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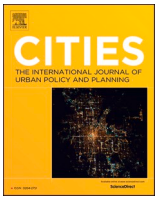

Inclusive smart cities? Technology-driven urban development and disabilities

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ABSTRACT

The concept of smart cities refers to urban areas that utilize (digital) technologies to enhance urban operations, services, and the quality of life of their residents. However, people have varying possibilities and capabilities for using (digital) technologies. This intertwines the technology-driven urban development with the ideal of inclusiveness (or the lack thereof) as it seems unrealistic to assume that smart cities would benefit equally the whole society. This controversy is approached by questioning whether smart cities can really improve the living conditions of the disadvantaged via reviewing the literature that ties technology-driven urban development to persons with disabilities. The study shows, first, that disabilities are rarely discussed in the extant literature on smart cities particularly from a critical perspective. Second, it is underlined here, based on the reviewed literature, that while smart city initiatives hold promise for enhancing urban living conditions of persons with disabilities, they are not one-size-fits-all answers to tackle the marginalization of persons with disabilities. Rather, since technological solutions do not counter the fundamental barriers of exclusion, urban technologies still need advanced ideas in establishing a truly inclusive smart city.

1. Introduction

The urban landscape is undergoing a transformative shift driven by technological advancements and the growing need for sustainable, efficient, and inclusive urban environments. Several overlapping (and often intertwined) terms are applied to conceptualize the ongoing transformation. One such concept that has gained significant attention both from the academics and practitioners is "smart cities" (e.g. Inkinen et al., 2021). It refers to an urban area or unit that utilizes digital technologies, data-driven solutions, and efficient resource management to enhance urban operations and services and the quality of life of its residents, improve operational performance and efficiency, and address various challenges related to urbanization and sustainability (Kitchin, 2019; Neirotti et al., 2014; Silva et al., 2018; Zhu et al., 2022). At the same time the concept is not just an academic one, but inevitably also refers to (large scale) business, as multi-national companies have been eager to invest enormous funds on research concerning smart cities (Hussain et al., 2015) due to the expected economic gains.

In addition to smart city, various other concepts such as "digital city", "intelligent city" and "knowledge city" have been used almost interchangeably (Kitchin, 2014; Komninos, 2002; Mora et al., 2017; Yigitcanlar & Kamruzzaman, 2018) as tools of classification and analyses of progressive urban (technology-based) development over the past few decades. While there is common understanding that smart city operates as an overarching umbrella concept, the terminological variety enriches the theoretical foundations and practical applications in technology-based urban studies (Hortz, 2016; Yigitcanlar, 2016). This discussion ties the technology-driven urban development to the concept of social justice (Alizadeh & Sharifi, 2023a, 2023b) and the ideal of inclusiveness (Blasi et al., 2022; Lee et al., 2020; Wang et al., 2021; Zhao et al., 2023). Indeed, inclusiveness is an important target for meeting the United Nations (2023) Sustainable Development Goals (SDGs) (Sharifi et al., 2024), for example, in the definitions of SDG8 ("Promote sustained, **inclusive** and sustainable economic growth"), SDG11 ("Make cities and human settlements **inclusive**, safe, resilient and sustainable") and SDG16 ("Promote peaceful and **inclusive** societies for sustainable development"). Technological development and new planning and policy concepts grounded on knowledge-based development are a potential means for achieving these goals (Yigitcanlar & Inkinen, 2019; Yigitcanlar & Velibeyoglu, 2008). However, at the same time technological development always bears a risk of exacerbating existing and/or generating new inequalities (UN-Habitat, 2022).

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Earlier research has also underlined that people have varying possibilities, capabilities, and motivations for using digital technologies in correspondence to their differing social, economic, and cultural positions (Inkinen et al., 2018; Merisalo & Makkonen, 2022; Ragnedda et al., 2020). Based on this, it seems unrealistic to assume that the technology-driven smart city development would benefit the whole society equally. An open question, therefore, remains regarding the potential of smart city development: How do technologies affect different population groups within the society? This discussion leads us to the research questions of this paper:

- How disadvantaged groups are considered and represented in the literature on smart cities?
- Has smart city development improved (or can it be expected to improve) the conditions of the disadvantaged?

We approach the research question by reviewing the exiting literature on the topic. From the variety of disadvantaged population groups, we decided to focus on persons with disabilities (PWDs) that are likely to experience the (potential) benefits of smart city development differently from the majority population (see Section 2). Based on the United Nations (2006) "*Convention on the rights of persons with disabilities*", PWDs include those, who have long-term physical, mental, intellectual, or sensory impairments, which in interaction with various barriers may hinder their full and effective participation in society on an equal basis with others.

The remainder of this paper is structure as follows. Section 2 will: first, discuss the backgrounds and definition of the concept of smart cities; second, showcase practical examples of successful smart cities; and finally, confront the concept of smart cities through critical conceptual and empirical lenses. Section 3 outlines our empirical approach including the procedures used in our literature search and a methodological discussion concerning content analysis (our empirical tool to process the data). Section 4 outlines the most important findings of our literature review on smart cities *vis-á-vis* PWDs. Section 5 concludes the paper by a policy discussion and by setting a research agenda for further studies on the topic for the benefit of making smart city development and its benefits inclusive for all.

