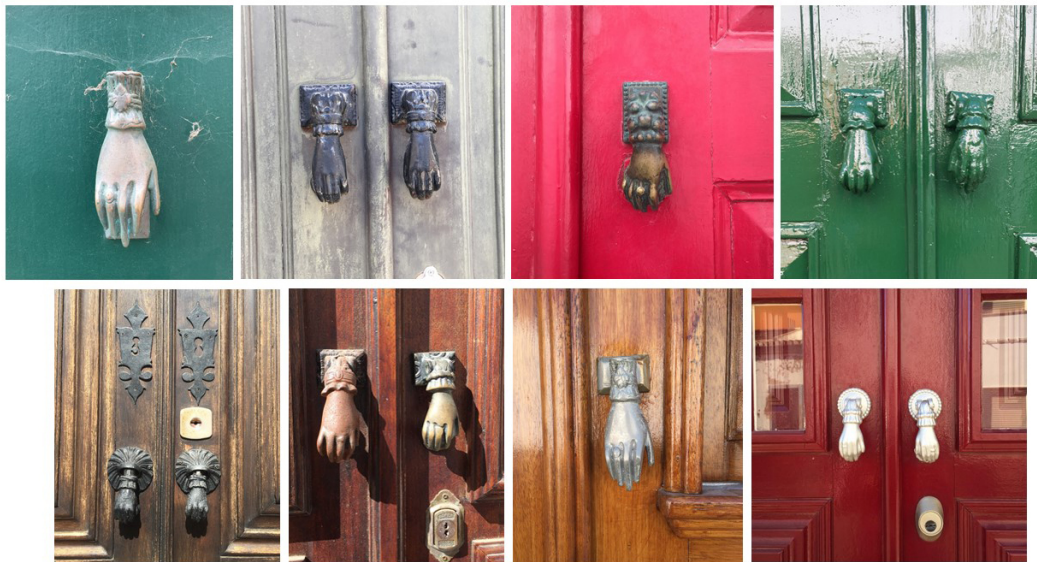
The door knockers "Hands of Fatima", as a product, embody certain features characteristics associated with traditional cast-iron design, that give the opportunity to various types of sensations responses. In general, they draw attention to their intensity and beauty (Figure 3).

In terms of vision, these door knockers in the old buildings are true cast-iron sculptures with decorative details, sometimes very feminine. Their different colours, and in general, the color contrast with the door's colour facilitate their observation by people with low sight.

In another way they can be understood by touch and, then, perceived how these pieces are delicate and, sometimes, feminine, inviting people to knock,

and experience their sounds. These particular experiences are very important for people with visual disability, as they can explore the object, play with fingers to produce sounds, understand the textures and the temperatures (Neumüller et al., 2014).

*Figure 3. Door knockers "Hands of Fatima" in the city of Lagos.
Source: the authors.*



Walking in the historic centre can also provide the hearing of the sounds of these cast-iron knockers, when they are used, which can be single or multiple.

The analysis of the spatial distribution of door knockers "Hands of Fatima" in the city of Lagos (Figure 4) indicates that these objects are scattered throughout the historical centre, with a greater concentration to the west, in the area surrounding the current Rua da Atalaia, coinciding with the old access road to Sagres, bordering the bulwark ("baluarte") Porta dos Quartos.

As already mentioned, in the second half of the 19th century, the city experienced an outbreak of expansion from the establishment of fish canning industries. At that stage, the door "Porta dos Quartos" was extended. There were the stables and barracks of a military company near this door, as Paula (1992) specifies.

Figure 4. Spatial distribution of door knockers "Hands of Fatima" in the historic centre of Lagos. Source: the authors.

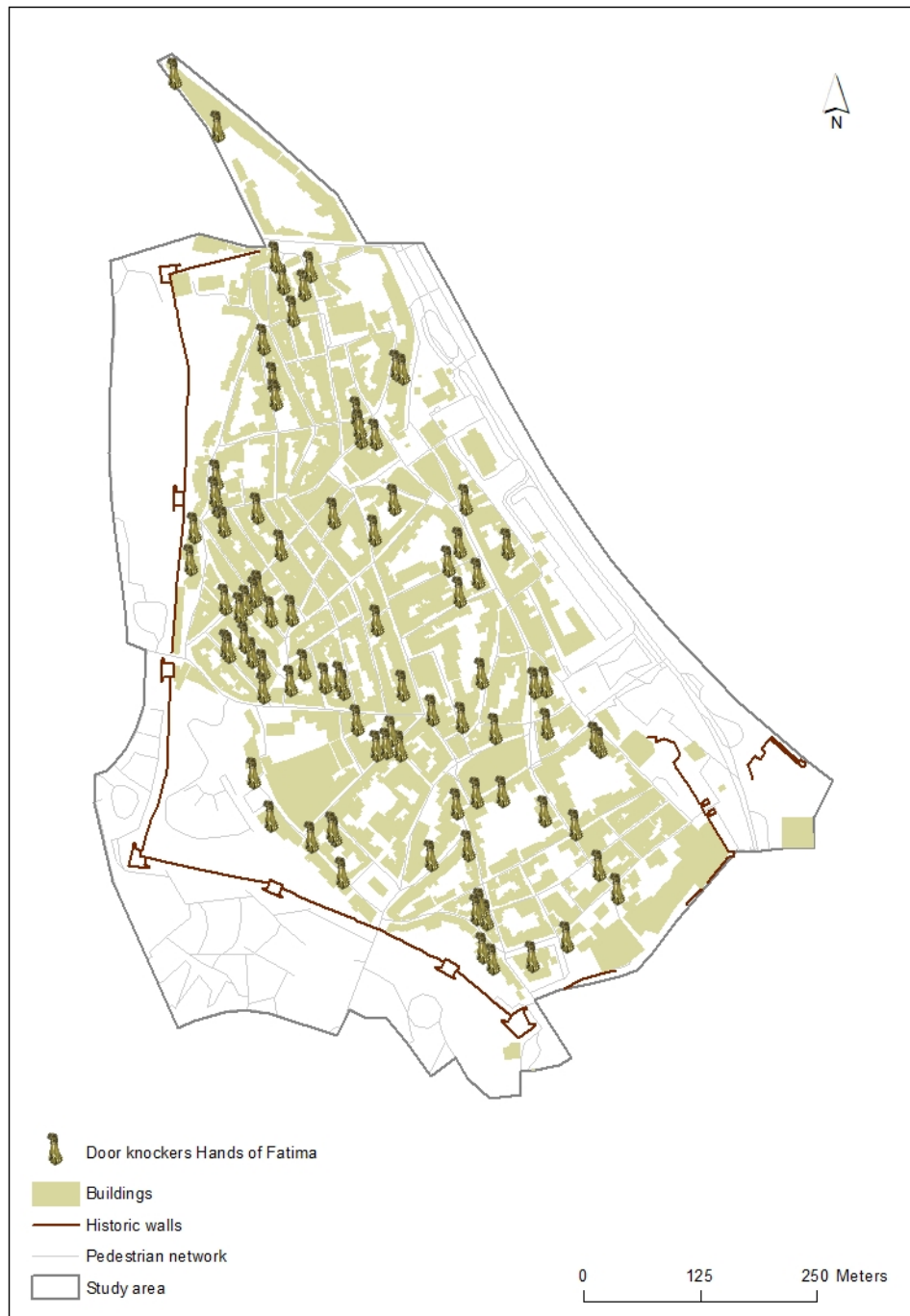


Figure 5. Association of door knockers "Hands of Fatima" with touristic routes in the historic centre of Lagos.



The dispersion of these elements throughout the historical centre makes it difficult to design a cultural route. However, they constitute an added value in the existing routes of Lagos dos Descobrimentos and the Accessible Touristic Itinerary proposed by Turismo de Portugal, I.P., the national tourist board (Figure 5). The route Lagos dos Descobrimentos is a guided audio tour "Lagos

dos Descobrimentos”. Part of this crosses the historic centre, going through the city's most emblematic cultural monuments and touristic places.

The Accessible Touristic Itinerary is mainly along the river marginal and marine, but there are some sections inside the historic centre (Câmara Municipal de Lagos, 2020).

On the other hand, these door knockers can be discovered by the curious tourists exploring the historic centre or guided by touristic professionals from the municipality of Lagos or private enterprises, enabling a richer narrative about sensory experiences associated with cultural heritage.

Conclusion

This study presents examples of sensory experiences that can be achieved in the city of Lagos. Direct observations, landfield and thematic mappings were developed, and they provided data to understand a potential new touristic product that can be perceived for all people, including persons with functional diversity.

The advantages of applying a multi-sensorial approach to the experimentation of objects and historical sites have been widely discussed and applied, especially in the sphere of sensory tourism experience. Expanding opportunities to understand the past through a broader sensorium is fundamental to arouse interest, encouraging tourists/visitors to use the five senses to explore the environment around them, in order to open new paths and possibilities for interpretation, understanding and experience, facilitating the formation of memorable experiences (Bembibre and Strlič, 2017; Miles, 2017; (Wilson, Stott, Warnett, Attridge, Smith, Williams e Warwick Manufacturing Group, 2017);

Research into the inclusion of people with sensory disabilities in the field of accessible and inclusive tourism has attracted increasing attention from literature (Dann and Dann, 2012; Small, Darcy and Packer, 2012). There is concern about the role of a multisensory approach to tourism experiences in the context of inclusion and accessibility, emphasising the importance of

further identifying and integrating sensory elements in the process of building inclusive experiences in tourism sites (Agapito, 2020).

The city of Lagos has much potential in creating new inclusive products that permit multiple sensory experiences, both in the natural and built environments.

In this article, the door knockers known as the "Hands of Fatima", that exist in all the historic centre of Lagos, are highlighted as tactile and auditory stimuli that, in interaction with the other senses, might enable the visitor a closer relationship with the environment, the local community, resulting in a richer and memorable experience.

There are multiple perspectives about the genesis of this element that could be associated with Islamic and Jewish cultures or only a colonial French element that appeared in 19 century. These varied interpretations and the associated mystery can enrich a narrative around these door knockers. The sounds they produce, when used, are associated with protection in a perceived superstitions context.

These door knockers can guaranty different sensory experiences, and all this conjunction enables the creation of a richer narrative, that could be interesting for tourists and could be considered in guided tours.

Since there is a strong link between sound and emotions (Marshall, Petrelli, Dulake, Not, Marchesoni, Trenti e Pisetti, 2016), the use of audio guides, besides being an inclusive tool (Lauría, 2016), is a way to provide a contextualisation, to tell the stories behind these elements, and to create a narrative that can help in the construction of the imaginary of visitors and tourists (Bender et al., 2020). These audio guides, or guided tours by residents or tourist professionals, have to guaranty multiple means of communication to consider human diversity.

These new ways of appreciating, looking at and interpreting with the senses are not only designed for tourists/visitors, but also for the local community. In the production of this new tourist product, the local population must be involved and participate inrecognising the touristic importance of these door knockers, derived from their symbolic charge, contributing to the cultural

identity of this territory. These door knockers, traditionally, have a private use, so it is advocated that only those knockers whose owners adhere to this touristic use, as a sensory experience, should be considered. So, touchpoints have to be planned collaboratively. Emphasis is given to this community-based tourism.

The density of the door knockers "Hand of Fatima" in the historical centre, which artistic detail catches the attention and makes possible an interaction through sight, sound and tact, contributes to the understanding of this historic centre as an authentic living museum that guarantees multiple sensory experiences and inclusive tourism.

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TACTILE PAVING SURFACES AT BUS STOPS. THE NEED OF HOMOGENEOUS TECHNICAL SOLUTIONS FOR ACCESSIBLE TOURISM

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Abstract: Accessible tourism promotes the right of all citizens to visit places and experience tourism. Therefore, universal accessibility must exist within the tourism value chain, where the public transport system is an important element. The research project "Accessibility for All in Tourism" focused on the attributes of inclusive bus stops and considered "Universal Design" and "Age Sensitive Design" approaches. In the built environment, products and spaces must consider the needs of all people to the greatest extent possible. In particular, adequate wayfinders to help people with visual disabilities in terms of orientation and danger alerts. Tactile paving surfaces are one of the fundamental elements of accessibility for people with visual disabilities, ensuring they have an independent life, whether they are residents in their city or tourists in another country. However, when considering these tactile surfaces, the needs of elderly people and individuals with visual disabilities

are divergent. This study is intended to present international examples of tactile surfaces used at bus stops, in some cases based on bibliographic research and direct observation. For a better understanding of the constituent elements of tactile surfaces, established examples were compiled. The results indicate that there is a great diversity of technical solutions for tactile surfaces at bus stops that attend to the needs of people with visual disabilities, some more age-friendly than others. In a context of equitable use and accessible tourism, homogeneous technical solutions, inclusive for all, should be implemented in all countries.

Keywords: social equity, universal accessibility, bus stops, tactile surfaces, people with visual disability, older tourists.

Introduction

The United Nations Convention on the Rights of Persons with Disabilities adopted the social/environmental model of human functioning, assuming that disability is intrinsically related to the interaction between people's characteristics and the behavioural and/or environmental barriers that exist in society and that interfere with their inclusion and participation (United Nations Organization, 2006). The person with disability or incapacity, able to lead an independent life, aspires to direct his/her own life in a process of self-determination.

The concept of "self-determination" corresponds to the right of the person with disability to take control of his/her life and to be able to make choices, know how to request, make decisions, develop self-knowledge, autonomy and independence (Nirje, 1972). The process of self-determination depends on the development of the individual and his/her interaction with the built environment.

