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Smart Cities for All? Bridging Digital Divides for Socially Sustainable and Inclusive Cities

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Abstract: This paper aims to emphasize the need for enhancing inclusivity and accessibility within smart-city societies. It represents the first attempt to apply Amartya Sen's capability approach by exploring the implications of digital divides for promoting inclusive and climate-friendly cities that prioritize well-being, equity, and societal participation. Sen's framework recognizes individual variations in converting resources into valuable 'functionings', and herein emphasizes the importance of aligning personal, social, and environmental conversion factors for individuals to fully navigate, participate in, and enjoy the benefits provided by smart cities. Adopting the capability approach and employing a cross-disciplinary analysis of the scientific literature, the primary objective is to broaden understanding of how to improve inclusivity and accessibility within smart-city societies, with a specific focus on marginalized community members facing first- and second-level digital divides. This paper underscores the importance of adopting a systemic perspective on climate-smart city navigation and stresses the importance of establishing a unified governing body responsible for monitoring, evaluating, and enhancing smart-city functionality. The paper concludes by summarizing some policy recommendations to boost social inclusion and address climate change in smart cities, such as creating capability-enhancing institutions, safeguarding redundancy in public-choice options, empowering citizens, and leveraging academic knowledge in smart-city policy formulation.

Keywords: smart cities; digital divides; social sustainability; climate-proofing; capability approach; conversion factors; redundancy; institutions; social inclusion

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1. Introduction

While the digitalization of cities and society can contribute to climate-proofing, the governance of smart cities often overlooks crucial social sustainability aspects. The neglect of this issue is evident in the gap between people's views of smart cities. While they are assumed to be climate-friendly and inclusive, they often fall short of these ideals. With few exceptions (see, e.g., [1,2]), there have been limited large-scale scientific surveys conducted on citizens' perceptions of smart cities. In a systematic analysis, van Twist et al. [1] found that citizens' appreciation varies from active discontent (expressed dissatisfaction with the technology, democratic process, and societal impact of the smart city) to passive discontent (citizen dissatisfaction that remains unexpressed due to citizens' lack of awareness and skills, coupled with the absence of channels to express their discontentment). In the absence of channels for individuals to express passive discontent, it is challenging for governing entities, if they exist at all, to monitor, evaluate, and improve the functioning of smart cities. In essence, this issue poses a fundamental democratic question that needs to be handled appropriately.

The notion of 'sustainability' has been at the heart of the international research and policy forefront ever since the Brundtland Report was first published in 1987 [3]. In general, research and practice have given insufficient attention to aspects of social sustainability when compared to economic and ecological sustainability [4–8]. This discrepancy is also evident when it comes to smart-city developments where social sustainability aspects remain inadequately explored. Despite a substantial surge in research on economic development over the past decade, social sustainability factors have not progressed at a similar pace. Remarkably, 1.6% of all studies on smart cities have focused on social sustainability factors, while 92.8% primarily address economic considerations. The remaining studies primarily concentrate on environmental considerations [9]. This disparity underscores the need for a more comprehensive exploration of social sustainability within the context of sustainability research.

Due to the nature of technological innovations and their rapid development, primarily driven by the high-tech industry [10], it is crucial for cities and society at large to establish governing entities with a legal mandate and responsibility to regulate this progress. City development today is affected by the general societal development characterized by increasing inequalities, social exclusion, and marginalization of disadvantaged communities [11,12]. Social exclusion is, therefore, a multi-dimensional process with mutually influencing components such as lack of resources and services, weak social capital, lack of participation and influence, and negative neighborhood effects [13,14]. While the notion of social sustainability has been lacking consensus and clarity [11], there exists a whole cadre of scholars arguing that in smart-city development, it is essential to pay increased attention to the existing social inequalities and increase efforts to address them [9,10].

The importance of considering social inclusion, equality, and justice has received wide recognition among scholars in the academic circles that conduct research on social sustainability. Nilsson et al. [11] discovered that 85% of the literature defining social sustainability connects the concept to various facets of 'equity', encompassing the fair allocation of societal resources, opportunities, and costs. The notion of social sustainability emphasizes, along with the imperative of equity and societal and individual well-being, the facilitation of active participation in and influence over societal development and the promotion of social capital [11]. Smart-city initiatives often promise to improve urban life by using innovative technology to create inclusive environments that ensure healthy, safe, and efficient living for everyone [12].

Scholars define 'equity' as the fair distribution of resources, especially to vulnerable groups. It is often tied to social justice and fair distribution of costs, benefits, and participation in community matters [13–15]. Turker and Ozdemir [16] argue that a socially sustainable society is characterized by justice and equality, ensuring that no one is excluded and by empowering citizens to live fulfilling lives in freedom.