2. Smart cities: conceptual backgrounds, implementation, and criticism

"Smart" is a buzz word that has been recently added in front of a multitude of planning and policy concepts to elevate them as the (most) intelligent way cities and regions – "smart territories" (Navío-Marco et al., 2020) – should be developed. These concepts include, for example, "smart specialization" (Foray, 2014), "smart shrinking" (Peters et al., 2018), "smart destinations" (Buhalis & Amaranggana, 2014), "smart growth" (Daniels, 2001) and "smart villages" (Zavratnik et al., 2018). It, thus, seems that (almost) all development worth pursuing today needs to be smart. This has added to the ambiguity of smart planning and policy concepts, as several scholars have criticized them for being vague, without concrete content and coherence (Gerli et al., 2022; Hassink & Gong, 2019; Rhodes & Russo, 2013; Williams et al., 2020; Ye et al., 2005). This conceptual opacity revolving around the different smart planning and policy concepts, naturally, applies also in the case of smart cities. Nonetheless, common elements can be identified as the key technology domains from the conceptual discussion revolving around smart cities.

In urban context, the smart concept family has been applied in studies and projects aiming at leveraging digitalization and novel policy concepts in order to optimize infrastructure, services, and resources. Their ultimate goal is generally in studying or creating a livable, attractive, competitive, connected, and sustainable living environment. It is worthy to note that the concept of smart cities has been dynamic and evolving, shaped by the specific needs and priorities of each region. Different cities may focus on different aspects of smart technology and development based on their unique circumstances and challenges (Yigitcanlar & Inkinen, 2019). What is common between the different approaches to smart city development is that, evidently, the roots of the concept are deeply embedded in numerous technology domains (Table 1).

United Nations (2018) as well as European Commission (2023) have a long tradition in defining and applying smart city dimensions in their policies. Well-known smart cities are identifiable around the world, as it has been widely applied in public sector governance and in practical implementation of urban development. Yigitcanlar and Inkinen (2019) present numerous cases including Austin (US), Barcelona (Spain), Brisbane (Australia), Copenhagen (Denmark), Helsinki (Finland), Melbourne (Australia), Singapore, and Stockholm (Sweden). In the context of social sustainability and wellbeing these smart city projects have implemented e-health systems such as distance-based medical advising (Jurado Pérez & Salvachúa, 2021), easy call-system as well as accessible and reachable living solutions for the elderly (Felber et al., 2023), and sophisticated transport system designs (Kuo et al., 2023). At the strategy level (top-tier urban management), the concept of smart cities is used, for example, in Stockholm, whose current "smart city strategy" (running until 2025) focuses on ecological, financial, social, and democratic principles. The strategy underlines the importance of quality of life as a key goal of smart city development together with strengthening the

Table 1
Key domains of smart city. Source: authors.

Domain	Description
Technology integration	Smart cities rely on the integration of various technologies, such as the Internet of Things (IoT), sensors, data analytics, artificial intelligence (AI), automation, etc. to collect and analyze data from different sources within the city.
Data-driven decision making	Technology integration is utilized to gain insights into urban processes, enabling city planners and administrators to make informed decisions about resource allocation, traffic management, waste management, energy consumption, etc.
Urban mobility	Smart cities often prioritize efficient and sustainable transportation systems including intelligent traffic management, public transportation improvements, bike-sharing programs, electric vehicle infrastructure, etc.
Energy efficiency	Smart cities focus on reducing energy consumption and promoting the use of renewable energy sources involving smart grid technologies, energy-efficient buildings, smart lighting systems, etc.
Infrastructure management	The monitoring and maintenance of critical infrastructure, such as water supply, sewage systems, and public facilities, are streamlined through sensors and predictive analytics to optimize resource allocation.
Quality of life	The aim of a smart city is to enhance residents' quality of life by providing improved public services, better healthcare facilities, better access to education and cultural amenities, etc.
Sustainability	Smart cities prioritize sustainable development practices, aiming to minimize environmental impact, reduce waste, and promote eco-friendly initiatives.
Citizen engagement	Smart cities involve citizens in decision-making processes through digital platforms, encouraging active participation in urban development projects and policy discussions.
Safety and security	Advanced technologies are used to enhance public safety, including smart surveillance systems, emergency response systems, disaster management solutions, etc.
Economic development	The integration of technology and innovation are used to stimulate economic growth by attracting tech companies, startups, research institutions, etc. to the city.
Connectivity	Access to high-speed internet and digital services is a crucial aspect of smart cities, enabling citizens to stay connected and access online services easily.
Resilience	Smart cities are designed to be resilient in the face of challenges like climate change, natural disasters, and other unexpected events, by incorporating adaptive and responsive infrastructure.

financial and economic foundations of urban development through innovation, transparency, and connectivity.

A common feature in the policy documents (such as in Stockholm), and success stories (such as the economy of Singapore) is that, while the smart city development enables social goal setting, it is fundamentally a techno-economic concept. Therefore, social scientists – for example, Caragliu et al. (2011), Hollands (2008) and van Deursen and van Dijk (2019) among others – have raised several points of criticism towards the concept. First, the concept enhances technocratic voices referring to societal development that celebrates technological advancement itself (as a goal), not its impacts on humans or societies. This view is often defined as technological determinism. Arguably, critical assessment of smart cities should encompass a thorough evaluation of the benefits, challenges, and potential implications of technology. Criticism towards technological determinism also highlights the emergence of social fragmentation: social cohesion and community bonds might weaken as interactions shift from physical spaces to digital platforms. This has direct implications for urban culture and practices since rapid technological change can erode the unique cultural and historical trajectories of cities. The criticism towards smart cities is linked with global homogenization and urban landscape banality. Critical voices have also been raised towards the potential drawbacks of smart city technologies relating to, for example, surveillance, algorithmic bias, and decision-making processes driven by AI (Yigitcanlar et al., 2022, 2024). Striking a balance between innovation and regulation, particularly in surveillance, is challenging, as rapid technological advancements often outpace the development of appropriate policies.