This emphasis on environmental factors external to the person determines that the built environment has to be designed take to into account the concepts of "social equity" and "social inclusion" that are considered in social sustainability (Rosa, 2018). This is associated with values of justice and

solidarity, equal opportunities in access to goods and services, access to the city and information, alternative forms of communication and the participation of all in decision-making and governance processes. Thus, ensuring universal accessibility is fundamental for the exercise of rights and duties under equal conditions.

According to the European Concept for Accessibility, “accessibility is the characteristic of an environment or object which enables everybody to enter into a relationship with, and make use of, that object or environment in a friendly, respectful and safe way” (Aragall & EuCAN members, 2003). This is connected with the “universal design” concept which is “The design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialised design” (Center for Universal Design, 1997). More recently, services were integrated into this approach, as well as transportation, information and communications.

The built environment must be usable by people with diverse abilities. It is an issue related to equitable use, as a democratic principle of equality, and so every person should have equal access to built and urban environments, making environments secure and safe to use by all (Story, 2001). Universal Design is seen as a significant component for sustainable life and social development (Kadir & Jamaludin, 2013).

So, in many European countries, over past decades, universal accessibility conditions for all have been implemented, including access to employment for people with disabilities. The subsequent financial autonomy has led to people with disabilities having an interest in tourism experiences in foreign destinations. This tourism for all participation is progressively perceived in countries as a right for all citizens.

Consequently, universal accessibility began to be considered in the field of tourism in England, and the Tourism for All project (Agovino, Casaccia, Garofalo & Marchesano, 2017) emerged.

In parallel, the promotion of sustainable and inclusive mobility prioritizes universal accessibility of public spaces, vehicles, products and equipment

associated with transportation, adapted services, communication and information technologies.

An accessible city considers citizenship and the qualification of urban spaces, seeking to include everyone, regardless of their physical, mental or psychological abilities, valuing the city itself and making it more comfortable, sustainable and competitive. This approach has also been taken in tourist cities.

Presently, many tourist destinations have considered this accessibility according to the Universal Design approach, providing accessible tourism that guarantees trips in which people with disabilities can have autonomy. However, there is a focus on providing barrier-free access for people with physical disabilities, for example, wheelchair users.

The concept of “accessible tourism” meets this attribute as it “enables people with access requirements, including mobility, vision, hearing and cognitive dimensions of access, to function independently and with equity and dignity through the delivery of universally designed tourism products, services and environments. This definition is inclusive for all people including those travelling with children in prams, people with disabilities and seniors” (Darcy & Dickson, 2009, 34). Tourists with trolleys and luggage can be included in this reduced mobility group of people.

Regardless of the significant advances in accessibility, barriers to accessing public transport persist (Cerdan-Chiscano, 2020). Accessible stops are essential for people with motor disabilities and are useful for people with prams or baggage (Fearnley et al., 2011).

Accessible transport often correlates to step-free access, which is not the solution for most people with a visual disability (Low, Cao, De Vos & Hickman, 2020).

Concerning visually impaired people, consistency in the layout and design of the entire transport infrastructure is important to ensure that they can move safely and confidently (Quinones, Greene, Yang & Newman, 2011).

Bus stops constitute one of the fundamental elements of the transport network and must guarantee universal accessibility for passengers to the vehicles, so they must be integrated into the urban space and, consequently, into the pedestrian network and modal interfaces. Thus, bus stops must be accessible to guarantee conditions of autonomy for all pedestrians to satisfy their travel needs. For this to be possible, it is necessary to provide these spaces with adequate information and resources to allow the movement of all. This is a challenge in tourist destinations, mainly considering the needs of people with visual disabilities.

Environmental characteristics should facilitate all users' lives in terms of their activities, but there is little information available for designing products and spaces considering the perspective of people with visual impairments (Rey-Galindo, Rizo-Corona, González-Muñoz & Aceves-González, 2020).

It is known that the ability of people with visual disability to orient themselves is a highly complex issue since they are by no means a homogeneous group (Silverstone, Lang, Rosenthal & Faye, 2000).

In fact, there are a great diversity of problems when considering people with low vision: decreased acuity and visual field, photophobia/light sensitivity problems, inability to distinguish colours, difficulty in adapting to light and darkness, difficulty in distinguishing contours due to the absence of peripheral vision, among others.

According to Pindado (2006), in the specific case of visually impaired people, they have difficulties with: (a) identification of spaces and objects; (b) detection of obstacles (such as unevenness, protruding elements or holes); (c) determination of directions and monitoring of routes; and (d) obtaining written information (such as texts or graphics).

In the built environment, many countries worldwide introduced tactile ground surfaces to facilitate the safe movement of people with a visual disability since they were created in Japan in 1965 (Mizuno, Nishidate, Tokuda & Arai, 2008).

Tactile warnings are an effective tool to aid the wayfinding process (Rosburg, 2008). As in the built environment, pedestrian crossings and platform edges

have tactile ground surface indicators, which are a set of square tiles with raised patterns to indicate direction, change of routes, warnings or change of ground level.

Sometimes, tiles have no raised patterns. For example, in Brussels (Belgium), tactile blocks are installed at bus stops, and rubber warning blocks are used where directional blocks intersect (Mizuno et al., 2008).

Christophersen & Denizou (2011) specify that guide paths may be created by architectural elements, components, or markings which, due to their form, colour, or texture, aid people with cognitive or sensory disabilities and other users. People with low vision must be able to see the guide paths and blind people should be able to perceive them via the feet or long canes.

Tactile floors must be specific textured surfaces, in general with contrasting colours, perceptible and identifiable by touch with the feet or with a white cane or through residual functional vision. They are used to guide and inform visually impaired people about a certain situation that requires guidance or attention.

However, accessibility for people with visual disability is often broken by the non-existence of tactile and/or chromatic floors that provide guidance and information to these users of urban spaces. The general quality of the barrier-free pedestrian infrastructure is also important.

A recent study that considered the participation of a target group of users with visual disability concluded that the main hazards identified by them were parked cars, the presence of external obstacles (e. g. planter boxes), irregular ground surface, i. e. all the physical attributes that prevent good accessibility in urban spaces (Campisi, Ignaccolo, Inturri, Tesoriere & Torrisi, 2020).

Considering bus stops, blind and vision impaired residents and visitors find the boarding point difficult to locate (Golledge & Marston, 1999). When there are platforms, tactile paving is a critical safety requirement, as it warns that they are approaching the platform edge (Jones & Jain, 2006).

In this context, bus stops offering comfort, safety and information, conditions favourable to greater use of public transport by people with a visual disability must be ensured.

However, tactile paving can be uncomfortable for some elderly people (Ormerod et al., 2015) and also for wheelchair users and ambulant disabled people that may be at greater risk of tripping (Dales & Priestley, 2020).

From the perspective of elderly tourists, particularly older individuals (+ 80), there is a lack of interest in tactile surfaces, so the needs of elderly people and individuals with visual disabilities are divergent (Pinto, Assunção & Rosa, 2020).

Previous research gave some attention to this problem. The tactile installation design must take into account the people with a visual disability, wheelchair users and elderly people (Mizuno et al., 2008). Other established studies from the point of view of older people in the outdoor environment inferred fear of falling or feeling unstable on tactile surfaces, mainly on dropped kerbs (Chippendale & Boltz, 2014). Tactile surfaces are being investigated, from the perspective of other people, as there is some criticism of their use by people with motor difficulties, specifically older people (Ormerod et al., 2015).

According to Mizuno et al. (2008), installations with an excessive number of warning block protrusions were observed in many countries, a situation that could confuse people with visual disability and be considered obstacles for the elderly and for those using wheelchairs or strollers. So, there is no need for huge rectangles of tactile paving, as this kind of installation is not helpful to blind people and is an annoyance for others (Duncan-Jones, 2015).

Recently, Dales and Priestley (2020) developed research on tactile paving, considering users' perspectives. There was a general recognition of the need to consider the concerns of other people with disabilities, especially those likely to experience discomfort or a trip hazard, as some blister dimensions are too high, affecting buggy and wheelchair users, and others.

Interpretation of these findings can come from health research through the concept of "minimum toe clearance" (MTC), or more generally "minimum foot clearance" (MFC), which translates a measure of the risk of the foot swing

contacting the walking surface or other object during the swing phase of walking (Winter, 1992). This author reported the MFC = 1.12cm in healthy elderly people. Group standard deviation in MFC has been reported as 0.68cm for elderly adults by Karst, Hageman, Jones & Bunner (1999), and so the height of 4.40mm looks admissible.

So, the dimension of 4mm can be considered adequate for all people. Being only 3mm in height, these protrusions seem likely to go unnoticed by people with visual disabilities (Mizuno et al., 2008).

The acceptable height to be detectable by touch with the feet is 4mm. This height of 4mm could be more convenient for the movement of wheelchair users or elderly pedestrians.

The present study is integrated into the Research Project ACCES4ALL - Accessibility for All in Tourism (2017-2019), in which the main goal was to design an accessible, smart and sustainable bus stop to be located at Faro International Airport, Algarve, Portugal. In 2016, more than 7 million passengers used this airport (Domingues, 2019), so it is the most important modal interface in this region. There is a traditional bus stop used by tourists and residents. The bus routes run between this airport and Faro city centre, as well as to some Spanish destinations.

This research considered the “Universal Design” and “Age Sensitive Design” approaches. The hypothesis posed at the beginning of the research project was whether older people are considered in universal design or whether they have specific needs that differ leading to the need to trigger age-sensitive design processes.

The present paper studies tactile surfaces implemented at bus stops, where possible raised bus stops, a necessary solution when the bus has a low floor but no kneeling system. So, it is not possible to bring its front end to ground level to eliminate the vertical gap.

This paper aims to present international examples of tactile floor routing systems located at bus stops, using bibliographic research and direct observation, when possible. The specific goal is to understand which of the researched tactile surfaces is more age-friendly.

Methodology

The study made an in-depth literature review of documents, mainly laws, decrees, standards, manuals and/or technical guides, in order to understand the various tactile surfaces used at bus stops and specially raised bus stops, when this kind of information was available.

The analysis focused on European countries that send the most tourists to Faro International Airport. More than 90% of the air traffic at Faro airport consists of international flights with origin and destination in Europe. The countries with the most direct routes between the Algarve Airport are from the United Kingdom, followed by Germany, the Republic of Ireland, the Netherlands, Spain and France (Padinha, Miguel & Almeida, 2014).

From the perspective of senior tourism, elderly tourists surveyed in the ACCES4ALL Project came mainly from Europe: The United Kingdom 340 individuals (40.6%), Germany 116 (13.8%), Ireland 72 (8.6%), France 65 (7.8%), The Netherlands 38 (4.5%), Italy 28 (3.3%) and Belgium 27 (3.2%) (Gameiro, Rosa, Sousa & Mestre, 2019).

This research confirmed, as expected in the ageing process, disability increases significantly with age. Of the 835 valid inquiries, 209 (25.0%) of the elderly have a disability. The nature of the disability is mainly related to motor problems (61.6%), hearing problems (15.2%), visual problems (14.8%) and orientation problems (1.7%) (Rosa, Gameiro, Sousa & Pinto, 2020). Four individuals used a white cane (Gameiro, et al., 2019). So, the needs of visually impaired people are also pertinent to elderly people.

This information influenced the study of tactile solutions considered at bus stops in the United Kingdom, Germany, Spain and France. Belgium was also considered, because rubber warning blocks are used as tactile surfaces, as seen before.

In addition, Dubai was considered, as this emirate of the United Arab Emirates has one of the most complete and recent universal design standards recognized internationally.

This review consolidates information collected from different mediums, such as laws, decrees, standards, manuals and/or technical guides, prepared by different institutions and participants. This process has taken time due to the diverse national sources of information in the various countries, as there are also technical standards on a regional scale.

The aim of the literature review was to answer the following research question: “what are the types of tactile paving surfaces that are used at bus stops, mainly raised bus stops, for providing information to people with visual disability, in different countries?”.

The research team conducted a literature review of relevant institutional documents to understand the various technical solutions. The main documents, considered to be more complete in terms of technical information about tactile paving at bus stops, were:

- Guidance on the Use of Tactile Paving Surfaces (DETR, 1998);
- *Barrierefreie Verkehrsinfrastruktur / Infrastructure for barrier-free transport* (ADAC, 2018);
- *Guia Técnica para la instalación de sistemas de encaminamiento en las infraestructuras de transporte público en la Comunidad de Madrid /Technical guide for the installation of guidepath systems in public transport infrastructures in the Community of Madrid* (Accesible, without a reference date);
- *Guide de bonnes pratiques pour l'aménagement de cheminements piétons accessibles à tous. Les manuels du MET. /. Guide to good practice for the development of pedestrian walkways accessible to all. The MET manuals* (GAMAH, 2006);
- *Guide d'aménagement des quais bus accessibles Schéma Directeur d'Accessibilité/Guide to the layout of accessible bus platforms Accessibility Master Plan* (SMT, 2009);
- Dubai Universal Design Code (Government of Dubai, 2017).

Additionally, two types of qualitative field research methods were developed focusing on capturing information from existing bus stops: direct observation and participant observation.

In direct observation, information was gathered primarily through close visual examination of bus stops and observation of their use by people with disabilities and the elderly. The main form of recording information was writing field notes, which detailed the urbanistic characteristics of the bus stops (with emphasis on tactile surfaces). Taking photographs was another form of data collected, avoiding people for ethical reasons.

In participant observation, the main researcher used, in a systematic way, the public transport system, which, as a user, contributed to a more detailed understanding of the existing inclusive solutions.

Some of this research on accessible bus stops was developed prior to the present investigation. As in the case of a visit in Nice (France), on 5th November 2013, with a field study undertaken on a rainy afternoon.