The proclamations listed above align well with Amartya Sen's capability approach, which emphasizes freedom as a fundamental component in enhancing equity, well-being, and inclusion. Well-being can be explained as both physical (e.g., health, access to water and food) and social/emotional well-being, where the latter connects to social inclusion and relationships, trust, education, and social equity [17]. In addition to involvement in decision-making and community influence, participation is a vital aspect of civil, democratic, and sustainable societies [18], and it is key for people living in smart cities to fully take part in all the benefits offered by digital resources and services, get access to information, and be part of urban decision-making processes.

1.1. Paper Objectives

This paper emphasizes the need for enhancing inclusivity and accessibility in smart-city societies. Its novelty lies in being the first scientific publication to apply Amartya Sen's capability approach to smart city research. With a background in urban planning and design, sociology, social work, sustainability science, and institutional economics, the authors of this paper employ a cross-disciplinary analysis of the scientific literature [19] related to how digital disparities inhibit the potential of digital technologies to work for the climate-proofing of smart cities. Adopting a social sustainability framework that emphasizes equity, well-being, participation and influence, and social capital [11], the major objective of this paper is to highlight the imperative of improving inclusivity and accessibility in the smart-city society by way of the capability approach, with a specific focus on marginalized community members who face first- and second-level digital divides. The former pertains to the accessibility to the internet, and the latter to the skills, participation, and efficacy of users in handling digital technologies [20]. By the term 'disadvantaged groups', we here mean segments of the population that face socio-economic, educational, or other challenges and who lack access to or skills in digital technologies that impede their ability to fully participate in and benefit from digitalization more generally. Experiencing digital barriers hinders their social and economic advancement, resulting in so-called digital divides compared to more digitally skilled and advanced segments of the population. As argued here, these barriers have implications for smart cities in dealing with climate change. We acknowledge that there are more aspects that affect the digital divide and social sustainability than those addressed in this paper, like language barriers, disability access, and other aspects. However, our focus here is limited to those factors that restrict access to full participation in a smart-city society and some of the repercussions that may result from this limitation.

Applying ideas from the economist and philosopher Amartya Sen's capability theory [21], we delve into key characteristics essential for advancing the promotion of equitable and inclusive smart cities. These characteristics aim to foster well-being and facilitate active societal participation. The capability approach was first developed by Sen in the early 1980s and has been further refined and expanded upon in various writings related to Sen's development studies and poverty analyses [22]. It posits that a socio-economic system encompasses numerous roles and 'functionings'. When appropriately employed, these functionings have the potential to enhance socio-economic performance and overall happiness of a country, region, or specific population group. Sen emphasizes the importance of focusing not only on material resources but also on individuals' capabilities and opportunities to lead the lives they value (Figure 1). While critics of Sen have voiced concerns about his failure to provide concrete policy recommendations [23], the United Nations Development Programme (UNDP) has adopted the capability approach in constructing the Human Development Index (HDI), which includes indicators like life expectancy, education, and per capita income [24].

Studies on smart cities have previously focused on various types of social inequalities and exclusion. For instance, Chen et al. 2022 provide examples of such studies, e.g., how transport apps take account of the needs of marginalized groups of people [25]. Moreover, Rebernik et al. [26] address the question of whether smart and sustainable cities consider the inclusiveness of all their inhabitants, assessing disability inclusion based on twenty indicators. Furthermore, Nápoles et al. [27] have elaborated on social inclusion in smart cities, and Nesti [28] has elaborated on gender equality in smart cities. The capability approach, however, has only rudimentarily been applied to urban research; but see Basta [29] and Kourtit et al. [30]. Except for a conference proceeding authored by Baldascino and Mosca [31], the capability approach has never before been employed in a scientifically grounded analysis of smart cities.

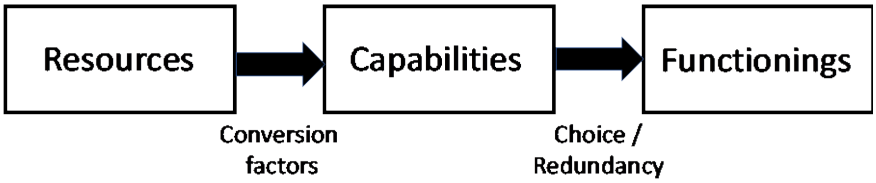

Figure 1. In the capability approach, 'functionings' are the ultimate focus, as they reflect individuals' real freedoms and opportunities to lead the lives they value. 'Resources' encompass the various assets, opportunities, and entitlements that individuals can access to enhance their well-being and capabilities. Certain so-called 'conversion factors' encompass personal, social, and environmental elements that collectively influence individuals' capacity to transform resources into 'capabilities' that represent the primary freedoms that people possess to choose and achieve various valuable 'functionings'. The latter represent different ways of being and doing that people consider important for their well-being and life fulfillment. By recognizing and enabling a broad range of functionings (the various things individuals can do or be), a society can foster a more comprehensive and meaningful measure of well-being beyond traditional economic indicators. In Sen's framework, the emphasis is on promoting human agency, freedom, and the removal of barriers that hinder people from achieving their desired functionings [22]. Adapted and modified from Bonvin 2008 [32].