Importantly, the smart city concept derives from business and technology studies. It is well recognized that the viewpoint of disadvantaged groups is not the primary one (Kolotouchkina et al., 2022) although recent approaches have recognized the importance of the social dimension of smart city development (see e.g., Alizadeh & Sharifi, 2023a, 2023b). However, related terms – notably "digital divide" – have been utilized from 1990s onwards to discuss the inclusiveness of information and communication technologies (ICTs): not all have the same capabilities and possibilities to use and benefit from digital technologies (Dobransky & Hargittai, 2006; Graham, 2002; Lin et al., 2018; Wang et al., 2021). Hence, the main criticism towards smart cities is social (or societal), not technological, by nature. This criticism leads to an important question: are smart cities able to improve urban living through accessible, affordable, and easy-to-use interfaced technologies for all or just for certain privileged groups as smart city visions seem to be largely disconnected from the social needs of the very people that live in cities (Vanolo, 2014, 2016)? These notions motivate our empirical review stance on disadvantaged groups (namely, PWDs) in smart cities.

In essence, smart cities are increasingly targeted on creating inclusive environments that cater to the needs of all residents, including those with limitations and hindrances in the use of "everyday" technologies. For example, real-time transit information and navigation applications provide accessible routes and information for people with visual or mobility impairments. Similar solutions are applicable also in seating and boarding as well in visual announcements of transit stops and ad hoc travel planning. There are countless, often locally designed application solutions, providing detailed indoor navigation within public buildings, airports, and shopping centers for the needs of disadvantaged groups. These examples demonstrate how smart city technologies and initiatives can be leveraged to create more inclusive urban environments for PWDs, fostering greater independence, accessibility, and quality of life. However, since smart cities are never constructed on tabula rasa, new smart city development is always (awkwardly) integrated into the existing (potentially very old) built environment (Shelton et al., 2015). This existing build environment includes physical and sensory barriers and discriminating architecture such as signposts, stairs, cobblestone sidewalks, etc. (Gleeson, 1998a). As such, criticism has been raised, whether smart city development will help to improve the lives of PWDs if the (basic) infrastructure of the city remains discriminating. In fact, concerns point out that technological development and digitalization may, rather, lead to further exclusion of PWDs (Gleeson, 1998b, 1999; van Holstein et al., 2021).

To summarize, socially sustainable smart urban development highlights the culmination of improved services, enhanced mobility, and expanded information access as transformative components that collectively enhance overall quality of life of the disadvantaged groups. However, the risk of excessive dependence on technology at the expense of essential human interactions and contextual elements in urban development is an identified concern. We argue that while there is an inherent sustainability element in smart cities, the question remains whether smart city development truly catalyzes the establishment of inclusive technologies and better quality of life through innovation and social cohesion. Smart city technologies are expected to have this potency, but the problems and challenges related to the smart city concept also need recognition, including an array of potent concerns in data collection, individual privacy infringement, and the potential for misappropriation of sensitive information. A critical assessment of smart cities involves weighing their potential benefits against the challenges and implications they present. While smart city initiatives hold promise for enhancing urban living conditions, addressing these challenges is essential for creating truly inclusive and human-centered (smart) cities.

3. Materials and methods

3.1. Literature search procedures

We utilized Scopus and Web of Science (WoS) databases for screening out the literature on the topic at hand due to their functionality, high quality, and good coverage (Norris & Oppenheim, 2007). Whereas the previous reviews on smart cities have not concentrated on PWDs or have done so by only reviewing the literature in some specific disciplines (Zhou et al., 2023), our approach was more inclusive. That is, we included all research into our review irrespective of the research field as long as it discusses both smart cities and disabilities. To operationalize this goal, we set up a search sting by the following logic.

As stated above, the smart city concept is ambiguous, and it has several synonyms that are often used interchangeably to describe similar processes to smart city development. We followed Li (2019: Table 2) and Mora et al. (2019: Table 3) in the selection of keywords and utilized the most common terms in use in previous literature: smart, intelligent, digital and knowledge cities. Additionally, due to our focus on sustainability we also utilized the emerging concept of "smart sustainable cities" (Ahvenniemi et al., 2017; Kim & Feng, 2024; Kramers et al., 2014; Yigitcanlar et al., 2019; see also de Jong et al., 2015; Schraven et al., 2021) in our search procedures. We then included four keywords for the population group under investigation (i.e. disabled, impaired, special needs, and handicapped) to tie the literature on smart cities to the disadvantaged. We also ran alternative search strings with additional keywords, "blind people" and "physically challenged", but the results did not change to a significant degree. For example, applying these alternative terms produced only four additional papers in Scopus after applying the filters (see below) out of which only one would have clearly fitted to our research scope. Therefore, these alternative terms are either not in wide use or they coincide with the ones already included in the search string. Nonetheless, in bibliometric research decisions regarding the literature search procedures affect the final sample to be studied. We, therefore, naturally acknowledge that we might have missed some useful contributions due to, for example, keyword, database, language or document type issues. To summarize, for screening the literature (title, abstract and keywords) we included the following set of search terms that take into account spelling differences and the use of singular/plural form:

"Smart cit" OR "Intelligent cit*" OR "Digital cit*" OR "Knowledge cit*" OR "Smart sustainable cit*"*

AND

"Special needs" OR "Disab" OR "Impaire*" OR "Handica*"*

Our aim is to provide an up-to-date review on the existing studies on smart cities and PWDs. Thus, while we acknowledge that the use of publication years as an inclusion criterion is not problem-free (Liu, 2021), the literature search process was carried out at the beginning of 2024 (in January) to include the most recent studies published in 2023 (including early access papers) into the analysis. Overall, the analysis period covers articles published from 2011 up to 2023.