More recently, observation to identify the elements of tactile paving surfaces at bus stops was undertaken in certain countries: the United Kingdom (visit Bristol, 10th June 2017, field study on a sunny morning) and Spain (visit Barcelona, 7th April 2017, field study on a sunny afternoon). In each city visited, walks were undertaken to find, observe and photograph examples of how tactile paving surfaces were implemented at bus stops. This fieldwork brought into awareness that there are different tactile paving surfaces and specific elements in their composition.

Technical drawings are presented in this study to perceive the different layouts used at bus stops in the studied countries.

Results

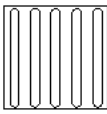
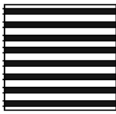
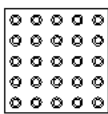

Types of Tactile Surfaces

There are many different tactile surfaces in the countries researched, but four styles are more present in the researched documents. Tactile blocks of ribbed

floor (with different purposes - guidance or warning), blister surfaces (purpose - warning) and neoprene rubber, a smooth and/or soft floor (purpose - informative), usually, with colour contrast (Figure 1).

The ribbed floor has a linear relief, with salient elevations (ribs or bars), parallel to each other, generally flat, whose edges and ends may be straight or slightly rounded, and whose spacing may or may not be regular. According to the form of application - whether longitudinal or transverse to the walkway - the type of flooring assumes different purposes and communicates different information.

Figure 1. Some examples of tactile surfaces. Source: Own elaboration

Element	Ribbed surface		Blister surface	Neoprene rubber or surface with contrasting colour
Purpose	Guidance surface	Warning surface	Warning surface	Information, indication
Plan				

When the ribbed floor is applied longitudinally, it generally takes on the function of direction/guidance to guarantee orientation for blind people and is used to indicate paths and routes. It is generally recommended to be applied in a few circumstances on public roads. In Spain, its use is recommended in the absence of a façade line. In Belgium, when a situation can lead to disorientation, for example, walking in a complicated transport terminal, finding a specific bus or train line.

When the ribbed floor is applied crossways, it generally takes on the function of warning, caution, danger, or is used to indicate a change of direction, points of interest (bus stop, information point, crossing points), change of levels (stairs and ramps), pedestrian level crossing or approaching unevenness on platforms at train stations (danger). The floor has a greater number of ribs with less spacing between them.

The warning floor has a "pythoned" (button or dot) relief profile, composed of protruding domes (rounded, usually with a flat top), generally regular spacing and sufficient height to be detectable by touch with the feet or a white cane.

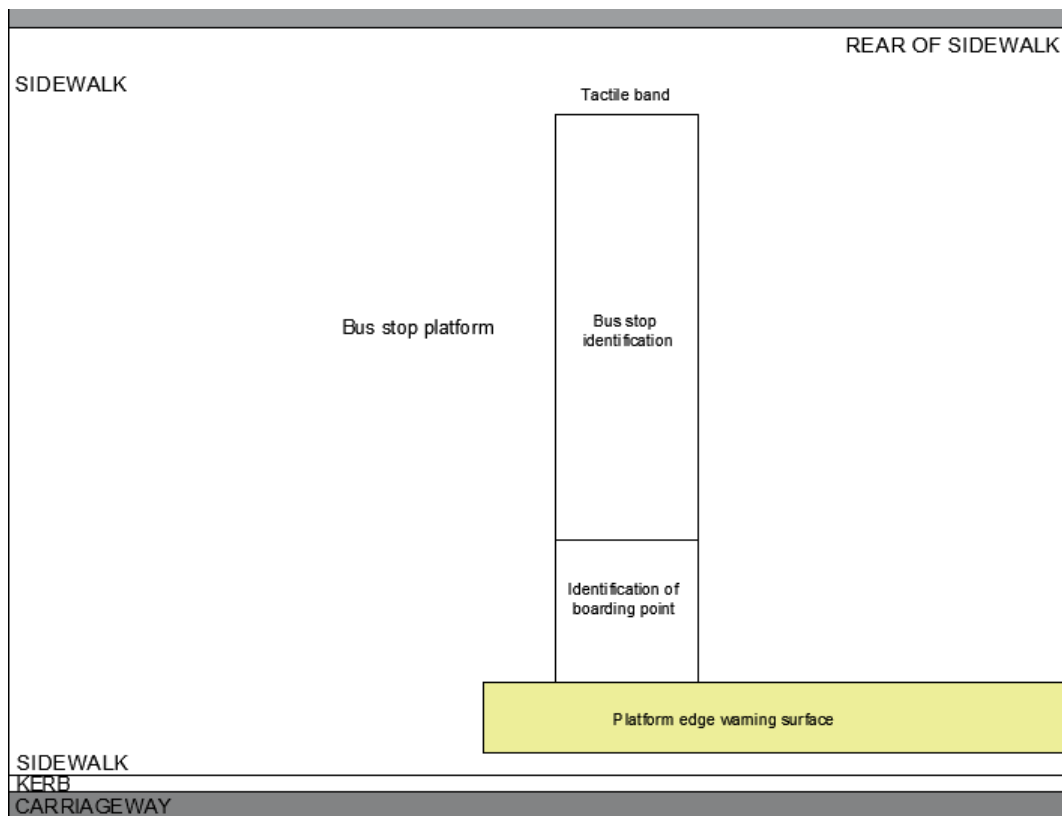
It can be used to indicate a change of direction, presence of obstacles, change of level (stairs and ramps), pedestrian crossing points, the approach of unevenness on rail or bus platforms (danger). In some cases, the positioning of the pythoned floor can indicate the direction of travel.

In the United Kingdom, floors with soft rough surfaces (not tactile) and contrasting colour were observed.

Layouts of Tactile Surfaces at Bus Stops

The use of tactile and/or chromatic differentiated tactile surfaces at bus stops, consider specific situations: a) identification of the localization of the bus stop; b) identification of the place of boarding; c) identification of the edge of the platform (Figure 2). Plus situations where only strips with chromatic differentiation are used.

*Figure 2. The layout of tactile surfaces at bus stops.
Source: Own elaboration*



United Kingdom

In the United Kingdom (UK), the Department of the Environment, Transport and Regions has a specific guide on the use of tactile floors that defines the scope, application, maintenance and design of seven different types of tactile floor and provides guidance on which colours should be used (DETR, 1998). Considering blister surfaces, the profile of the comprised rows of flat-topped 'blisters' is 5mm (± 0.5 mm) high. In this document, the lower tolerance (4.5mm) guarantees that people with visual disabilities will still perceive the surface. But if the blisters fall below that height, the effectiveness of the surface will be significantly reduced and can become undetectable. Below 3mm, the material is likely to be virtually undetectable.

It mentions not to use tactile flooring at raised bus stops without justifying the reason. The Department of Transport also developed recommendations for the design of accessible bus stops and confirmed not to use tactile surfaces (DfT, 2002).

However, Dales & Priestley (2020) recently developed a collaborative research regarding tactile paving and proposed that on the platform edge (on the street), lozenge tactile surfaces should be used on raised bus stop platforms to warn people with visual disabilities of the edge.

In the UK, to draw attention to installations, an information surface can be used, which has no relief, but is made of a material that is slightly softer than conventional paving materials, for example, neoprene rubber or similar elastomeric compound.

This kind of information surface is used to highlight the main elements of street furniture that exist in pedestrian environments, such as telephone boxes and automated teller machines (ATMs), which visually impaired people may have difficulty to locate. This material should contrast in colour and texture with the surrounding area.

A smooth and soft strip (0.10m yellow line), parallel to the kerb, at a distance of 0.45m (DfT, 2002), should be provided on the waiting platform (Figure 3) to provide guidance to bus drivers and to indicate to passengers that they should stay away from the edge of the platform. In the fieldwork it was

observed that on bus stop platforms, there are sometimes warning strips (but not tactile) parallel to the kerb, in the form of surface marks (Figure 4).

There are many situations where local authority practitioners in towns or cities implement technical solutions on bus stop platforms but with non-compliance with the existing Guidance on the Use of Tactile Paving Surfaces (Greenshields, Wells, Barham & Dales, 2018).

*Figure 3. The layout of warning paving on a bus stop platform in the UK.
Source: Own elaboration.*

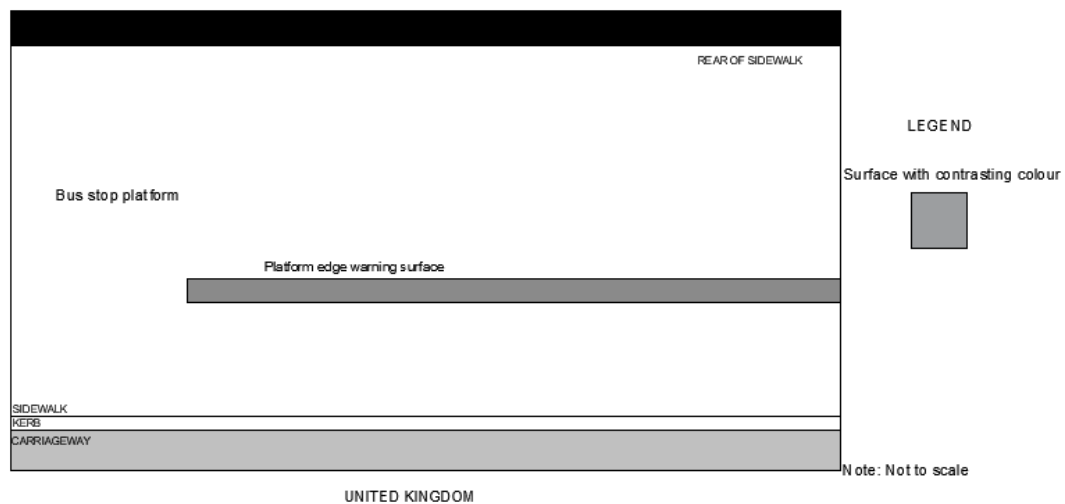


Figure 4. Soft rough surfaces and chromatic contrast floors and strips on a raised bus stop platform in the UK. Source: Personal file with photographs.



Germany

In Germany, the General German Automobile Club (Allgemeiner Deutscher Automobilclub) developed the document “Barrierefreie Verkehrsinfrastruktur” (ADAC, 2018), meaning “Infrastructure for barrier-free transport”.

The design of tactile guidance systems is regulated by the standard DIN 32984 (2011). Considering blister surfaces, the profile of the comprised rows of flat-topped blisters is 4-5mm high.

The tactile strips (*Auffindestreifen*) or directional or localization strip are used in any context where lateral points of interest, or the route itself, are to be indicated. This typology can be used to communicate the presence of a bus stop, in association with another typology, used to identify the boarding point (*Einstiegsfeld*), which acts as an indication of the place of embarkation at the bus stop. This is identified by means of ribbed plates, placed parallel to the kerb, which indicate the waiting point for boarding directly at the front door of the bus or tram. This boarding point can be identified at the end of the directional lane and have an extension of about 0.60 metres (DBSV, 2016).

An example of tactile flooring application at a bus stop in Germany can be seen in Figure 5. This kind of technical solution is presented in Figure 6.

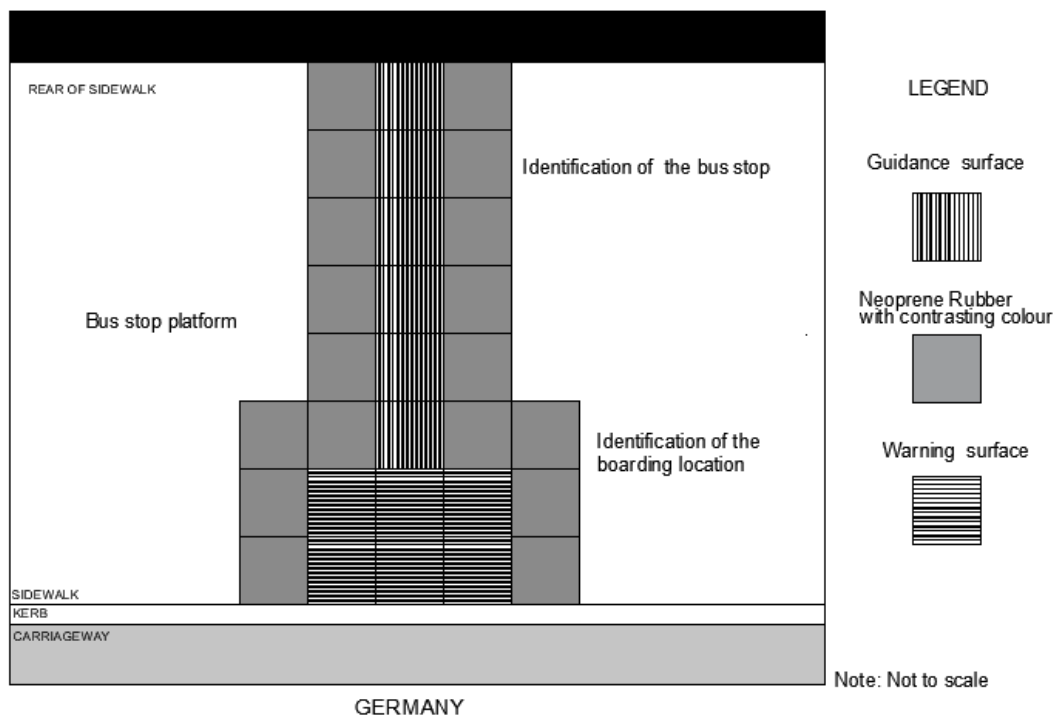
Spain

In Spain, a law regulates the basic conditions of accessibility and non-discrimination for access and use of means of transport for people with disabilities (Real Decreto 1544/2007, de 23 de noviembre). In this document, for urban and suburban transport by bus, the presence of the stops is indicated on the pavement, by placing a tactile, touch-visual detection strip, 1.20m wide and with considerable chromatic contrast to the adjacent areas of the floor. This strip is placed across the whole of the walkway, from the edge to the façade of the building, the garden area or the outermost part of the pedestrian path, to the kerb (Figure 7). In addition, a strip will be installed next to the kerb of the bus stop, in bright yellow colour and with a minimum width of 0.40m.