1.2. Paper Outline

This paper is structured as follows: We commence by framing the key argument presented in this paper by outlining some essential benefits of digitalization for climate-proofing cities. While digital technologies have a real potential to provide huge climate-proofing benefits, they function as a double-edged sword. On the one hand, they broaden access to online services in the smart-city context for a large portion of citizens, arguably improving their use and benefits of these services. For instance, they provide digital access and inclusion of people with disabilities [33–35]. On the other hand, they simultaneously deny this advantage to a subset of disadvantaged groups, giving rise to social exclusion and 'digital divides'. This study concentrates on these divides, exemplified by an exploration of digital technology accessibility and the impact of human behavioral traits. Following this, we adopt Amartya Sen's capability approach to delve into the significance of individuals' navigation within the smart-city society. We underscore a systemic perspective on climate-smart city navigation and stress the importance of establishing a unified governing body responsible for monitoring, evaluating, and enhancing the functionality of smart cities. We conclude by summarizing policy recommendations for such a governing body.

2. Climate Change, Smart Cities, and Social Sustainability

Due to ongoing climate change and the necessity of addressing it successfully, Obringer and Nateghi [36] contend that the link between climate justice and smart cities is unclear and argue that more research is needed on smart cities coupled with social equity and sustainability. While not explicitly focused on climate justice, this paper aims to underscore the impact of digital divides on climate justice within smart-city societies. Addressing these disparities is important for several reasons: First, in the pursuit of establishing a smart city accessible to all, it is crucial to elucidate the various constraints that individuals encounter while navigating in the smart-city landscape. Second, enhanced planning and design of smart-city policies are not realizable unless efforts are directed towards overcoming these specific constraints within the smart-city society. Third, it is crucial to address democracy-related issues and citizenship to further improve the smart-city paradigm [37,38]. Fourthly, capability constraints often carry systemic implications. As argued herein and drawing inspiration from Sen's work, the freedom of agency that individuals hold in the smart-city society is ultimately contingent and constrained by the social, political, and economic resources and opportunities available to them [22]. These opportunities, in turn, we argue, are never offered by the Information and Communication Technology (ICT) itself but from the ruling body of the state or local government of which the prevailing institutions are paramount, as they "enable or restrict the operation of political and economic activities, and in so doing they have an important influence on the achievement of capabilities" [39] (p. 222).

While it is difficult to assess the environmental impact of ICTs on a city level, it is often argued that they hold key value for climate-proofing [40]. ICTs and the Internet of Things can, for instance, aid in reducing greenhouse gas emissions through reduced energy use by substituting resource-intensive activities such as conference travel through virtual means or by making existing services more efficient [41]. Energy savings through ICT technology in smart cities have been shown, for instance, for the operation of transport and heating of buildings [42], as well as numerous other benefits [43].

Estimating the full impact and potential of ICTs in smart-city developments remains a challenge and will probably remain so in the future as well, as novel technologies based on, for example, Artificial Intelligence (AI) are emerging, leading to quite a substantial electricity consumption [44].

While the potential of ICTs in combating climate change is seemingly huge, accessibility to this technology is paramount. Currently, though, one-third of the human population does not have access to the internet. Hence, not everyone can take part in all the benefits that digitalization provides; there are still significant differences between and within countries in accessing and using ICTs. At the same time, there are huge differences in the potential for electrification of transport among developed and developing countries and megacities [45]. There are also significant disparities in internet access and usage between countries in the global north and south [46]. North America recorded the highest internet usage rate, reaching 87.65% in 2017. This figure was more than double the percentages observed in Sub-Saharan Africa and South Asia, as reported by Yang et al. [20].