As seen from Fig. 1, the number of initial "hits" were much higher in Scopus than in WoS. However, after we applied two filters – we focused only 1) on scientific articles due to their, on average, higher quality than conference proceedings, etc. and 2) on English language texts as the most utilized language in scientific communication – the number of included articles evened to similar figures. We then screened the abstracts of the articles to make sure that they were indeed discussing the topics under investigation here. We disregarded roughly one third of the articles for not fitting to our scope. Common reasons behind their poor fit had to do with the keywords "*digital cit**" which covered also papers on digital citizens or citizenship, not cities, and to "*disab**" and "*impaire**" when they were used in connection to things, not persons. After cleaning the data from duplicates that appeared in both databases, our final data consists of 68 articles. In an earlier paper, Apostoaie et al. (2023: 18) have stated "…there are no articles dealing with research on improving the quality of life of PWDs in smart cities." While our screening process suggests that this is not exactly the case, the relatively low number of articles on the topic does echo such statements: smart city development is rarely studied from the perspective of its impacts on PWDs.

3.2. Content analysis

For the purposes of the analysis, we first provide a description of the data based on publication years, most prominent journals and research areas as obtained from WoS and Scopus. For the in-depth analysis of the articles, we first read them in full to get a general overview on their content and at the same time flagged all the contents that discussed the advantages or the challenges of smart city development from the perspective of PWDs. These excerpts were further analyzed in detail to give a qualitative account of the advances made for helping PWDs to access and live in smart cities and the barriers faced by them. The aim of the content analysis is to pinpoint similarities and differences within the smart city literature that addresses PWDs and to identify gaps in our knowledge on the development of inclusive smart cities. To this end, we utilized a series of categorizations designed to help us in our interpretations.

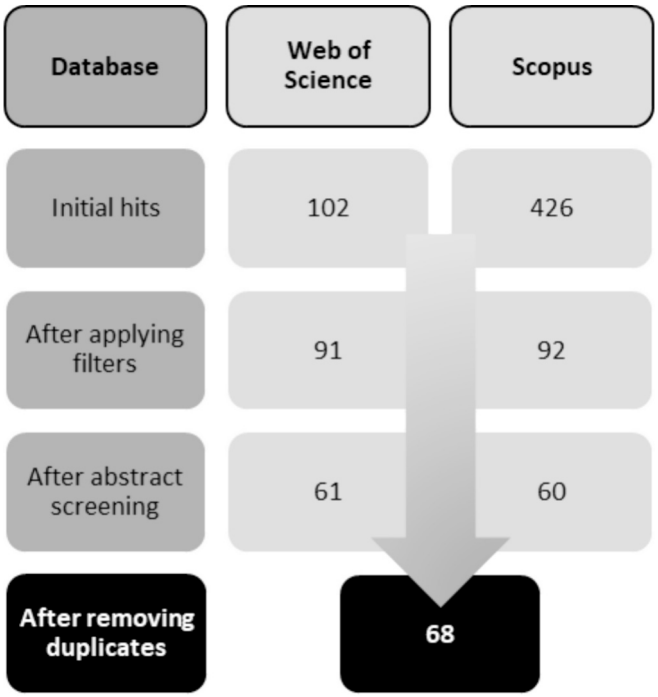

Fig. 1. An overview of the literature search process. Source: authors.

Importantly, while we acknowledge that dichotomies can oversimplify the nuances of a debate, for practical purposes we first divided the data into two separate categories based on their content (and research fields) as either: 1) **technical** descriptions of instruments designed to help PWDs in the context of smart cities; and 2) to papers taking a more **societal** stance towards smart city development *vis-á-vis* PWDs (as discussed in Section 2). Second, we also categorized the data as either 1) founded on the confidence that technological advances can make the city more hospitable to PWDs that we label as "**techno-optimism**" or 2) taking a **critical** tone towards the prospects of smart city development to improve the quality of life of PWDs (Danaher, 2022; Gleeson, 1999). This analysis will give us insights on the predominant stance towards the possibilities offered to PWDs by smart city development.

Next, we categorized the studies (a single article can belong to two or more categories) based on their focus on the different "dimensions" of disability discrimination identified in earlier (urban) studies on PWDs: 1) **physical barriers** (e.g., guttering and paving) that hamper the mobility of PWDs; 2) **building architecture** (e.g., stairs and hand-opened doors) that complicates or excludes the entry of PWDs; 3) inaccessible **public transport** modes; 4) **signage and signaling** that do not take into account differing levels of perception and mobility (Gleeson, 1998b, 2001); 5) practices that limit PWDs' **participation** in urban life, policy and planning (Edwards, 2008); and 6) **(e-)services and information** that are not readily available/accessible for PWDs (van Holstein et al., 2021).

Finally, we also marked down the types of disabilities that the authors state they are addressing in their articles and made the following data-driven categorization (a single article can belong to two or more categories of the disability types from one to five): 1) **visual impairment**; 2) **movement disability**; 3) **cognitive disability**; 4) **hard of hearing**; 5) **social impairment;** and 6) **not specified (all)**. Articles in the last category do not address any specific type of disabilities, rather they discuss all disabilities generally.

4. Results

4.1. Descriptive overview on the analyzed articles

Over half of the papers on smart cities and PWDs have been published in the 2020s and the peak year is 2021 (Fig. 2). Thus, the topic (disabilities) seems to be gaining prominence in the literature on smart cities. However, the increased number of publications concerning PWDs and smart cities might reflect a more general development. According to earlier reviews on smart city research, as a relatively young scientific and planning concept, its popularity has experienced a general upward trend in recent years (e.g., Gracias et al., 2023). The articles in our data have appeared in a wide range of different journals. Journals with more than two articles include *IEEE Access* (n = 5), *Sustainability* (n = 5), *Sensors* (n = 4), and *Sustainable Cities and Society* (n = 3). In terms of research areas, technical disciplines such as engineering, computer science, telecommunications, etc. are the ones through which the topic is most commonly approached, but also social sciences and urban studies stand out as significant scientific fields investigating smart cities and PWDs (Fig. 3).