Figure 5. Example of tactile markings implemented at a bus stop in Germany. Source: Kohaupt (2014, p. 05)



Figure 6. The layout of tactile surfaces on a bus stop platform in Germany. Source: Own elaboration



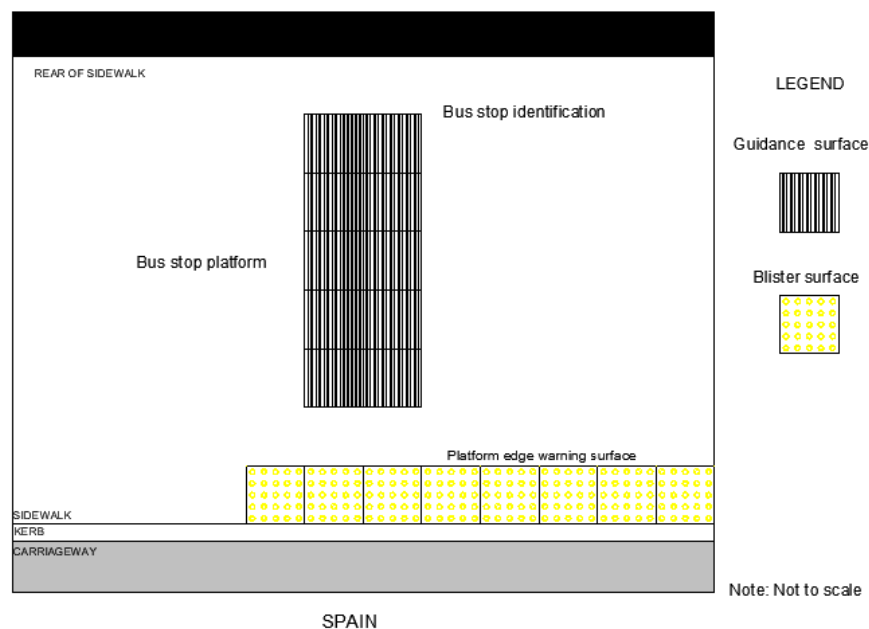
However, in Madrid, a Technical Commission on Accessibility of Modes of Transport presented additional criteria (Accesible, without a reference date). It considers that the orientation band is at least 0.40m from the façade line and extends to a distance of 0.90m from the kerb. At this distance of 0.90m,

the warning strip (franja de advertencia de peligro de los andenes) is situated at a distance of 0.40m from the kerb, which consists of a line of attention blocks (button), parallel and close to the kerb, of a yellow, reflective and shiny colour, and whose width is ideally 0.50m (absolute minimum of 0.40m). This strip warns of the unevenness of platforms (train, bus) and has variable length depending on the size of the stop. This kind of technical solution is presented in Figure 8. Considering blister surfaces, the profile of the comprised rows of flat-topped blisters is 3.5-5mm high.

*Figure 7. Guide path on floor surfaces on a bus stop platform in Spain.
Source: Personal file with photographs.*



*Figure 8. The layout of tactile surfaces on a bus stop platform in Spain.
Source: Own elaboration*



Belgium

The document "Les manuels du MET. Guide de bonnes pratiques pour l'aménagement de cheminements piétons accessibles à tous", developed by Ministère Wallon de Equipamentos e dos Transportes (MET) presents precise guidelines on the use of tactile flooring at bus stops (GAMAH, 2006).

The horizontal marks identifying the place of embarkation, for all types of bus stops, are placed on the front door axis of the bus, thus indicating the point of access to the vehicle. It corresponds to a square block of a smooth/soft floor, 0.60m x 0.60m, situated at a distance of 0.30m to 0.60m from the kerb, complemented by a strip of ribbed slabs 0.60m wide that cross the logical path of the pedestrian, placed along the entire width of the pavement, from the façade of the buildings to the smooth/soft floor (Figure 9). This kind of technical solution is presented in Figure 10.

This guide specifies that the height of the reliefs is between 4.5 and 5.5mm.

Figure 9. The layout of tactile surfaces on a bus stop platform in Belgium.

Source: GAMAH (2006, fiche 4.1)

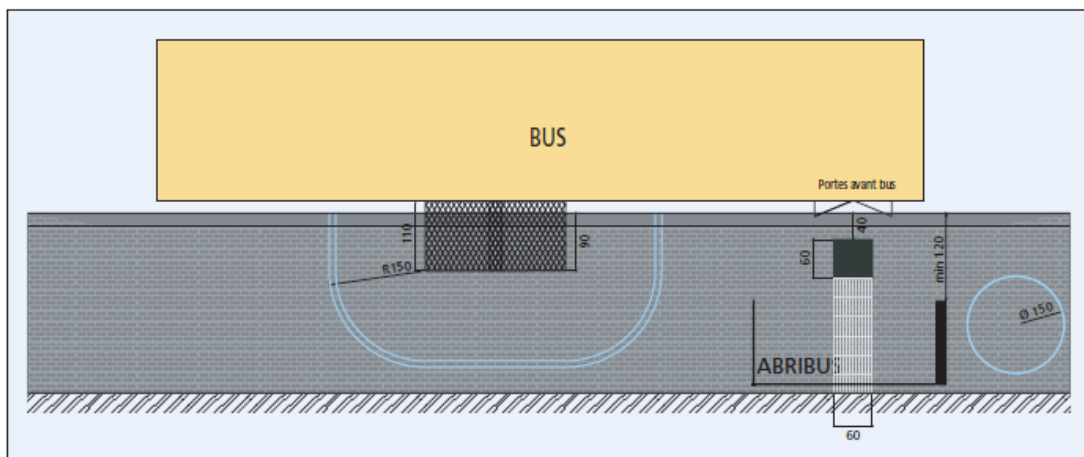
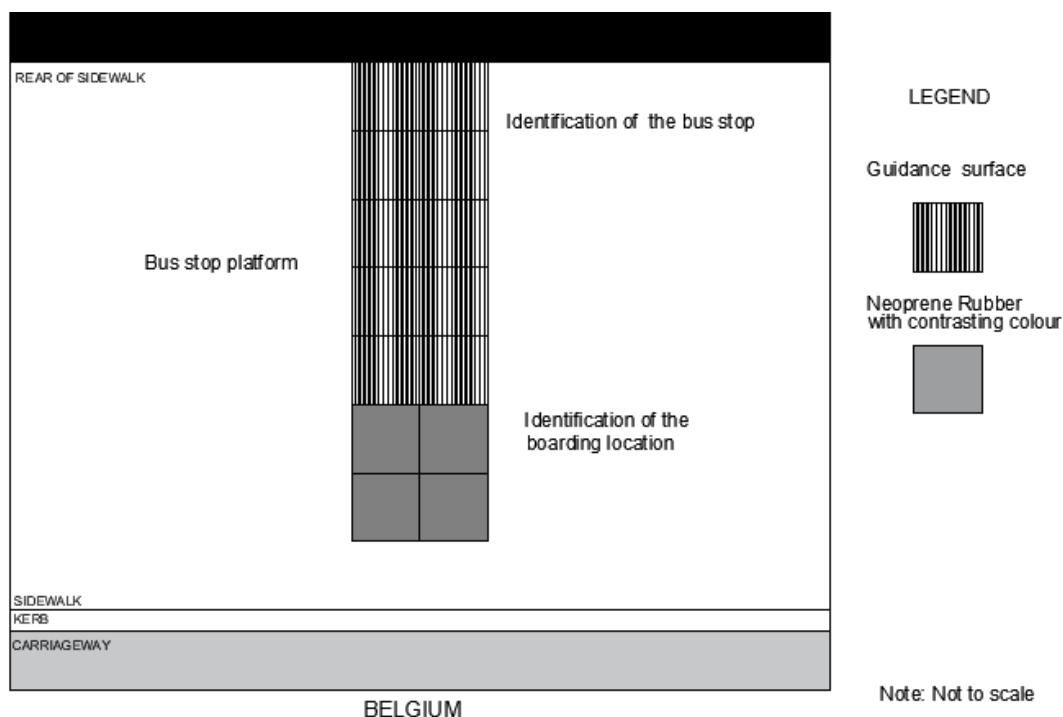


Figure 10. The layout of tactile surfaces on a bus stop platform in Belgium.
Source: Own elaboration



France

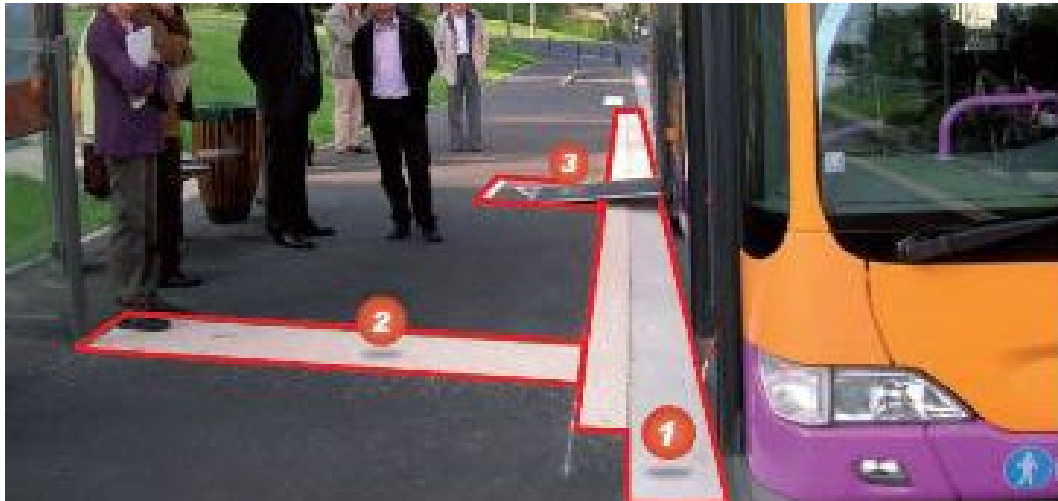
The principles of accessibility of streets and public spaces are, mainly, defined by " l'arrêté du 15 janvier 2007 portant application du décret 2006-1658 et modifié par l'arrêté du 18 septembre 2012". In this document, accessible streets, public spaces and stopping places for public transport vehicles are considered fundamental in the travel chain. In the case of a guided transport stop raised more than 26 centimetres above the roadway, a warning strip shall be installed along the entire stop length.

In France, a wide variety of tactile flooring solutions have been observed in multiple documents. In the "Guide d'Aménagement des Quais Bus Accessibles Schéma Directeur d'Accessibilité" meaning Guide to the Layout of Accessible Bus Platform Accessibility Master Plan (SMT, 2009), the stop identification tactile band, located at the foot of the front door of the bus, has a width of 0.60m and its length varies according to the distance between the colour contrast band (Bande Contrastée) near the kerb and the façade of buildings or urban furniture when this exists. A contrasting tactile band of 0.50m wide is used along the entire length of the platform to signal the proximity of the kerb

to alert people with visual disability in situations of raised platforms (Figure 11). This kind of technical solution is presented in Figure 12.

*Figure 11. Horizontal signalling at a bus stop in France.
Source: Adapted from SMT (2009, 13).*

Legend (1) Tactile band with 0.50m visual contrast bordering the kerb along the entire length of the waiting platform (2) Tactile band with 0.60m visual contrast to signal the bus's boarding gate (3) Band with visual contrast to signal the central bus gate

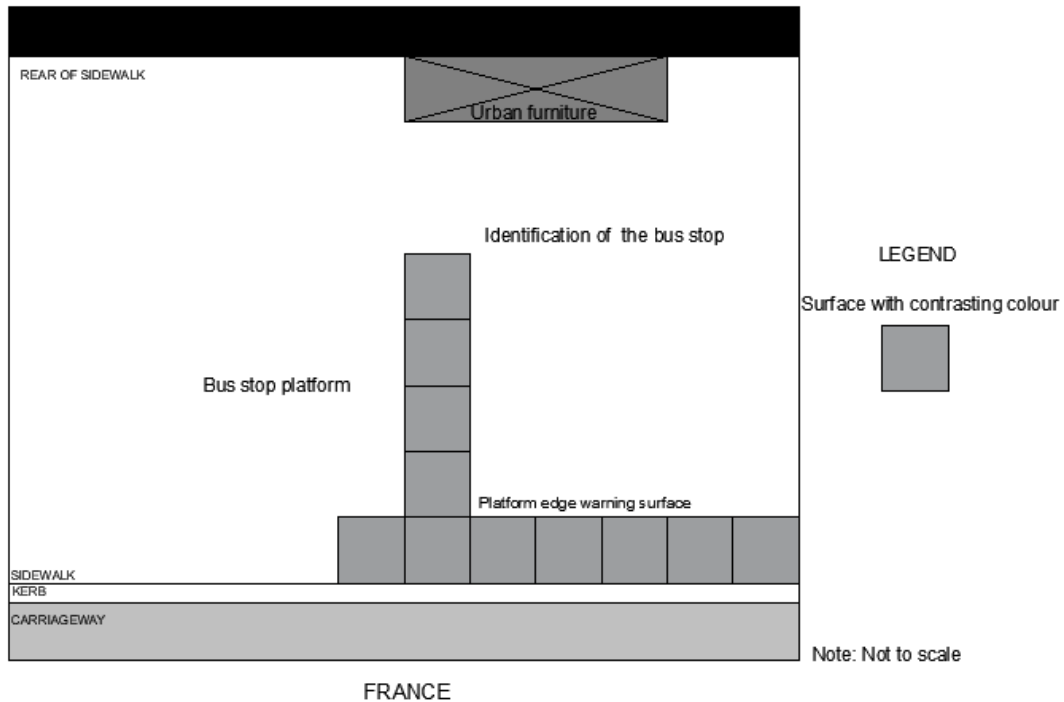


At a bus stop, the blind or visually impaired traveller should be able to identify the position of the vehicle's front door to be close enough to hear the announcement of the line and destination indication (which the fleet of vehicles provides) and be in verbal contact with the driver (CERTU, 2010).