Some groups of humans are also having more difficulties in accessing and using ICTs than other groups, expressed in digital divides related to gender, geographical location, and income The term 'digital divide' is commonly employed to describe the inequality in the access to and/or utilization of digital technology among households, regions, and countries [20]. The concept emerged in the early 1990s in the context of discussions about disparities in access to information and communication technologies, highlighting the unequal distribution of digital resources and skills among different populations. The disparities that are most referred to are first- and second-level digital divides, with the former pertaining to accessibility to the internet and the latter to skills, participation, and efficacy of users in handling digital technologies such as smartphones, computers, and other gadgets [47]. Third-level digital divides refer to the skewed benefits among individuals being online and where certain groups get more out of their ICT skills than others [48,49]. Gender inequality related to ICTs is a significant challenge, particularly in developing countries, where it is both a consequence and cause of human rights violations [50]. Acilar and Sæbø [50] (p. 234) define the 'gender digital divide' as "the unequal access and use of ICT between genders." This inequality results, among other issues, in the exclusion of women from education [51]. Moreover, the ramifications of digital exclusion are amplified by the fact that education serves as a foundational requirement for personal fulfillment, societal engagement, political representation, and employment opportunities [3]. Since ICT skills are crucial for success in both work and academia, any systematic inequality in these skills becomes a social sustainability issue—a problem also affecting developing countries.

Digital technology for remote work is considered a key factor in reducing climate impacts, such as through decreased commuting [52]. Nevertheless, not all employee groups have access to this option. For example, nine out of ten workers within the Swedish Trade Union Confederation cannot work from home using digital technology due to their work situation [53]. Currently, white-collar workers and knowledge workers are significantly overrepresented in remote work, with a substantial increase during and after the COVID-19 pandemic. Therefore, a 'temporal digital divide' might also be observed, referring to a situation in which a person has access to ICT and possesses the cognitive skills and capacity to use it but cannot use it during working hours. It is also important to emphasize that some persons make an active choice to abstain from using ICTs for various reasons, such as having a negative attitude towards technological equipment and services [54].

2.1. Limiting Behavioral Traits

Despite the climate-friendly nature of a technology, its impact can be compromised by the way humans engage with it. For example, it is widely known that even as a technology becomes increasingly energy efficient, 'rebound effects' often occur with increased use of the technology and the overall increase in energy use [55,56]. Rebound effects refer to the phenomenon wherein efficiency measures aimed at reducing the use of a resource (e.g., energy, money, time) are counteracted by undesired secondary effects that result in consequences in the opposite direction [57]. This phenomenon was already observed during the early stages of industrialization when the increased efficiency of coal-powered steam engines, expected to reduce coal dependency, instead led to a faster depletion of the coal reserves. In market economies, when the production and use of a resource are made more efficient, the price usually decreases, creating a situation that can lead to increased demand and consumption of the resource in question [58].

Rebounding effects are but one classic example of wicked problems that can obscure the climate-proofing of smart cities [58]. Suffice it to say, psychological obstacles often impact human environmentally friendly behavior [59]. Among others, human decision-making often depends on simple rules of thumb known as heuristics. These heuristics can introduce systematic biases into the human cognitive system, stemming from both automatic and rapid intuitive processes, as well as conscious, analytical, and reflective processes [60]. In addition, the design of the physical environment can establish limits on behavior, shaping habits and triggering action responses [61]. In the field of environmental psychology, this spectrum of potential behaviors is framed as the connections between environmental features and the capabilities of the individuals, commonly referred to as 'affordances' [62,63].

A tool related to affordances to boost climate-friendly behavioral change is the use of nudging and defaults. In a decision theoretical context, a default is the outcome that users are left with when they refrain from making an explicit choice [58]. In the affordance literature, various characteristics of the physical environment frequently act as default scenarios, subtly guiding individuals toward specific behaviors [64]. For example, programmable thermostats can be set with energy-saving default settings, encouraging users to maintain more moderate temperatures and reduce energy consumption without having to manually adjust the settings. Also, manufacturers can set energy-saving modes as the default settings on appliances, encouraging users to use energy-efficient options without having to actively select them. A third example of such defaults constitutes public transportation defaults, such as automated ticketing systems, in which integrated and user-friendly automated ticketing systems can be implemented to streamline the boarding process for public transportation. This may include contactless payment methods, mobile apps, or smart cards, making it convenient for individuals to use public transit without the hassle of purchasing tickets every time.

2.2. Second- and Third-Level Digital Disparities

Disparities in digital skills, participation, and efficacy, known as second-level digital divides, have wide-ranging effects on a significant portion of the human population, including individuals possessing technical expertise. For instance, the ongoing updates of applications and the introduction of new smartphone models require cognitive abilities like memory and problem-solving skills, which typically diminish with age [65,66]. While smartphones and other mobile technologies can potentially enhance cognitive functions, the physical aspects, such as navigating touchscreen interfaces, become more challenging as individuals age [67].