Fig. 3 showing the most common research areas, already gives us clues on the division of the articles per the two categories investigated: 1) technical (e.g., engineering, computer science, etc.) and 2) societal approaches (e.g., social sciences, urban studies, etc). Out of the 68

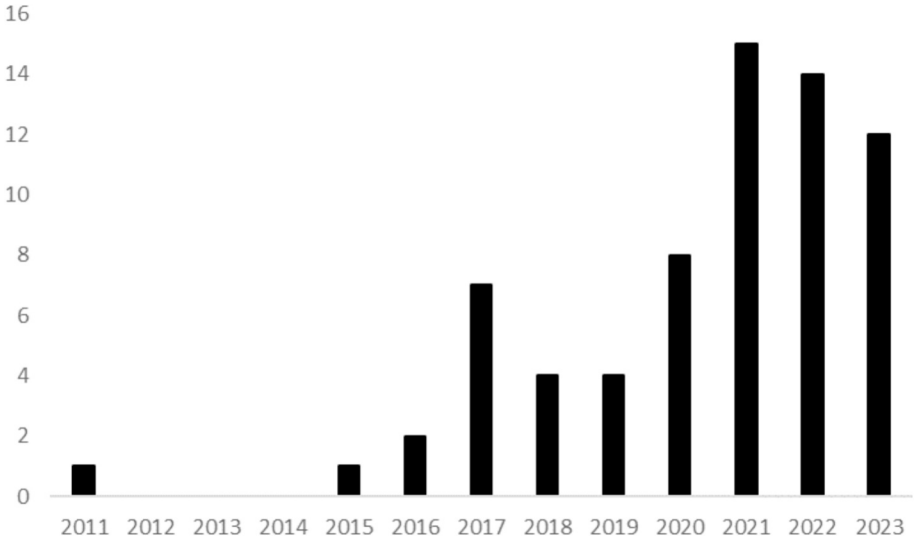

Fig. 2. The articles in our data on smart cities and persons with disabilities by the year of their publication ($N = 68$). Source: authors' elaboration based on data from WoS and Scopus.

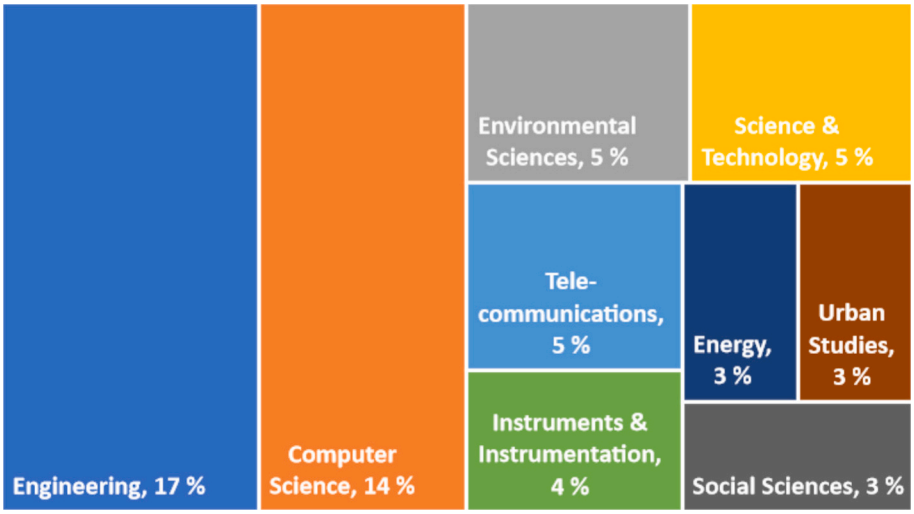

Fig. 3. The most prominent research fields in the data ($N = 129$). Source: authors' elaboration based on data from WoS and Scopus.

articles in our data, 43 (around 63 %) belong to the first category and the remaining 25 (around 37 %) to the second category. Moreover, only six articles were labelled as clearly critical towards the possibilities of smart city development to truly improve the lives of PWDs. All the critical papers belong to the societal category covering around 9 % of the data. These results are in line with the general smart city discourse: smart city

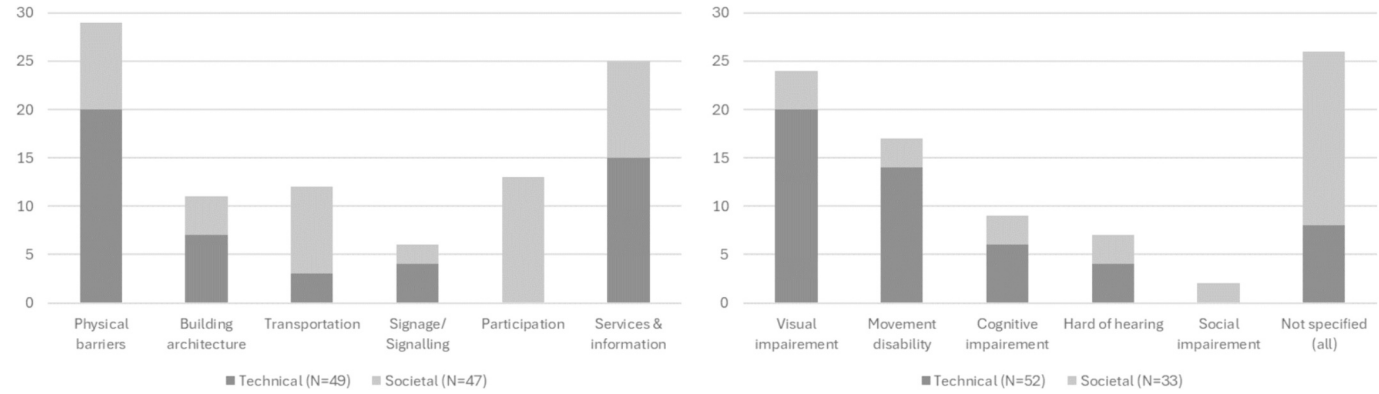

Fig. 4. The number of articles addressing the different dimensions of disability discrimination (left) and disability types (right). Source: authors' elaboration based on data from WoS and Scopus.

development is more often a technologically oriented rather than a social endeavor (Joss et al., 2019).