The movement of people with visual disability must be ensured, assuming reliable auditory, tactile or architectural solutions (Cerema, 2014).

The central door of the bus can be identified by a visual contrasting floor with a white square (ideally white on black) and a wheelchair person logo (international access symbol). This last surface also serves as a stop mark to guide the driver in positioning the vehicle.

Figure 12. The layout of tactile surfaces on a bus stop platform in France.
Source: Own elaboration



The Norme NF P98-351 frames the use of the tactile bands and considers that the profile of the blister podotactiles comprises rows of rounded blisters with a height of 5mm.

This standard does not recommend the use of tactile flooring at bus stops. It is considered that these strips should be reserved for platforms with a height of more than 0.26m for guided transport (rail) and pedestrian crossings. Putting them at a bus stop can mislead blind and short-sighted people by causing confusion with a pedestrian crossing, putting them at risk of falling.

In Nice, a raised bus stop was observed where the platform had a small tactile band near the kerb (Figure 13).

Figure13. Small band of tactile surface on a raised bus stop platform in Nice. Source: Personal file with photographs.



Dubai

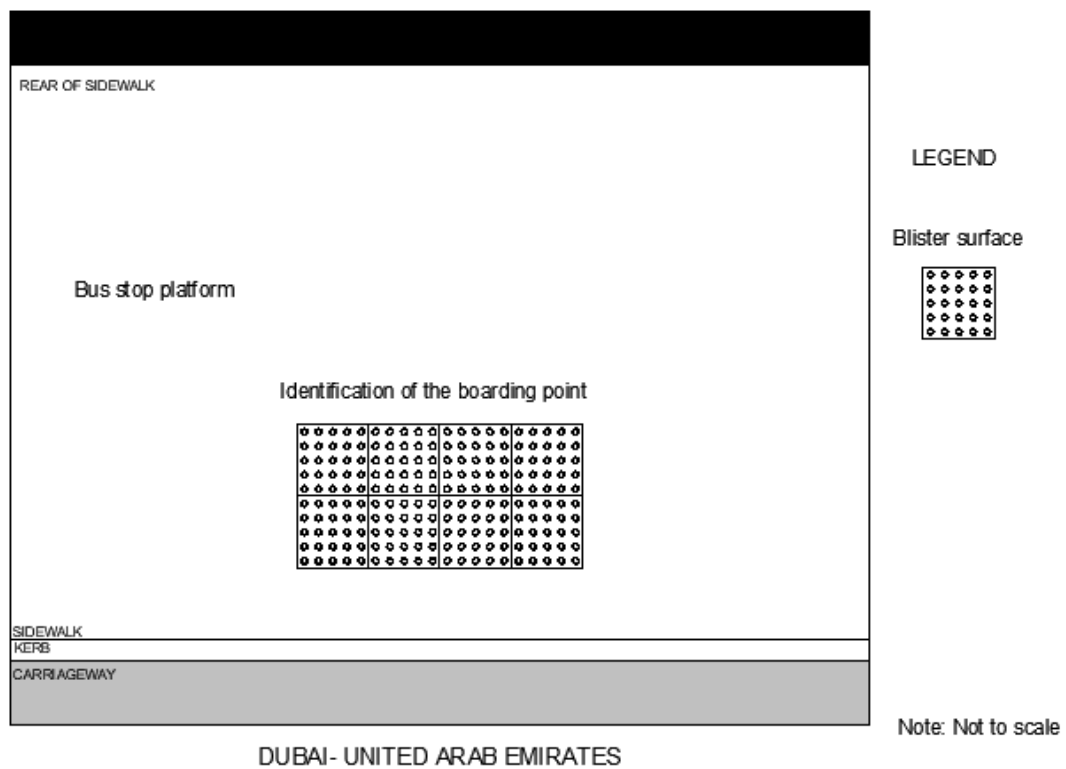
The Dubai Universal Design Code (Government of Dubai, 2017) is the reference document for universal design in public and private environments in Dubai. It recognises that the use of tactile guidance is very useful for people who are blind or short-sighted and use a white cane, but that guidance can also be achieved via walls, facades, doors or other texture changes on floors.

At bus stops, the tactile floor is used only to identify the place of boarding. It is recommended that a high contrast colour warning strip be placed on the surrounding floor (difference of at least 50 points in light reflectance value) so that it is better identified by a blind person or short-sighted people. The floor should be installed in parallel, at least 0.30m from the edge of the kerb, at the location corresponding to the front door of the vehicle when it is parked near the boarding platform (Figure 14). The warning surface shall be between 0.30m and 0.40m wide and not more than 4 mm high. This kind of technical solution is presented in Figure 15.

Figure 14. The tactile surface at a bus stop in Dubai. Source: Government of Dubai (2017, p.182)



Figure 15. The layout of tactile surfaces on a bus stop platform in Dubai. Source: Own elaboration



Conclusion

The present study was integrated into the ACCES4ALL Project, whose main goal was to research the characteristics of universal accessibility of a raised bus stop to be installed in an important tourist transportation hub in the

Algarve. Universal Design and Age Sensitive Design approaches were developed.

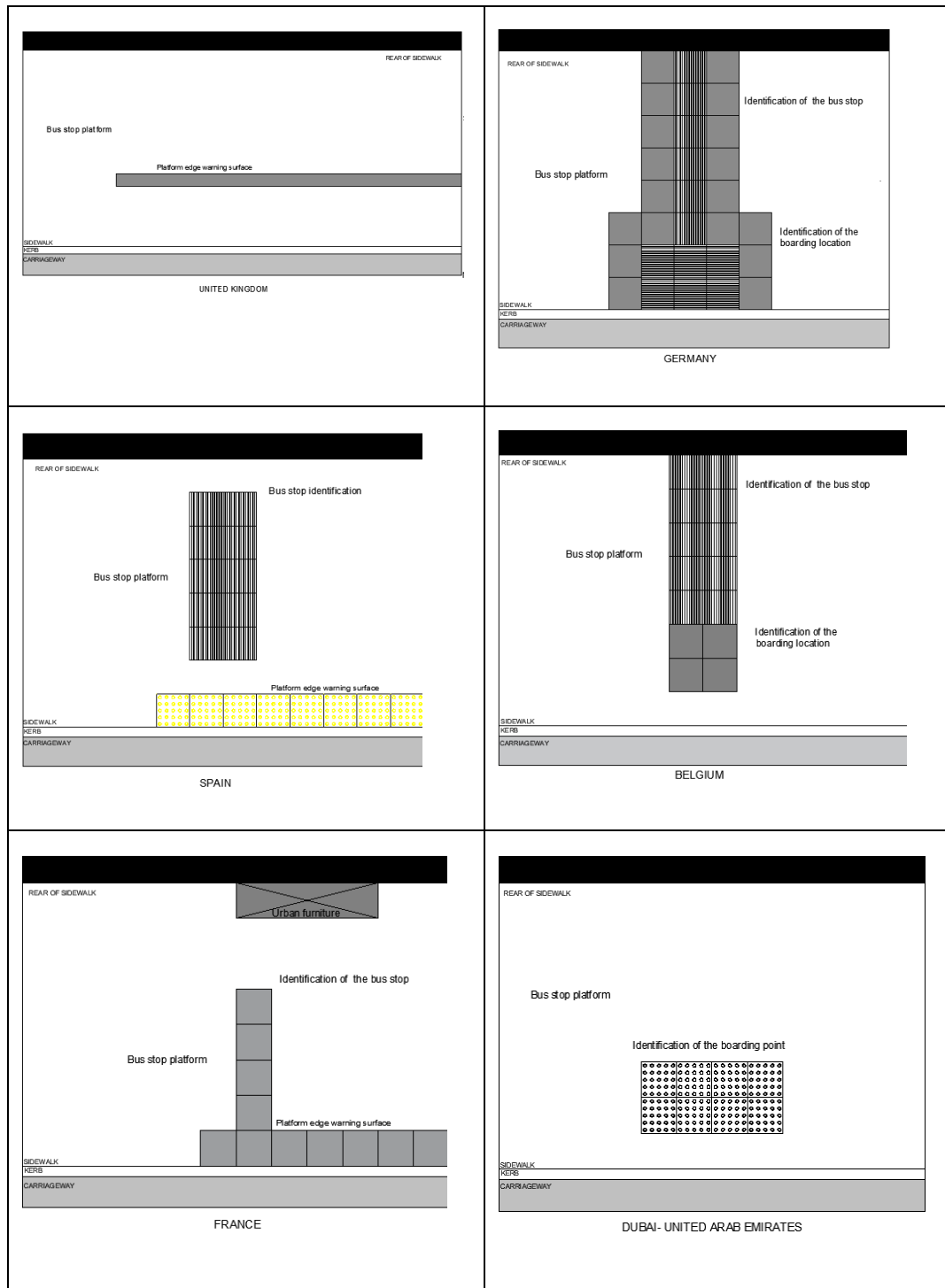
Considering accessible and inclusive tourism, specific needs of people with visual disability were recognised. So, international examples of tactile surfaces used at bus stops, were studied, using online research and, in some cases, direct and participant observation. The analysis was mainly focused on the standards and recommendations existing in European countries that send many tourists to Faro International Airport: The United Kingdom, Germany, Spain, France and Belgium. In addition, Dubai was also considered, as universal design standards there are recognised internationally.

It was understood that the use of tactile and/or chromatic differentiated tactile surfaces at bus stops consider specific situations: a) identification of the localization of the bus stop; b) identification of the place of boarding; c) identification of the edge of the platform; d) situations where only strips with chromatic differentiation are used.

However, these different types of tactile floor compositions were generally associated with each other to better communicate relevant information at a bus stop to people with visual difficulties.

Through the analysis of digital drawings of bus stops' layouts, the study concludes that these countries present different technical solutions for the tactile surfaces of bus stop platforms (Figure 16). Although they use elements (ribbed, button plates, smooth, chromatic contrast) and similar tactile information in identifying the bus stop, identification of the place of boarding and marking line of the platform edge.

Figure 16. Synthesis of layouts of tactile surfaces on bus stop platforms.
Source: Own elaboration



So, this work reinforces the current lack of consistency in the layout of tactile surfaces at bus stops in different countries.

With literature review it was concluded that the consideration of an adequate area of rectangles of tactile paving (minimum) and the height of 4mm for the

reliefs can be considered inclusive for people with visual disability and elderly persons.

In general, most of the studied bus stops have too much tactile surface tiling. The finding results indicate that some of the tactile surfaces that attend to the needs of people with visual disabilities are more age-friendly than others.

The technical layout of a small band of tactile surface on a bus stop platform presented in the Dubai Universal Design Code appears beneficial to everyone, including blind people. However, the implementation of small bands is possible because urban buses in Dubai are capable of kneeling, and so, no raised bus stops are required.

This study observed that, in some cases, in France and the United Kingdom, floors with colour and texture differentiation, without being tactile, are employed. Tactile surfaces are mainly implemented in kerb cuts or sidewalks ramps. Consequently, the information provided by tactile paving surfaces can be misinterpreted by blind people and generate dangerous situations. It is more common to observe the demarcation of the stop area with chromatic differentiation of the floor, to facilitate its location by users.

However, Dales & Priestley (2020) recommended that the platform edge should have a specific tactile warning on raised bus stop platforms, and further research is needed.

In the Dubai guide, the use of tactile guidance is considered useful, but the guidance can also be achieved via walls, facades, doors or other texture changes in floors. In fact, there are other wayfinders that help people with visual disability in a complex built environment; for example, using auditory or even olfactory signals may provide important information while commuting (Rey-Galindo et al., 2020).

According to the accessed documents, the present study analysed the height of the reliefs of tactile surfaces. In the United Kingdom it is 5mm (± 0.5 mm) and it is considered that the lower tolerance (4.5mm) guarantees that the surface will still be perceived by people with visual disabilities. In Germany the height of reliefs is 4-5mm, in Spain 3.5-5mm, in France 5 mm, in Belgium 4.5-5.5mm and in Dubai 4mm. Thus, the presented cases have different

heights of reliefs for tactile surfaces. In Spain the minimum of 3.5mm high is assumed. Further research is needed to understand if people with visual disabilities perceive this last solution.

In addition, considering blister surfaces, the flat-topped form is considered in the UK, Germany, Spain and Dubai.

The pattern of relief distribution on the floor can be staggered or rectilinear and benefit all users. In most of these countries, this type of warning floor is arranged in such a way as to form an orthogonal grid oriented in the direction of travel, thus facilitating the passage of people in wheelchairs or other elements with wheels, such as prams and trolleys.

Considering the safety of older people, Mantilla & Burt (2016) recommend that footpaths must be free from tripping hazards with non-slip surfaces, delineation of edges and consideration of impact absorbing materials. Lighting is also an important factor for older pedestrian safety.

In Belgium, smooth and soft floors are used on the bus stop waiting platforms.