With age, people inevitably encounter generational time lags in skill loss and cognitive decline due to the constant evolution of digital technology and the introduction of new smart gadgets. Consequently, as ICT increasingly integrates with traditional urban infrastructure, there is a risk of further marginalizing those facing challenges with digital technologies, either due to difficulty or a refusal to use them [68].

Barbosa and Vetere [69] (p. 2) note that ageing is a heterogenous experience, marked by "both structural (e.g., social class and education) and agentic dimensions (e.g., individual action, attitudes, and dispositions)." Nevertheless, it is essential to recognize that the swift progression of technological advancements has left numerous older adults struggling to adjust, resulting in their growing marginalization within an information-based society [70].

Digital disparities also exist at the third level, with varying benefits from ICT skills highlighted in studies by Wei et al. [48], Van Deursen and Helsper [71], and Van Deursen and van Dijk [72]. These disparities, especially in internet outcomes, can reinforce existing social inequalities. For instance, Public Participation GIS (PPGIS) [73], which can enhance community participation in planning through citizen involvement, may pose democratic challenges. Townsend [38] suggests that PPGIS could lead to a permanent offloading of government responsibilities, disallowing less digitally skilled groups to have a voice in city planning. Prior to the digital era, participatory events faced challenges in adequately representing disadvantaged groups, such as people living in marginalized neighborhoods and low-income earners. The introduction of digital tools has facilitated broader participation, enabling individuals to contribute their opinions regardless of time and location. However, even if there is a potential for digital tools to facilitate the inclusion of a more diverse array of participants in decision-making processes and civic engagement, participation might be skewed towards more privileged groups with greater internet access and digital skills [74].

3. Capabilities for Navigation in the Smart-City Society

It should be noted that ICTs provide important technological tools and solutions to disabled individuals who have challenges, limitations, and restrictions in their ability to perform everyday activities due to physical, sensory, cognitive, or other types of disabilities [33–35]. Hence, the merits of ICTs for the inclusion of people in the smart-city society are indisputable. Still, and as earlier pointed out, ICTs often act as a double-edged sword by denying the advantage of having access to and making use of digital technologies to a subset of disadvantaged individuals in the form of various digital divides. These disparities create challenges for individuals, groups, and communities in the smart-city society, making navigation within this environment problematic. Such navigation involves utilizing digital technologies to access services and critical resources electronically. It also encompasses the process of efficiently moving through the urban landscape with the aid of digital tools. For instance, individuals can navigate smart-city systems to access public transportation schedules, find real-time traffic information, or locate nearby healthcare services through mobile technology applications. The seamless integration of digital navigation enhances accessibility and streamlines the utilization of essential resources within the city environment.

From a sustainability standpoint, the task of leveling out disparities and achieving social justice in the smart-city society involves establishing conditions that foster and elevate people's skills, abilities, and participation. Otherwise, the inclusion of the prefix 'smart' before cities becomes devoid of any meaningful purpose.

To enhance social sustainability and to attain a more nuanced comprehension of social well-being within the realm of smart cities, we contend that it is essential for a more extensive exploration of the capabilities and freedoms crucial for individuals and groups to lead liberated and fully functional lives [75]. This holistic perspective is inspired by the 'capability approach' of Amartya Sen, underscoring the importance of individuals having the freedom to choose diverse ways of living that align with skills and values. In this perspective, development is perceived as the broadening of these tangible freedoms.

In alignment with the insights posed by Sen [22] and Nussbaum [76], capabilities refer to the actual opportunities that individuals possess to lead functioning lives. By adopting this perspective, we argue that smart-city initiatives can better address the diverse needs and aspirations of their citizens, fostering a more inclusive and sustainable urban environment. Unlike traditional economic approaches as indicators of well-being, the capability approach recognizes that income is only a means to an end—the end being the ability to lead a life that one values. Sen highlights the importance of diversity in options and means for reaching human goals and the fact that individuals have different priorities and values. Hence, facilitating a range of different options for navigation in the smart-city society is an important governance aim. The one-size-fits-all approach that currently circumscribes many smart-city developments should be avoided.

Sen's ideas about the diversity of options align well with the resilience thinking principle of 'redundancy', which plays a central role in establishing resilient social-ecological systems [77]. The concept of redundancy, in this context, emphasizes the importance of having a variety of responses available to navigate and address both anticipated and unforeseen changes, as well as to seize new opportunities [78].

In the smart-city development, the redundancy principle echoes Sen's emphasis on expanding real freedoms by fostering a diverse set of options and responses through which people can enhance their adaptive capacity, ensuring they are better equipped to handle the complexities and uncertainties inherent in urban environments. This approach not only promotes resilience but also aligns with Sen's vision of expanding individuals' capabilities to choose and pursue ways of living that resonate with their values and preferences.