As seen from Fig. 4, papers in the technical category most often address problems that physical barriers in urban environments have on the lives of PWDs or introduce service and information related solutions. Not a single technical paper focused on issues related to participation, which in contrast is the most often discussed dimension of disability discrimination within the societal category. Also, transportation issues are more often discussed through the societal rather than technical lens. From the data, it is also apparent that, whereas individual technical papers are largely focusing on a single dimension, papers from the societal perspective often look at more than one dimension within a single article.

A similar division (as in the of disability discrimination dimensions) is identifiable when looking at the disability types (Fig. 4). Most technical papers focus on a single disability type, visual impairment and movement disability being the most often addressed types, whereas papers in the societal category commonly approach the issue from a general perspective without specifying single disability types. A noteworthy detail is that the smart city literature has only very seldom covered social impairment.

4.2. Technical solutions to aid persons with disabilities in smart cities

Almost all of the papers belonging to the technical category introduce a single assistive technology aimed for easing the lives of PWDs in urban environments. There is a vast variety of different technological solutions discussed including, for example:

- Technologies for improving safe street crossing (smart traffic lights) in cities (Huang et al., 2022; Montanha et al., 2022; Theodorou et al., 2023).
- Electronic canes or sensor units that can be attached to off-the-shelf canes (smart cranes) to facilitate independent movement of the visually impaired people in urban environments (Dhou et al., 2022; Ramirez et al., 2017; Rodrigo-Salazar et al., 2021).
- Technologies to remotely monitor and assess (smart meters, etc.) the health condition of elderly and/or PWDs living at home (Celesti et al., 2020; Javed et al., 2021; Lai & Lai, 2022).
- Social media, crowdsourced or web scraped (big) data-based systems and interfaces providing PWDs information about mobility barriers as well as personalized paths and public transport journey suggestions based on their preferences, needs and urban accessibility (Prandi et al., 2017; Sánchez-Ávila et al., 2020; Vela et al., 2019).

The technical papers are very optimistic on the potential of smart city development to improve the quality of life of PWDs. However, as also pointed out by Telles et al. (2021), two striking features of these technical solutions are indefinable and pinpointed. First, they mostly concentrate on individual spots in the urban fabric (the home of a PWD, a pedestrian crossing, etc.) or are specific gadgets/devices meant for individuals. That is, they rarely cover geographically broad areas, such as the whole city or metropolitan regions. Second, they are only very rarely generic in terms of disabilities and, rather, are usually intended only for one type of disability. A related observation is that the technical literature only rarely questions whether PWDs are willing to adopt and use the developed assistive technologies and whether they are accepting towards increased data collection (via, for example, smart meters) concerning their daily lives. That is, whether PWDs trust smart technologies (see also Zhou et al., 2023)? These statements give raise to a series of criticism – discussed in detail below – towards the ability of smart city development to enhance the quality of life of PWDs.

4.3. Critical societal aspects of living in a smart city as a person with disability

The reviewed papers in the societal category largely repeat the ethos of the technical category by following the "smart city discourse that emphasizes technical solutions to urban problems" (Wigley & Rose, 2020: 168). That is, they are infused with techno-optimism arguing that technological improvements associated with the smart city development will provide the tools needed for tackling the complex global challenges faced by urban areas and, wider, the humankind (Blacutt & Roche, 2020; Gonçalves et al., 2021). The reasons behind why PWDs have not benefitted from smart city development are often linked to lack of knowledge of (Chaparro-Mantilla et al., 2021) or acceptance (Walczak et al., 2023) towards new technologies – a challenge that can be tackled with training (Chaparro-Mantilla et al., 2021; Doukas et al., 2011). Only few papers take a very critical stance towards smart cities. Rather, the critique in the articles is often directed towards earlier smart city solutions and concepts in an effort to underline the need for the presented improvements, but not fundamentally challenging the virtues of smart cities for PWDs. However, there are a few expectations.

Tellingly, the first identified paper on smart cities and PWDs sets a vision of future infrastructures (pervasive systems) put out across urban environments to assist PWDs population as they move around in the city (Doukas et al., 2011). While the authors are optimistic on the future potential of smart city development for PWDs, they nonetheless find several social challenges (in addition to technical problems) in implementing such infrastructures. These challenges include the issue of 1) **affordability and acceptability** due to the **high (public and private) costs** of such systems as well as 2) **security and privacy concerns** (as people would need to be monitored) discussed in the subsequent literature on PWDs and smart cities:

1. Generally smart city development overlooks PWDs because there are no easy one-size-fits-all solutions. Designing solutions (e.g. common devices) that would work for all PWDs (Reuter, 2019) or even those within specific groups of impairments is extremely challenging if not impossible (Ghosh et al., 2021). This naturally narrows down the market for specially designed devices making them economically less feasible for companies involved in smart city technologies. In fact, a review of 60 mobility apps indicates that the populations with a transport disadvantage due to limited physical ability are a minority and, thus, represent a smaller market for app developers. As a result, the proportion of apps for general use compared to those that encourage social sustainability in transport is proportionally lower than the share of PWDs in the population (Gebresselassie & Sanchez, 2018). Thus, since tech companies are accused of being rather slow to invest in assistive technology this means that such small technological markets are not pursued in the first place (Reuter, 2019) or that their costs are unaffordable for cities to implement or individuals to acquire (Doukas et al., 2011). While there are attempts to design more affordable technical solutions (e.g., Beingolea et al., 2021; Zubov, 2018), in practice the high costs of assistive technologies will give raise to inequalities between PWDs depending on their (or their families') wealth.
2. Data security issues raise concerns as sensitive information might be leaked or stolen and used against PWDs (Doukas et al., 2011). Whereas the smart city rhetoric assumes that the problems of PWDs can be alleviated with sufficient data and that privacy-preserved techniques can tackle security issues and concerns (e.g., Meshram et al., 2023), the reality is that the general public is increasingly wary towards public data collection (monitoring systems, data storing, registry interoperability for profiling, etc.) and towards giving up personal information to the service providers (Walczak et al., 2023). In the age of cyber-attacks this seems sensible. The flipside is that missing data hinders the performance of assistive technologies (Ghosh et al., 2021). Moreover, since in a word increasingly reliant

on data, blind spots create injustices that discriminate PWDs (Deitz, 2023). For example, Deitz et al. (2021) discuss how the lack of public data on urban features hinders safe pedestrian travel of PWDs.

A more general and fundamental criticism is directed towards the concept of smart city development and its inability to improve the quality of life of PWDs. For example, a recent study shows that cities give insufficient attention to underrepresented population groups (such as PWDs) when planning smart city initiatives (Wang et al., 2021). Thus, they can (unintentionally) reinforce, rather than alleviate, existing inequalities between PWDs and the majority population. Rebernik et al. (2020) draw similar conclusions stating that the topic of disability inclusion is hardly ever covered in city evaluation systems. Thus, while some cities have implemented promising innovative practices related to, for example, the digital inclusion of PWDs, they are far from being commonplace on a global (urban) scale (Kolotouchkina et al., 2022). Pineda and Corburn (2020) argue that by implementing smart-city technologies that are not universally accessible, cities have left behind those with physical impairments. For example, ICT can never be a simple answer to tackle the marginalization of PWDs since, while potentially offering some improvements for inclusion, technological solutions do not counter the fundamental barriers of being excluded. Thus, urban development needs to be transformed radically to fulfill the promise of inclusive smart cities and PWDs' right to the city (Reuter, 2019). Kimura et al. (2023) draw similar conclusions stating that smart city initiatives only appear to be improving the lives of PWDs but will not eliminate the genuine barriers unless the existing system is essentially transformed. Thus, new technology can reinforce rather than disrupt the traditional marginalized role of PWDs in smart city development (Wigley & Rose, 2020).

5. Discussion and conclusions

This paper set out to investigate two research questions. First, how disadvantaged groups are considered and represented in the literature on smart cities? Second, has smart city development improved (or can it be expected to improve) the conditions of the disadvantaged? These questions were approached by reviewing the literature on smart cities and disabilities. That is, from the variety of different disadvantaged groups, we focus here on PWDs.

To answer the first research questions, the data gathering (literature screening) process highlights that disabilities are a relatively rare topic within the literature on smart cities. Further categorization of the data revealed that most of the articles discussing smart city development and PWDs approach the issue from a technical perspective (Fig. 5). This is in line with the general smart city discourse that is more technologically than societally driven (Joss et al., 2019). The technical studies mostly focus on a single disability type and a single dimension of disability discrimination (physical barriers, building infrastructure, public transport, etc.) with the aim of designing assistive technologies that aid PWDs in urban environments. As such, they mostly concentrate on individual spots in the urban fabric (rather than cities as single units) or are about specific gadgets or devices meant for individuals with a specific disability type. Critique can be raised concerning the benefits of such "dotted" smart city development, if the remaining urban infrastructure remains discriminating (Gleeson, 1998a, 1998b, 1999).

The literature on smart cities and PWDs is infused with techno-optimism: it is believed that technological solutions will improve PWDs' quality of life and their inclusion into the urban life. Contrarily, very few papers take a critical stance towards smart city developments (Fig. 5). It is almost automatically considered (as a research stance or design) that technologies inevitably have a positive impact on the daily lives of PWDs. At the same time, it is often forgotten that technological development can also generate new sources for and types of disparity (UN-Habitat, 2022) due to interconnected cultural, economic and social reasons (e.g., Merisalo & Makkonen, 2022). The critical papers contradict the optimistic views held by most of the reviewed literature by raising important concerns. First, the costs of assistive technologies can give raise to deepening inequality. Second, smart city development brings about several data-related privacy and security concerns. Finally, and most importantly, individual technological devices are not enough to improve the quality of life of PWDs if the urban system itself is not more profoundly transformed towards the ideal of an inclusive smart city. Thus, answering to our second research question: while smart city initiatives hold promise for enhancing urban living conditions of PWDs, technological solutions alone do not counter the fundamental barriers of being excluded.