The smooth and/or soft floors have smooth profiles, without relief. They adopt different characteristics from country to country, with differences in stiffness/flexibility and colour. They can be used to indicate a change of direction, presence of equipment, presence of information or, as in Germany, to reinforce the tactile-visual contrast between the tactile, ribbed and button floor and the adjacent floor.

In another way, wayfinding strategies consider solutions that recognise good conditions of perception and legibility for all pedestrians. In the built environment, it is possible to highlight the axis of circulation, intuitive location of accesses, architectural structures, contrast colours and lighting, guaranteeing space references that keep people oriented (Hunt, 2015).

Presently there is a context of social equity and accessible tourism which is considered in tourist policies and strategies. The right to decide to travel alone, with autonomy and independence, is associated with the self-determination of people with visual disability and all other persons.

The adoption of a common and universal language that can be used internationally in all contexts of urban public transport is considered fundamental. Flexibility for the multiplicity of tactile solutions triggers recognition problems by the visually impaired, who cannot perceive unity in the different reliefs and surfaces.

Designing with people with disabilities can guarantee a successful design of the urban transport experience (Cerdan-Chiscano, 2020).

Design with users (co-design) is needed to involve, first of all, people with visual disabilities in the design of new solutions for surfaces associated with raised bus stop platforms. In this collaborative process, multiple solutions need to be thought and implemented through prototypes and then, testing them by different people with functional diversities. The scope of users of bus stops and tactile floors needs to be increased, for example, by elderly people. Active ageing demands that older people can remain mobile and safe. This issue is relevant as the senior population grows in the years ahead. These demographic groups are not homogenous, and there is a combination of different functional aspects. Their needs must be considered, too.

User-sensitive design and responsive design architecture, that serves communities, are emergent concepts that must consider alternative designs and materials considering the different needs of people to be universal and inclusive.

The ACCES4ALL project contributed to a better knowledge of universal design principles considering tactile surfaces implemented at bus stops. Technical solutions for pavements can consider, simultaneously, the needs of different groups of people in a harmonized process. User-centred approach was considered in this inclusive design process that took into account the perspectives of people with disabilities and elderly persons. It reinforces the need and importance of harmonising podotactile solutions worldwide, considering a context of social inclusion and accessible tourism. It is expected to influence policies and global standards in universal design.

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A PARTICIPATORY QUALITATIVE ANALYSIS OF BARRIERS OF PUBLIC TRANSPORT BY PERSONS WITH DISABILITIES FROM SEVEN EUROPEAN CITIES

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Abstract: Although there is literature published by a considerable number of scientific publications regarding disability and transport, the affected persons are only very rarely involved in the research. The paper presents the results of two qualitative studies conducted jointly with persons with different forms of disabilities: i) a social media content analysis and ii) peer-to-peer interviews with persons with disabilities ($N = 49$). The studies aimed to identify barriers that persons with access needs face during their trips with public transport. In line with a participatory approach, persons with disabilities from seven European cities were involved in conducting the research allowing for new interpretations of transport equity issues. Qualitative content analysis of both studies revealed barriers clustered into eight categories: regulations, public awareness and assistance, information provision and communication, infrastructure, vehicles, general service quality, stops and stations and emotional barriers. The two studies highlight important factors that influence disabled users' experiences of public transport. Upon reflection, the paper derives research hypotheses and demonstrates the value of involving people with disabilities in the analysis of disability research to derive in-depth insights about equity in transport.

Keywords: accessibility, barriers, inclusive transport, universal design, user research, qualitative research, participatory approach.

Introduction

The lack of fully accessible public transport vehicles and services prevents people with disabilities from participating equally in society. Transport is essential for accessing education, employment and health services, among others. Inaccessible transport thus creates social exclusion for people with disabilities and other vulnerable-to-exclusion groups of society. The relevance and urgency of improving accessibility in transport are further increased by the demographic change that implies a growing number of mobility-impaired elderly.

The paper adopts the social model of disability that defines disability as a social creation based on the relationship between people with different access needs and a disabling society and environment (Shakespeare, 2006). In transport, these disabling factors include the inaccessibility of vehicles, information, infrastructure, and services. Public transport agencies, transport operators, transport policy, and equal opportunities representatives have made efforts in proposing sustainable and inclusive transport solutions, including accessible forms of active and green transport. However, despite the effort made by the European Union with the EU charter of Fundamental Rights and specific legislations (e.g., EU Regulations No. 181/2011 on Bus Passengers, European Parliament, 2011), an acceptable level of public transport accessibility is still not achieved (Bezyak, Sabella, & Gattis, 2017; Park & Chowdhury, 2018). This applies especially to particular groups of persons with disabilities, e.g., people with mental and intellectual impairments (Wilson, 2003).

State of the Art in user research related to user needs for accessible public transport

For transport systems to be accessible to everyone, it is important to consider all barriers that people with disabilities may experience along the transport chain (Wilson, 2003). A survey study with nearly 1.000 participants from Great Britain provided insights into the perceived barriers in public transport for disabled people (Disabled Persons Transport Advisory Committee, 2002). The study found that a considerable number (40%) of respondents stated they did

not feel secure while travelling by public transport. The study further revealed that bus drivers are often perceived as not helpful, and the intention to travel by bus would be increased if the staff were better trained to deal with the access needs of travellers with disabilities (ibid.). A face-to-face survey with over 2.000 participants in Great Britain showed that the difficulties most commonly mentioned by persons with disabilities were getting to and into bus stops or stations (23 %) and on and off buses and trains (24 %, Grewal et al., 2002).

There are also literature reviews that provide an overview of the existing state of research and identify gaps in knowledge regarding disability and mobility barriers. A literature review by Wilson (2003) summarized barriers in public transport for users with disabilities in Great Britain. The review found that facilitating transport chains are a key issue for inclusive transport (Wilson, 2003). Furthermore, the authors emphasized the need for consulting persons with disability in the design and implementation of accessible transport systems (Wilson, 2003). Kett et al. (2020) presented a thematic review on the factors affecting the mobility opportunities of people with disabilities in middle-income and low-income countries. In their analysis, the authors emphasized that “one size will not fit all” (p.15), implying that transport planners need to listen carefully to a range of voices to understand the diverse needs and requirements. Although individuals might have the same nominal disability, people’s needs can be extremely different. This is why it is important to follow an individualized approach when looking for inclusive and accessible solutions in public transportation.

In this context, qualitative studies, like interviews, add to quantitative analyses by providing deep insights into the experiences, attitude and behaviour of persons with disabilities (Edén et al., 2006; Lomax et al., 2014). Grewal et al. (2002) conducted 35 individual depth interviews and seven discussion groups with disabled people. The study revealed that getting to work with public transport was perceived as challenging. Difficulties included the accessibility of busses and trains, a lack of adjusted pavements and limited access to train stations were mentioned as barriers (Grewal et al., 2002). In the context of inclusive city design, an interview study by Hanson (2004) found that accessible public toilets are often considered as a missing link in the

transport chain. In an interview study from New Zealand, bus drivers' attitude and unawareness of disabled users' needs was a common concern for both considered groups of users - visually impaired and physically impaired persons (Park & Chowdhury, 2018).

Despite the amount of empirical research regarding disability in mobility and public transport planning, the number of research projects that actively involve persons with disability in their research is rather small and "there is no denying that disabled people have largely been excluded from disability discourse" (Kitchin, 2000, p. 25). In an interview study, Kitchin (2000) asked 35 people with disabilities about their satisfaction with research and the possibilities of participating in research. Respondents articulated a need for inclusive, action-based research strategies and the wish that disabled people "are involved as consultants and partners not just as research subjects" (Kitchin, 2000, p. 25). Even though Kitchin's (2000) requests and Duckett and Pratt's (2001) recommendations for involving persons with disabilities in research are already twenty years old, only a limited number of research projects invited persons with disabilities to actively contribute to research (e.g., Liddiard et al., 2019), and these often do not go beyond the first rungs of Arnstein's (1969) *ladder of citizen participation*, like *information* or *consultation* (Bigby et al., 2014; Keeley et al., 2019). However, participatory research with non-scientific actors as co-researchers, described by the rungs of *partnership* or *delegated power* (Arnstein, 1969), facilitates the understanding of complex and often implicit issues, such as the perception of service quality of public transport. Participatory research is premised on the notion that people have unrivalled expertise in their own needs and requirements as experts about their own lives. Participatory research empowers a person to be not only an object of research but a subject who shapes the research agenda and methods. Participatory approaches enable people to assume a leading role in the research and thereby contribute with their expertise and experience to the identification of existing gaps and barriers in public transport. Furthermore, engaging affected persons in identifying research priorities as well as in designing and conducting research could improve the relevance and appropriateness of research findings as shown before (Wright et al., 2006).

Research needs

Even though the literature review revealed a great amount of empirical research regarding the assessment of public transport by users with disabilities, our understanding of the mindset, beliefs, and opinions of people with disabilities regarding inclusive mobility is still limited. Although the aim of improving accessibility of transport made its way into mainstream transport planning and policy-making (Geurs et al., 2012), these claims often fail in reality. One explanation is that the identification of the right measures to improve the accessibility of transport is challenging. Therefore, a way of thinking calls for starting a dialogue with vulnerable-to-exclusion citizens and involving hard-to-reach or excluded groups in transport planning (Lucas, 2012). The literature review revealed the need for integrating the affected persons in the research by participatory approaches (Duckett & Pratt, 2001; Kitchin, 2000). Accordingly, Wilson (2003, p.46) recommended: “Disabled people need to be consulted in the design, delivery, and implementation of accessible transport systems”. However, the participation of people with disability should exceed mere consultation but engage them in the research according to involvement in higher rungs of Arnstein’s ladders of citizen participation (Arnstein, 1969). The paper thus addresses the following research aims:

- To explore needs regarding the mobility of persons with different types of disabilities and access needs
- To conduct an analysis across different European cities
- To develop and apply a participatory approach to gain implicit knowledge by empathizing with people with disabilities

This paper integrates insights from two qualitative studies conducted in collaboration with disabled users on their perspectives on public transport systems as part of the European research project TRIPS. First, a social media content analysis performed by persons with disabilities to identify barriers the local community of disabled people have faced and commented on social media networks. Second, semi-structured interviews conducted by persons

with disabilities with their peers and then interpreted to provide more in-depth insight into the thoughts, attitudes, and beliefs related to public transportation of persons with disabilities.

The research project TRIPS

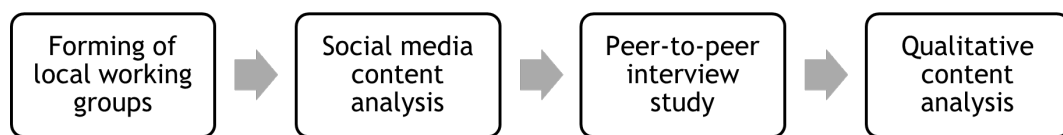
The EU-funded project TRIPS (TRansport Innovation for disabled People needs Satisfaction) aims to redress barriers to public transport accessibility for persons with disabilities. Building on the independent living philosophy (Charlton, 2000) underlying the declaration of Human Rights for Persons with Disabilities (United Nations, 2006), the project aims to empower citizens with disabilities in seven European cities (Bologna, Brussels, Cagliari, Lisbon, Sofia, Stockholm, and Zagreb) to take an active part in local transport planning and lead open innovation and co-design processes. Within the project, people with disabilities from the seven cities are co-creating capacity building activities (such as seminars, conferences, workshops, trainings, and webinars) and research methods and data collection (including surveys, interviews, and workshops). In the first phase of the project, existing barriers of public transport were identified and described. In the second phase, solutions (e.g., accessible mobility apps) were co-designed in workshops and evaluated in selected use cases in the seven cities in the third phase of the project. Finally, policy and regulatory recommendations were derived to drive accessible public transport innovations forward and establish user participation in transport planning.

Methods

Establishing the working groups in each of the seven project cities was the first step of the co-production process in the qualitative research. The working groups consist of 10-15 people. The working groups comprise a Local User Lead (LUL), the Core User Team (CUT) members, representatives of local transport providers, and city council and academics. The CUT members of the working groups face different access needs due to impairments and disabilities (e.g., wheelchair users, visually impaired individuals).

The studies took place between February and July 2020 at the beginning of the COVID-19 pandemic in Europe. Our methodology and methods respected social distancing rules. Social media content analysis was performed to identify public transport use barriers in the project cities. Furthermore, peer-to-peer, online interviews enriched social media content analysis with thoughts, experiences, and emotions driven by the current situation. Figure 1 visualizes the research process.

Figure 1: Research process. Source: authors



Social media content analysis

Social media content analysis uses user-generated social media data that serve as a barometer for monitoring changing attitudes toward newsworthy or controversial issues (Macnamara, 2005). Through social media, users can upload, share and comment on photos, videos, music, images, and texts to share ideas, feelings, opinions, and experiences with other members. Media analysis is a well-established research method for studying violence, racism, and other societal topics in TV (Macnamara, 2005). Social media content analysis has been used to study public opinion on topics like concerns and challenges related to introducing a new mobility offer such as an e-scooter system (Gössling, 2020). The method was chosen for different reasons. First, it has wide accessibility in all EU countries involved and its accessibility to LULs, the broad range of topics discussed, its online availability, and its up-to-date content. Furthermore, the method was intended to elicit regional and situation-specific insights. The search involved local social media channels, such as Facebook groups, which promised to identify specific barriers in the city. Figure 2 shows an exemplary post found on the social media platform Instagram from Sofia related to accessibility.

Figure 2. Exemplary Instagram post from Sofia, Bulgaria. Source: authors.