3.1. Navigation in the Smart-City Society: A System of Capabilities

So-called 'commodities' represent a key concept in the capability approach. Sen distinguishes between 'functioning' and 'instrumental' commodities, with the former constituting the actual goods and services that individuals use or consume to achieve a certain functioning or capability. The latter represents commodities that serve as instruments or tools to achieve other commodities or functionings. Navigation in the smart-city society greatly depends on the possession of instrumental commodities, such as various gadgets of ICT technology, and the proficiency in using these tools, which together can be regarded as capabilities [79]. Technical artifacts can enhance social justice, well-being, and equality, yet they can also hinder full participation in activities of society, as various so-called 'conversion factors' may impede this process [80].

Conversion factors, as outlined by Sen [22], encompass 'personal', 'social', and 'environmental' elements that collectively influence individuals' capacity to transform resources into valuable functionings. Personal factors are those characteristics that a person is endowed with and which affect the bodily operation as well as her or his psychological make-up and operation. Examples include a person's intelligence, psycho-motor skills, metabolism, physical or mental handicaps, and height. Social factors include institutions, social norms, social hierarchies, and government policies that can promote or inhibit the conversion of a commodity into useful functionings. Environmental factors refer to the external conditions and circumstances that impact an individual's capability conversion. This includes the physical environment, socioeconomic conditions, and access to resources such as public goods, technological infrastructure, and natural resources.

In accordance with the capability approach, to fully navigate, participate, and enjoy the full benefits of society, the three conversion factors need to be aligned; if one is failing, it is impacting the other two, limiting individuals' chances to pursue well-being. It is important to recognize that in Sen's argument, the diversity of options and the fact that people have different capacities to convert resources into valuable functionings are important determinants for reducing inequalities and promoting social sustainability.

Disruptive technologies, such as the internet, smartphones, blockchain technology, and AI, play pivotal roles in shaping smart cities [81]. The integration of these technologies into various applications contributes to the development of smarter cities, fostering improved living conditions and granting residents enhanced access to products and services. Nevertheless, and as previously highlighted, realizing the benefits of these technologies, or what Sen terms "functionings", necessitates the harmonization of the three conversion factors.

In the context of smart cities and drawing an analogy to Sen's capability approach, digital divides emerge as critical obstacles to individuals' capabilities. For example, first-level digital divides can be seen as the exclusion from essential environmental factors required to navigate within a smart-city society, stemming from an individual's incapability to access the internet and other ICTs. On the other hand, second-level digital divides can be construed as the absence of personal factors necessary to adeptly manage instrumental commodities like digital gadgets. This includes both cognitive skills and motor skills, such as the handling of touchscreen interfaces, updating apps and gadgets, and so forth—skills that often decline with age.

While smartphones and other mobile technologies have the potential to enhance human cognition, it is important to note that they may also impede an individual's ability to fully participate in all the functionings offered by the smart-city society. The dual nature of these technologies, serving as both facilitators and barriers, underscores the importance of addressing digital divides to ensure equitable access to and sharing all the benefits of smart-city developments.

3.2. Non-Choice Default Technologies

It has been argued that the prevalence of one-size-fits-all thinking in smart-city societies limits the availability of diverse options for navigation [58]. An illustrative example of this phenomenon is the widespread reliance on smartphones and inexpensive tablet computers, which increasingly perform various functions within smart cities. For instance, a growing number of remotely controlled electronic home devices, which require financial resources to acquire, are now managed through smartphones or other online gadgets. Certain public services are exclusively accessible through these devices, including cashless transaction apps for everyday payments, smartphone-operated parking meters, various medicare services, and so forth. Furthermore, as the use of smartphone- and online-operated services experiences a significant surge, there is a corresponding decline in alternative methods such as credit card or cash payments. This shift has notable implications for public choice and accessibility.

When disruptive technologies become the exclusive means for carrying out daily tasks, leaving little room for alternative or supplementary options, they represent 'non-choice default technologies' (NDT) [58]. A pertinent illustration of an NDT is the complete reliance of farmers on a single type of genetically modified crop and a tailor-made pesticide designed for it. Such tightly interwoven dependencies can result in severe social consequences [32]. In urban settings, the widespread adoption of a specific ride-sharing platform to the exclusion of other options could also be considered an NDT. In other words, if most people use and rely on a specific ride-sharing service to the exclusion of other options, it limits the choices available to individuals in that context. This can happen if a particular platform becomes so popular and widely adopted that other alternatives are less practical or less commonly used. This process is driven by market forces, but local governments can regulate this imbalance by devising adequate institutions that safeguard analog alternatives or by substituting alternative ride-sharing platforms.