Based on this study on smart cities and disabilities, more needs to be accomplished in order to address the barriers caused by the existing (old) inaccessible urban infrastructures (Shelton et al., 2015). In this work, the most urgent near future policy and research demands concern such technological solutions that tackle the various dimensions of discrimination to improve the inclusion of PWDs into daily urban life. These technologies include, for example, accessible public transportation, smart pedestrian pathways, and smart traffic management systems. The topic is directly linking to the socio-technological acceptance of assistive technologies (such as smart wearables, navigation apps, and voice-controlled devices) that has received relatively little attention in the literature on smart city development. It also relates to the acceptance of data processing (essential for smart city development)

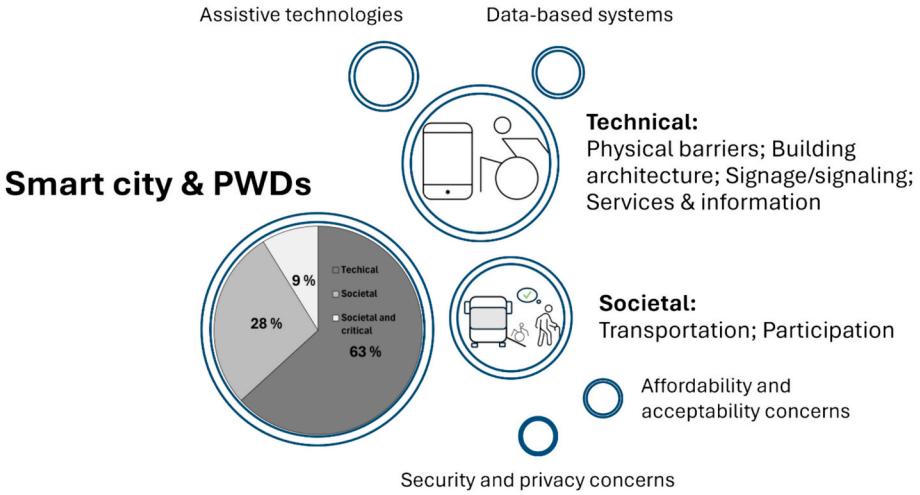

Fig. 5. Visual synthesis of the main findings. Source: authors.

since the way data are collected and stored brings about concerns and risks. From this perspective data security issues should be an integral part of future policy discussions and research on smart cities and disabilities.

From the policy perspective, the public sector should subsidize assistive technologies so that they do not create greater inequality between those PWDs who can afford them and those who do not. Relatedly, while smart city development is already in the radar of tech companies, thus far, the interest has been on larger markets than PWDs. The issue of further incentivizing the private sector into developing assistive technologies is, thus, a pressing one. Moreover, smart city development for PWDs has remained at the level of individual spots rather than on the city level as the costs of implementing city-wide smart development are naturally high. As a solution, in line with Kolotouchkina et al. (2022), we acknowledge the value of public-private partnerships for three interlinked reasons (Lam & Yang 2020). First, they can leverage the private sector's interest towards smart city development geared at PWDs. Second, they can help to scale up individual smart city projects to the city level. Third, they can ease the financial burden of smart city development for individual organizations via shared costs (and benefits).

Technologies do pose great potential for aiding the quality of life of PWDs but in order to truly achieve inclusiveness in smart cities, and in addition to technical solutions, a more profound policy changes are needed. Smart city planning needs to more fully embrace the fact that when designing city services and infrastructure, the citizens – including PWDs – are the most crucial stakeholders (Zhou et al., 2023). Smart city planning needs to incorporate universal design principles for creating spaces, buildings, and services that are usable by everyone. As such, smart city initiatives should promote social cohesion and reduce the potential problems of isolation particularly since social impairments are only rarely studied in the literature on smart cities; since technological advancements shift interactions from physical spaces to digital platforms, the potentially eroding social equality among different groups of people should be addressed; etc. However, and most importantly, smart city research and policies should acknowledge that not all problems have technological solutions. For example, it is hard to imagine an app or a device that could eradicate (the antecedents of) discrimination (Roth et al., 2019). Rather, other non-technological means (e.g., raising awareness, setting societal goals above economic ones, participatory planning processes, impact assessments of smart city development that take into account PWDs, inquiring PWDs about their willingness to use assistive technologies, etc.) are needed to tackle such deeply rooted issues that act as barriers to achieving inclusive smart cities.

Finally, it is important to note that our focus on PWDs is not implying that other groups – such as refugees or the elderly (see e.g., Merisalo & Jauhiainen, 2020; Mubarak & Suomi, 2022) – would be less/more affected by smart city development. Similarly, the consideration of social discrimination and awareness in the context of smart cities requires future studies. These principles are extendable to other socially disadvantaged groups who face restrictions or limitations that are not physical in essence (e.g. behavioral, mental, social, experience, or discriminative). Technological solutions cannot remove all the barriers they encounter. For instance, individuals facing socio-economic disadvantages, racial or ethnic minorities, or those facing gender-based discrimination may also experience exclusion in mainstream smart city technology solutions. While these barriers may not be physical, they are nonetheless real and impactful.

An inclusive smart city should indeed assist all its PWD citizens, not just those with physical limitations. It involves not only the development of assistive technologies, but also policy changes and societal shifts towards inclusivity. This derives our policy implication that smart city planning needs to incorporate universal design principles to create spaces, buildings, and services that are usable by everyone. Keeping this future research agenda in mind, in this paper we did the decision to focus on the defined aspects of smart city categories in order to gain an in-depth view on a specific disadvantaged group, as opposed to remaining at a general level by scratching the surface of all existing groups. We hope that our paper will also encourage more research on smart city development *vis-á-vis* the multitude of disadvantaged groups that require additional studies.

CRediT authorship contribution statement

Teemu Makkonen: Writing – original draft, Visualization, Methodology, Formal analysis, Data curation, Conceptualization. **Tommi Inkinen:** Writing – review & editing, Supervision, Methodology, Formal analysis, Conceptualization.

Declaration of competing interest

The authors report no competing interests.

Data availability

The data consists of the reviewed articles, which can be accessed online from their publishers' platforms

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