Procedure

The LULs of the seven cities were responsible for the social media analysis and online interviews. To ensure the same approach is followed across the cities, the TRIPS consortium made a practical step-by-step guideline to be followed for social media analysis and a semi-structured interview protocol with prompting guidelines for interviewers and held training meetings to ensure its understanding.

At least 30 media entries concerning topics such as accessibility of public transport, barriers or assistance services, were researched in each of the project cities. For the analysis, social media platforms, such as Twitter, Facebook, and Instagram, were scanned based on appropriate search terms, like disabled, mobility-impaired, wheelchair, visually impaired, blind, deaf, hearing impairment, public transport, bus, metro, subway, transit, mobility, and others. In contrast to other approaches, such as the one reported by Gössling (2020), only social media entries by private persons were selected for analysis; official journalistic reports or articles were not included in the analysis.

Peer-to-peer interview study

Based on the project's participatory approach, the interview study was conducted as a peer-to-peer study to involve the local working groups in research. Peer-to-peer studies are expected to improve access to participants, disrupt the power imbalance inherent in interview studies, and increase the comfort of the interviewees (Scannell et al., 2017). Peer-to-peer interview studies are a common method of qualitative social research in research domains like education on homophobia (Peters, 2003), disaster experiences (Scannell et al., 2017), and training (Schmidt, 2017). Whereas interview studies with trained researchers or professionals are common in research regarding persons with disabilities (Kitchin, 2000), peer-to-peer interviews have never been used to the best of the authors' knowledge.

Material

The interview study was conducted based on a semi-structured interview guideline that allowed for additional prompts and clarification as necessary and gave the opportunity to receive unanticipated answers (Liedberg & Henriksson, 2002). The guideline was co-created by the project team and LULs based on several iterative review loops. The interview guideline comprised 10 open questions, as well as sociodemographic questions. The questions were clustered around choice behaviour, barriers, and assistance. The list of questions can be found in the appendix.

Procedure

The interviews were conducted by the LULs of the seven cities. The LULs are disability activists in their countries and have a big network of users with different types of disability and different types of access needs. They used this network to invite people to take part in the project. The interviewers followed the ethical protocol established for the study and reviewed the informed consent with the interviewees, who then signed the consent. The interviews began with some general demographic questions (i.e., location of residence, age) and then moved into the four aforementioned topics.

Initially, the interviews were planned to be conducted face-to-face but due to the pandemic situation, they were conducted via phone or online video chat (e.g., Skype). The interviewers audio-recorded all interviews using the audio recording function of the video chat software. Professional translators translated all the recorded interviews from the native languages (Bulgarian,

Croatian, Dutch, French, Italian, Swedish, and Portuguese) from the audio format of recordings to written text. These transcripts were then imported into the software MAXQDA for data analysis.

Participants

The 49 interview partners came from the seven project cities. They were aged between 22 and 70 years, with an average age of 43.7 years ($SD = 13.4$ years). 21 participants were females and 28 males. Most of them reported having physical or sensory impairments. For an overview of the sociodemographic characteristics of the interview partners, see Appendix 1.

Data preparation and analysis

Both the social media content and the interviews were translated to English by the LULs and professional translators. The research partners then analysed the datasets following the inductive categorization process (Mayring, 2014) using the software MAXQDA (VERBI Software, 2019).

Results

Identified barriers from social media content analysis

More than 300 parts of the researched social media content were linked to existing barriers to public transport use. Figure 3 provides an overview of the subcategories that were built in the inductive categorization process. As shown here, eight subcategories revealed in the analysis with *infrastructure* ($n = 85$) and *public awareness and assistance* ($n = 71$) containing the most social media content related barriers.

Figure 3. Overview over subcategories of the category barriers of the social media content analysis (line thickness and number in brackets mark the frequency of codes in the subcategory)

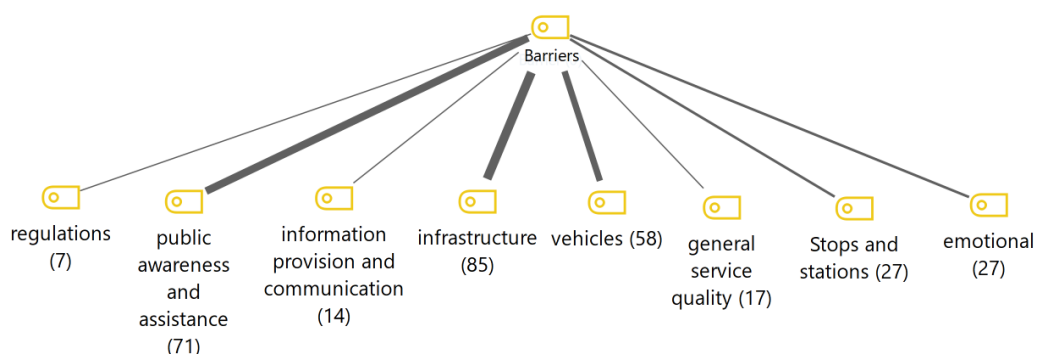


Figure 4 provides an alternative visualization of the data. The frequency of codes by city is shown. The size of the squares visualizes how often the specific

barrier was identified in the social media entries from the specific city. As shown here, some of the barriers, like staff behaviour, were mentioned in most of the cities, while others were only addressed in some of the cities.

Figure 4. Code matrix browser showing the frequency of codes by city

Code System	Brussels	Sofia	Lisbon	Zagreb	Stockholm	Cagliari	Bologna
Barrier							
regulations							
public awareness and assistance							
support by other passengers/persons							
pre-registration							
accompaniment							
behaviour of staff							
information provision and communication							
request complaint handling							
information on transport service							
communication							
traffic lights and signaling							
infrastructure							
surfaces and stolps							
toilets							
elevators							
parking							
buildings							
stairs and ramps							
intersections							
sidewalks							
vehicles							
comfort							
space							
specialized vehicles							
interaction with vehicle							
get on and off							
Stops and stations							
inaccessible toilets							
gaps at platforms							
lack of protection							
missing lighting							
need for assistance							
elevators, ramps and stairs							
accessibility of platforms							
general service quality							
price							
connectivity							
availability of adapted transport							
operating times							
emotional							

Identified barriers from interviews

Based on the interview guidelines, all text passages related to challenges people with disabilities face during their end-to-end trips were included in the analysis. These challenges were manifold, ranging from physical barriers, like missing ramps, to inaccessible information or impolite staff. Overall, more than 1.000 cases of barriers were identified in the interviews. As shown in figure 5, the identified barriers were clustered into eight subcategories.

Figure 5. Overview over subcategories of the category barriers of the interview study (line thickness and number in brackets mark the frequency of codes in the subcategory)

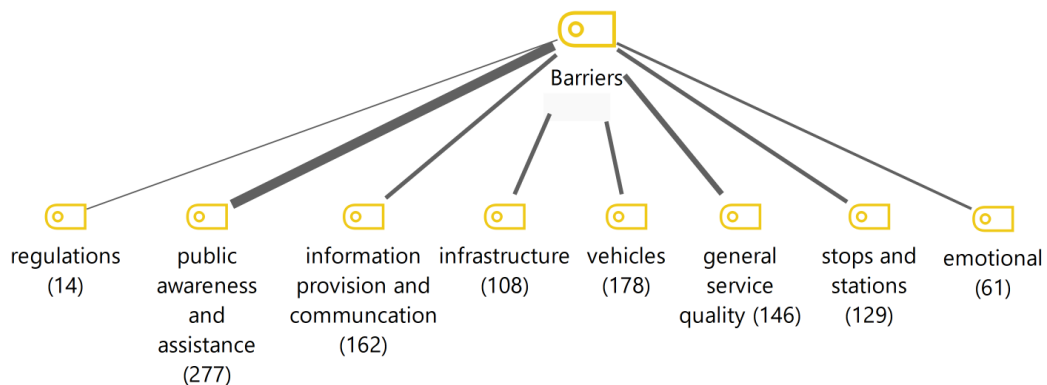


Figure 6. Code matrix browser showing the frequency of codes by city

Code System	Lisbon	Zagreb	Sofia	Stockholm	Brussels	Cagliari	Bologna
Barriers							
regulations							
public awareness and assistance							
slow pace of improvements							
lack of possibility for participation							
behavior of staff							
accompaniment							
pre-registration							
support by other passengers/persons (+)							
information provision and communication							
traffic lights and signaling							
communication							
information on transport service							
request complaint handling							
infrastructure							
sidewalks							
intersections							
stairs and ramps							
buildings							
parking							
elevators							
toilets							
surfaces							
vehicles							
get on and off							
interaction with vehicles							
not adapted to special needs							
space							
comfort							
general service quality							
safety							
hygiene							
operating times							
availability of adapted transport							
connectivity							
price							
stops and stations							
information provision							
accessibility of platforms							
gaps at platforms							
elevators, ramps and stairs							
need for assistance							
missing lighting							
lack of protection							
inaccessible toilets							
emotional							

In the following, each subcategory of barriers is shortly introduced, and examples from the social media content analysis and the interview study are presented.

Regulations

This category relates to institutional and legal barriers, and comprises a total of 14 entries from interviews and another 7 from social media content analysis.

Barriers related mostly to non-compliance with regulations: *“Precisely what I’m in the process of requesting, to try and stop this anarchy with everything, as there is great anarchy where works are concerned! In St Josse - one of the smallest communes in Brussels - it’s UN-BE-LIEVABLE when you see the quantity of discrepancies. From one pavement to another, even between two pavements opposite one-another, there are already differences.”* (Brussels_06). For Sofia, a comment on a website stated, *“There are good regulations, but they are not being implemented.”* (Website comment from Sofia). This was also associated with over-reliance on *self-monitoring*: *“The problem is that they [National Railway Company of Belgium] are their own monitoring organization. Meaning that they monitor their installations themselves. I believe that is a big problem”* (Brussels_03). Users also expressed disagreements on specific regulations: *“We also believe that those who have a permanent blindness or serious visual impairment should not have their permit to travel re-examined every 3 years.”* (Website comment from Stockholm)

Public awareness and assistance

This category comprised 277 interview passages and 71 posts from the social media content analysis and was the largest category of identified barriers. Four subcategories were identified: 1) support by other passengers and persons, 2) pre-registration, 3) behaviour of staff and 4) lack of opportunities for participation.

The subcategory *behaviour of staff* contained the most statements from users (n = 124 for interviews and n = 13 for the social media content). It was shown that users sometimes experience uncooperative behaviour of public transport staff. The experiences expressed in the interviews were supported in social media posts relating bus and taxi drivers: *“We as people with disabilities, who use wheelchairs, have a problem with ordering taxis and taxi drivers who are*

not very willing to help.” (blog entry from Zagreb). Social media entries pointed to barriers regarding inappropriate and sometimes even dangerous behaviour of public transport staff: *“A lady enters the 70’s and many, I believe, dragging her little shopping cart. The bus starts its march and the lady is almost projected to the bank and at some cost she manages to balance her shopping cart.”* (Instagram post from Lisbon). Such behaviours are sometimes attributed to a *lack of training*: *“it seems that many [bus drivers] do not have the right training on how to behave in front of disabled people in wheelchairs. Many do not even know how to open the bus platform”* (YouTube video from Cagliari).

Another frequent barrier named by the users was the need for a pre-registration of assistance and specialized transport services (n = 74 for interviews and n = 15 for social media content). In Lisbon, for example, the specialized van needs to be pre-ordered two days in advance: *“the vehicle has to be requested up to 48 hours in advance, which is discrimination and takes away our right to decide our life like any other citizen who often decides, at short notice, where he wants to go”* (Facebook post from Lisbon). The need for early registration is even more relevant for trips beyond the urban areas: *“When I need to go to Cagliari I have to call the ARST [local bus service] even 10 days before. But not always, for visits to the hospital and for private matters, I have the possibility to know in advance when I will need means and unfortunately, I always have to count on a plan B”* (Website comment from Cagliari). The pre-registration of services not also applies to specialized transport but also to ramps for accessing trains, which is assessed as a barrier: *“Using the train irritates me because I have to call in advance and inform them of my travelling times and dates, as well as routes so that they would have disability ramps ready for me”* (Lisbon_02).

Information provision and communication

The category information provision and communication comprises all the content that refers to barriers based on a lack of information or misleading communication. The category includes 162 text passages from interviews and another 14 from the social media content analysis. The barriers in this category were clustered into four subcodes: 1) request complaint handling, 2)

information on transport services, 3) communication and 4) traffic lights and signalling.

A statement from an interview showed that information is not always accessible due to the obligation of using technology, like a smartphone app, to access the information. People with hearing impairments expressed their concerns about non-accessible information: “I often fear that there is an audio warning that I do not hear.” (Lisbon_05). A lack of appropriate signals and information was also addressed in social media entries: “Many times - and there are many buses - they don't stop at the stops. This has already happened to me and to other people. I am visually impaired and cannot see enough to identify the bus, and my hearing impairment does not allow me to identify the sound of them either” (Facebook post from Lisbon) and “On the other hand, there is no signalization, there are no signs for the blind and deaf to at least know where to buy a ticket, where to get information when their train leaves” (blog entry from Zagreb). For persons with mental disabilities, misleading information was shown to act as a barrier for public transport use: “when you are to take a bus, they don't tell you which side of the street you're supposed to wait for the bus, because it could be the bus on the way back, or the bus on the way to the place you want to go, but you don't know which one of those stations is the one where you're supposed to wait for the bus. It's so unclear. And I think that for some people it is clear, for other people like myself, it is so unclear. That I have missed or taken the bus in other direction, many times” (Stockholm_7, Pos. 38).