A development where smartphones become the only default option to access various kinds of services and operative functions in a city is inherently problematic from a resilience perspective. Maintaining traditional, analog, manual back-up systems that co-exist with digital ICT-driven systems is critical in times of disturbance, for example, hacker attacks or extreme weather events that are predicted to increase in the near future [82]. During crises, analog technologies can step in and perform functions in case of digital system malfunctions. For instance, manual traffic surveillance systems should supplement automatic ones, alternate payment methods should support smartphone-operated parking meters in the event of digital failures, and mechanical locks should complement digital locks [83].

Another illustrative instance highlighting the impact of a default non-choice scenario occurred during the COVID-19 pandemic when certain groups of people faced challenges in scheduling screening appointments and vaccination slots. Despite studies indicating that smart technologies contributed to improving community well-being and enhancing urban resilience during the COVID-19 pandemic [84], the intended goals of these technologies and screening programs were hindered because a significant number of patients could not access the online system [85]. Thus, smart gadgets function as a double-edged sword. On the one hand, they broaden access to online services for a large portion of the human population. On the other hand, they concurrently exclude this benefit for other individuals and already marginalized groups.

NDTs challenge Sen's concept of the freedom to exercise free choice, a fundamental aspect of capabilities [39]. In instances where they dominate the management of daily affairs in a city, individuals find themselves compelled to adopt the technology, regardless of whether they want it or not. Consequently, an individual's agency to engage in the life of a smart-city society is constrained by digital divides, leading to a missed opportunity to benefit from digitalization. Participation limitations arise not only from personal characteristics but also from a combination of social and environmental factors, including the state of ICT infrastructure.

4. Governing the Smart-City Society for Social Sustainability

The three levels of digital divides are intricately linked to social conditions and the evolution of socially sustainable societies. The first level of the digital division concerns the distribution of material resources, crucial for gaining access to the digital sphere. The second and third levels of digital divides emphasize the need for discourse surrounding the equitable distribution of intangible resources and opportunities. Digital development, in connection with social sustainability, extends beyond mere access to the internet and material resources. While the digital divide may appear to be a relatively minor issue affecting only a minority of the human population, the global landscape of the digital divide shows significant variations. Obtaining real-time statistics about the size of the digital gaps is a challenge. However, Jan van Dijk, in his book "The Digital Divide", emphasizes that this divide is not a simplistic binary concept but rather a continuum spanning an entire population. As he notes, it ranges "from people having no access and use at all to those with full access and using several applications every day" [86] (p. 3). This spectrum spans from an information elite at one extreme to a digitally illiterate segment at the other, fully excluded from the digital landscape. Suffice it to say that those in the digital elite will have a much greater capacity to fully realize their functionings, sensu Sen, than those who are less skilled or completely unskilled. This makes inequalities almost inevitable, risking increasing already existing inequalities and social exclusion.

To completely close the digital gap may not be entirely possible. Still, much can be done, and it is going in the right direction. For one thing, access to the internet through broadband development has improved, particularly in developing countries. Nevertheless, bridging the gap in skills and usage remains a considerably greater challenge [86]. Van Dijk alerts that the development and spread of digital technology could unexpectedly worsen social and digital inequality at both national and international levels, contending that addressing this issue requires a focus on social development rather than solely technological progress [86].

The connection between social and digital inequalities emphasizes the significance of prioritizing social sustainability aspects in the planning, design, and management of smart cities. Therefore, it is crucial to integrate considerations of equity, inclusion, and social justice at every stage of smart-city development [9,87]. The architect and urban designer Jan Gehl argues that physical changes in the urban landscape may entail, in addition to altered patterns of movement, mental and social transformations [88]. This can affect how the city is used, determine the representation of diverse groups within its confines, and dictate the extent to which various communities feel a sense of ownership, engage in decision-making processes, and establish a sense of place in the urban environment. As the urban landscape has evolved beyond its conventional physical boundaries and now incorporates a digital sphere, we also need to discuss how the digitized and smart cityscape fosters changes in movement patterns and impacts mental as well as social reconfigurations. Furthermore, interaction with the digital sphere serves as a prerequisite for accessing various facets of the physical environment, as exemplified by parking and public transportation applications. What societal consequences might follow if a part of human diversity is lost within these domains because of digital barriers? Addressing these issues is also pivotal in the context of climate-proofing cities, as the climate crisis is not solely a technical problem but rather a challenge rooted in social conditions and human behavior where climate justice constitutes a precondition for implementing economic and institutional policy instruments aimed at mitigating climate change [89].