Some of the identified barriers in the context of information were related to the request handling. It was shown that some of the interviewees and social media users are not satisfied with the request handling of public transport companies: “More than four months ago, Carris [transport company in Lisbon] received a request from a group of disabled citizens for clarification and improvement of the conditions of the new buses and coaches, which has so far received no consideration” (Facebook post from Lisbon).

Infrastructure

The category infrastructure included identified barriers linked to the construction measures like stairs and elevators, as well as elements of the

infrastructure like sidewalks and intersections. Most remarks from interview partners (n = 22) and social media users (n = 21) were assigned to the subcategory sidewalks. To name one example, an interview partner from Sofia states: *“As soon as I leave my building, I come across high curbs, holes, setts, and other physical barriers”* (Sofia_05). In social media, barriers concerning sidewalks are discussed as well: *“The city is a reflection of people's mentality. The same mentality that parks on the sidewalk because it is only 5 minutes and forces the person in a wheelchair to walk on the road. And then someone tells them they're doing something wrong...”* (Twitter post from Lisbon).

Barriers in the form of missing or broken ramps were mentioned in nearly every city. One interview partner also states that persons using wheelchairs have to help themselves to use the ramp: *“But the ramps are so bad that you have to carry a screwdriver. Some of us carry screwdrivers all the time because there is no other way to open the ramps”* (Sofia_01). An Instagram post from Sofia, showing stairs with a drive-up ramp commented *“Their brakes need to be in a very good condition”* (Instagram post from Sofia). Another frequently mentioned barrier was elevators that are out of order: *“Our elevators are out of order half the time, but hey that's ok, because we are within the standard”* (Website comment from Brussels).

Vehicles

The category *vehicles* comprises all interview statements that refer to barriers based on the inaccessibility of the vehicles. This category includes five subcodes: 1) comfort, 2) space, 3) specialized vehicles, 4) interaction with vehicle, and 5) getting on and off. The subcategory *getting on and off* included the most statements in the current category. This subcategory is strongly linked to the existence and functioning of ramps in the vehicles as shown in one exemplary statement: *“And the poor maintenance of the ramps which allow for people with disabilities to board the vehicles (the buses often drive around the city with ramps which are not in function), which then in turn makes me have to wait at the same bus stop with various buses stopping and passing by until a bus with a working ramp finally turns up and I can board it”* (Lisbon_02).

Regarding the space on vehicles dedicated to people with disabilities, several interview partners refer to the challenge of travelling with friends that use wheelchairs as well: *"Sometimes it is not possible to travel with more people with disabilities, with friends, more specifically, because the spaces are occupied, and this is an interesting question that should be given more attention to"* (Lisbon_03). A lack of space for wheelchairs on vehicles was also addressed in a Facebook post from Lisbon.

Barriers concerning the passengers' interaction with the vehicle were often related to buying or validating a ticket: *"Well, as I don't use a card, I have to buy a ticket from the driver, and I have to ask someone to help me with that and then to perforate the ticket because the perforators are positioned too high. If I use a card, I can just validate it myself in the vehicle"* (Sofia 05). Furthermore, other barriers were addressed, such as door openers: *"New public transport in Sofia is not accessible for blind people. The new buses, trams, and trolleybuses in Sofia proved to be difficult for the blind, as they could not find the button to open the doors."* (Website comment from Sofia).

[Stops and stations](#)

The category *stops and stations* includes all interview passages that refer to barriers that are based on a lack of accessibility of stops and stations of the public transport system. The category includes five subcodes: 1) lack of protection, 2) need for assistance, 3) information provision, and 4) accessibility of platforms.

The subcategory *accessibility of platforms* included statements related to gaps at platforms, missing or broken ramps, and elevators at the stations. The results revealed that ramps and elevators that are out of order is a recurrent barrier in all of the cities as represented in the following statement in the interview: *"In the latter, the problem is with the elevators, we need to use them to be able to get to the platforms, but there is a maintenance problem and the elevators are often broken and therefore cannot be used."* (Lisbon_06).

The users' need for assistance at stations and stops is mainly related to the broken ramps and elevators: *"[...] when I use the train, it is more complicated*

to use it than the bus or the metro. There should be security at the platforms. There should be workers that can help the disabled board the vehicles” (Lisbon_03). The need for assistance at stations is also caused by missing or non-accessible information: *“Once at the platform itself, my main barrier is the lack of written warnings, I often depend on other passengers to be able to understand the communication done via audio warnings.”* (Lisbon_05). The category of stops and stations also included users’ statements regarding a lack of protection and safety. In a Facebook post, a user expressed a lack of perceived safety at public transport stops: *“I feel afraid to be so often alone at night in unlit stop”* (Facebook post from Lisbon)

General service quality

The category *general service quality* included all interview statements and social media content that referred to the service quality of public transport. This category was clustered into five subcategories: 1) price, 2) connectivity, 3) availability of adapted transport, 4) safety, and 5) operating times.

Availability of adapted transport is the subcategory that comprises the most barriers in this category. A recurrently mentioned barrier of using specialized transport is the long pre-registration time: *“I’m aware of its existence but I have never used specialized transport. I am on their list, but if I want to use it, I have to book my trip many days in advance. That stops me from using it. Sometimes I just need transportation one day to the next, and no matter how organized I am, I can’t fit in their mechanism.”* (Sofia_01). Some of the interview partners complained about the limited availability of specialized transport: *“It is more difficult in the earlier hours of the morning. It is not possible to gain access to the door-to-door service in the hours before the rush hour. I have the same problem with access in the evening hours, any time after 8 PM.”* (Lisbon_04).

Another often mentioned barrier was related to the price of the service. The pricing system of specialized transport seems to be a barrier, especially in Lisbon, as shown in these two statements: *“And I do not have the right to get a bus pass, even though it is the same company that is in charge of the regular buses as well. So every day I pay four euros for the tickets.”* (Lisbon_01) and *“The door-to-door service refuses any kind of bus-pass, meaning that all the*

trips are paid for at the price of a single ticket per person (which means that nowadays I always have around 80 euros per month in small change at disposal so that someone could give the two euros to the driver for each of my return trips)." (Lisbon_02).

Emotional barriers

Emotional barriers refer to content from interviews and social media platforms based on social and psychological attitudes regarding the use of public transport, which can cause emotional reactions, such as feeling of insecurity, claustrophobia, or social anxiety.

Emotional barriers are commonly related to the behaviour of other passengers: *"A disabled in a wheelchair getting off the bus ... Old women start to complain that it's taking too long. Shit people !!!"* (Twitter tweet from Lisbon). Uncomfortable feelings regarding the behaviour of other people are also reflected in the following: *"It's really not a nice feeling when outside someone has to constantly wear up and down. You just don't feel welcome in that space then. However, we were persistent. As you find yourself in that position, you can't understand how much that little step means that you can go in on your own without having to beg people, instruct people, and think about whether you're difficult for them, how glad they are at all."* (YouTube video from Zagreb). The fear of facing inappropriate behaviour of fellow travellers was also mentioned: *"Many times they do not wait for me to get off the bus. They put pressure on me to hurry up."* (Cagliari_04).

For people with intellectual disabilities, mentioned barriers are related to over-crowded public transport: *"For me, it gets difficult to be in crowded trains. And then the sound, as I said, makes it impossible for me to continue to make a journey if I don't have my headphones. And the problem is when I have headphones in the bus and the train, driver says: "Ok, everyone has to get off the train." All of a sudden, the train just turns off, but I didn't hear that, because I didn't hear... [...] Those things that are scary. [...] It's stressful for me. I need to know what's going on. I need to know what's the next step and what I'm supposed to do. Many times I find myself confused."* (Stockholm_05).

In conclusion, the following statement summarizes the emotional barriers of many public transport users with disabilities: *“I simply do not want to draw attention, so I just make do with what I can”*. (Lisbon_03)

Discussion

Reflection on results

This study aimed to implement participatory methods of social media content analysis and peer-to-peer interviews to identify the barriers that people with different types of disabilities face every day while using public transportation. This research has provided valuable insights into the perception of people with disabilities from seven European cities. Despite the lively debate about the importance of having accessible and inclusive transport in all European countries, people with access needs still face many barriers while trying to use different means of public transportation in their cities.

First of all, the results have shown that the limited number of accessible public transport vehicles and services prevents people with various disabilities from actively participating in society. People with access needs perceive the current public transportation services to be limited in their availability and inflexible. As users noted, many services need to be booked several days in advance. Furthermore, there are no assistance or accessible transport at night, or early in the mornings, fewer choices when it comes to the transportation and the regular journey usually takes longer than it typically should. The following statement from an interview illustrates the basic needs of people with disabilities for equity in public transport: *“Listen, Ideally, we, the people with disabilities, would be able to use any sort of public transportation without any special requests, without having to ask anybody for anything, from helping us to board the vehicle to getting off, without calling anyone for anything and booking the ride in advance.”* (Lisbon_01)

The results have also revealed that when it comes to accessibility solutions, the access needs of people with intellectual disabilities or people with mental health issues are rarely put into consideration. They were underrepresented in social media, and their needs are rarely identified in scientific literature.

As our insights have shown, most of the investments in accessibility are funnelled to simple engineering solutions - adjustable ramps for wheelchair users or providing audio information for visually impaired people. Perhaps the stereotype that if person's disability or impairment is not visible, they do not have any access needs for public transportation is to be blamed for the phenomenon. Also, addressing mental health barriers will require investment in changing staff attitudes, organizational structures, and provided services, and not all service providers are aware of or either willing to implement these changes.

Yet, not all barriers refer to an inaccessible environment - social barriers, such as the rude behaviour of staff and other passengers towards people with disabilities, are equally important. People with disability still too often experience situations in which they feel uncomfortable due to the attitude and behaviour of other passengers, as well as the public transport staff.

Interestingly, the analyses revealed no noticeable differences between the considered cities. Apparently, people with disabilities from the seven cities experience similar barriers in their everyday mobility.

Besides the content of the analysis, the study also provided significant insights into the application of participatory research methods for addressing equity and accessibility issues, as had been requested by Kitchin (2000) and Duckett and Pratt (2001). Peer-to-peer interviews and the social media content analysis revealed powerful and time-efficient methods to identify barriers to public transport for people with disabilities. For a more detailed reflection on the participatory approaches see König et al. (in review).

Despite these strengths, our study has several limitations as well. An essential disadvantage of the peer-to-peer interviews is based on the heterogeneity of the interviewers that entails a reduced standardization of conducting the interviews. Another limitation was that both groups of people with intellectual disabilities and people with mental health issues were underrepresented in the research. As mentioned before, their access needs were very seldom discussed or mentioned in social media, and it was difficult to find people with these access needs who would like and could participate in the interviews. There might be various reasons for the latter: difficulties to speak or express

yourself, speech impairment, not willing to disclose the impairment, getting permission from their guardians, and others. Even though this study has provided some insights on the barriers faced by these users, further research is required on the topic to ensure that everyone's access needs are considered.

Derived hypotheses and insights

To set the direction for future research that considers our current insights on the barriers faced by these users, we outline the following insights and research hypotheses.

1. Mental health issues, sensory and intellectual impairments are underrepresented, while physical impairments (especially wheelchair users) are more likely to be presented in social media content that does not reflect compared to their representation in the overall population of persons with disabilities
2. Technologies and accessibility solutions that are supposed to make public transport more accessible are often not used properly, or broken, like elevators, escalators, or audio announcements on buses.
3. The behaviour of public transport staff (especially bus drivers) is often unaccommodating to the mobility needs of disabled users.
4. Social media users, as well as interviewees, emphasize the need for policy and transport providers to take the next steps in improving accessibility of public transport.
5. People with disabilities lack equal opportunities in their transport choices. Public transport has only a limited number of vehicles/services being accessible. In addition, specialized transport and assistance services, like ramps at stations, require long pre-order lead times.

6. Overcrowding is a practical barrier, especially for wheelchair users and persons with mental health issues, due to space limitations, difficulties in embarking, and sensory overstimulation.
7. Non-accessible information is still an important barrier for people with sensory impairments.
8. People with disabilities experience similar barriers in their everyday mobility, regardless of where they live.
9. Participatory approaches that involve people with disabilities in disability research make a valuable contribution to our in-depth knowledge about equity in transport and should be empowered more often to participate in the research that affects themselves.

Research questions and next steps

Besides the role of technological assistance systems for improving mobility, further studies should also address the question of how disabled people perceive the possibilities of user involvement in transport planning in their cities. Furthermore, in the light of emerging mobility systems, like shared e-scooters it is also interesting to study how people with disabilities perceive and assess new shared mobility systems, like e-scooter sharing regarding their accessibility. Furthermore, an open research question emerges from the cross-country comparison. Given regard to the finding that there are no noticeable differences between the cities, further research is needed to provide insights into commonalities and differences in the perception and attitude of persons with disabilities about accessibility of public transport with the help of more quantifiable methods.

The TRIPS project will continue until February 2023 and will bring forth more empirical findings and concrete solutions to make public transport more accessible for people with different access needs. The results of the two qualitative studies have informed the development of a questionnaire to gauge the broader disability community's attitudes and other vulnerable-to-exclusion

groups towards the accessibility of public transport and used as user research in the development of design concepts for new mobility systems or adaptations of emerging ones.

Conclusion

Although research has already addressed barriers of public transport use for people with disabilities, empirical studies are still missing that involve the concerned people in research to gain deeper insights. The research process included the formation of local working groups who performed a) a social media content analysis and b) a peer-to-peer interview study. The paper derives hypotheses and insights regarding the barriers that people with disabilities from seven European cities face when using public transport, based on reflections of two qualitative studies. The paper further demonstrates how participatory approaches that involve people with disabilities in accessibility research could make a valuable contribution to our in-depth knowledge about equity in transport.

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