Research also indicates that minority populations are more negatively affected by these divides than majority populations [49,71], hindering their access to crucial information, including information about climate issues. For instance, the substantial energy demand of the transport sector and the rapid increase in emissions underscore the importance of promoting commuting through public transportation. This is crucial to conserve energy and reduce emissions compared to other commuting options [45]. However, as smart navigation apps become more prevalent for activities like ticketing and fare collection, there is a risk of excluding individuals from various generations who are not digitally connected or skilled enough to commute by public transport without considerable personal costs. From a sustainable governance perspective, this necessitates the creation of instrumental commodities that offer a blend of digital and analog technological options. Additionally, services that involve manual operation by human beings should be considered to support the development of a green job market and to improve service-mindedness. To encourage the preference for public transportation, like commuting by train instead of flying, cities should carefully plan services to overcome both physical and cultural obstacles, avoiding NDTs and the resultant digital divides. This guarantees the existence of an attractive alternative for residents, fostering both socially and environmentally sustainable transportation decisions.

5. Concluding Remarks

While ICTs provide important technological tools and solutions to disabled individuals, the general expectation is that online services are accessible to everyone and always positive [72]. However, as discussed in this paper, a smart city for all will remain more of an ideal than a reality unless more firm action is taken to avoid the various types of digital disparities that exist in the smart-city society. As clearly elaborated on here, digital development is clearly related to social sustainability issues and to overall societal development. Currently, the development of smart cities is predominantly led by a conglomerate of ICT developers, high-tech companies, and urban prospectors actively seeking investment opportunities in urban development, real estate, and high-tech ventures [90]. This conglomerate may differ substantially from the public authorities, responsible for governing the smart-city network and managing its diverse operation and maintenance. Due to the demand for specialized technological expertise, governance tends to lean toward technocracy, leaving limited space for social expertise to address sustainability aspects [91]. As a result, a participation gap arises in the governance of smart-city development, posing a risk of further diluting existing social exclusion. This situation is likely to contribute to inertia in addressing inequalities associated with the growing digitization of services in cities.

To conclude, it is imperative to establish a unified governing body tasked with monitoring, evaluating, and enhancing the functionality of smart cities. This necessitates the creation of new institutions that facilitate active participation from the bottom up, with significant involvement from the public sector and civil society actors. Given the bureaucratic challenges prevalent in many European countries, such a body would ideally be integrated with existing pan-European initiatives and programs, leveraging their resources and expertise. One such initiative is the European Innovation Partnership on Smart Cities and Communities (EIP-SCC), initiated by the European Commission in 2012 [92]. The EIP-SCC aims to promote collaboration among cities, industry stakeholders, and other relevant parties to develop and deploy smart-city solutions. The EIP-SCC also includes various working groups dedicated to topics such as ICT, citizen participation, and engagement, further facilitating the advancement of smart-city initiatives.

In Table 1 and based on the major issues brought forward in this paper with its focus on Amartya Sen's capability approach, we conclude by providing some more explicit policy and research advice to such a governing body for the promotion of more inclusive and socially sustainable smart cities. This is with the hope that all individuals, including disadvantaged groups, can reach their desired functionings in a smart-city society.

Table 1. Policy recommendations for inclusive and socially sustainable smart cities.

Devise Capability-Enhancing Institutions	Develop policies and institutions that align with Amartya Sen's capability approach to enhance people's capabilities to participate and navigate in the smart-city society
Prioritize Conversion Factors	Focus on conversion factors to maximize the benefits of digital technology, ensuring a comprehensive approach to societal well-being
Safeguard Redundancy in Public-Choice Options	Maintain diverse choices, including analog options, to enhance public-choice options and bolster resilience
Empowering Citizen Voices	Establish a smart city feedback system linked to the capability-enhancing institutions, fostering channels for ordinary citizens and marginalized groups to voice their experiences, including dissatisfaction. Continuous monitoring of satisfaction evolution over time for informed decision-making, enhancing sustainability perspectives
Promote Research on Smart Cities Aligned with Social Equity and Sustainability	Prioritize research on smart cities intertwined with social equity and sustainability, mirroring, for example, the UNDP's incorporation of capability approach indicators into the Human Development Index
Leverage Scientific Knowledge in Policy Formulation	Encourage the integration of more peer-reviewed scientific knowledge into smart-city policy documents, moving away from reliance on other non-reviewed policy documents
Avoid One-Size-Fits-All Approaches	Integrate Amartya Sen's diversity of options into smart-city frameworks, creating smart cities that are both technologically advanced and socially sustainable
Prioritize Social and Organizational Aspects in Digitalization Policies	Highlight the need for policies to place greater emphasis on the social and organizational aspects of digitalization, considering social exclusion, inequalities, and divides in society

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