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Envisioning the New Urban Informatics

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Introduction

The technology utilized in cities has continually evolved and expanded to new domains. In the Vitruvius era, over 2000 years ago, water and sewing systems were developed, and today, sensors are delivering real-time weather information and forecasts to our mobile phones, alongside applications that assist us in moving from one place to another or aid our participation in urban development initiatives. In tandem with technology development, the impact of technology usage has rapidly transformed, with networks and devices now being ubiquitous in the daily lives of citizens, in stark contrast to the situation 30 years ago.

Technology and cities are being discussed employing the concepts of a digitalized city or smart cities. What is common among all these concepts is the integration of technology with the people using it in urban

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contexts. However, the term smart city has been criticized for being overly nebulous, as the cities have always been smart, and the strong technological orientation in the pursuit of smartness has been criticized for becoming more of a goal rather than a tool for achieving greater purposes, such as sustainability (Martin et al., 2019). The need to acknowledge the sustainable development that is connected to technology design has led to the reconceptualization of smart and sustainable cities (Martin et al., 2019), and the terms "resilient," "carbon neutral," or "resource-wise" have been employed to address sustainability issues and the objectives to tackle climate change. Simultaneously, with the emergence of techno-criticism, smart cities' inherent anthropocentrism has also been problematized. The call for a "more-than-human" smart city that takes into account the non-human aspect of the city, such as the ecosystems it is home to (Yigitcanlar et al., 2019), and has planetary-centric approaches instead of a user- or human-centric technology design (Clarke et al., 2019; Heitlinger et al., 2019; Wolff et al., 2021) is raised. A wider understanding of the impacts of technology on cities must be attained.

In this chapter, we define technology in an urban context utilizing the concept of urban informatics instead of a smart city. Emphasizing on the specific types of information collected and supplied through technology, we delve into the realm of urban informatics. Urban informatics involves the collection, analysis, and communication of behavioral data from cities and their citizens through computational methods. According to Foth et al. (2011, p. 2), urban informatics constitutes a research domain that represents the intersection of "place, technology, and people in urban environments." Furthermore, the technology in question aims to support citizens' life as technology users. Technology is utilized in urban environments for urban management and operation of systems such as waste management process, transportation, health care, and safety and security management. For example, identifying distractions in traffic flows, updating the latest pandemic situations, or having 24-hour surveillance technology in certain urban areas exemplify different types of technology usage. With the introduction of these different types of technologies, the role of the individual citizen as a technology user also varies. Citizens could either be primary users of technologies or they may simply

recognize the systems and technologies but not directly interact with them, making them secondary users of technology. This notion of different roles of technology influences how technology usage is experienced (Alsos & Svanæs, 2011).

Quite often, when technology has been utilized to achieve sustainable development in cities, sustainability initiatives have been focused on technology that aims to promote the environmental or economic dimensions of sustainable development. For example, by measuring air quality (Kök et al., 2017) or energy consumption (Chui et al., 2018) or through waste management (Anagnostopoulos et al., 2017), the aim is to achieve healthy environments or efficiency in consumption and civil engineering efforts. Likewise, economic sustainability has been supported by technological advancements such as the development of blockchain technology (Xie et al., 2019). Initially, the Brundtland Commission (World Commission on Environment and Development, 1987) presented the three "pillars" of environmental, social, and economic sustainability that were defined in 2002 during the Sustainable Development Congress in Johannesburg. Subsequently, the fourth pillar of cultural sustainability was added to the discussions (Hawkes, 2001; Soini & Birkeland, 2014). So far, the clear emphasis on economic and environmental sustainability is evident, as is the lack of research on social and cultural sustainability and urban informatics.

Only quite recently, social sustainability has gained emphasis in technology development research in the urban context, with the recognition of its connection to environmental sustainability. Social sustainability has been defined by Candia et al. (2018, p. 192) as "the ability of guarantee, in the most impartial and widespread way possible, even to the weakest subjects, a good accessibility to all city functions; therefore, social sustainability implies a safe and accessible urban mobility." Accessibility to city functions and safe environments are a couple of the many aims that technology should strive to achieve for its citizens through efforts such as provision of public digital services and smart lighting in the streets. Hence, as Candia and colleagues (2018) underscored, accessibility and safety are integral components of social sustainability. This chapter focuses on the social sustainability dimension of safety and explores its connections to urban informatics.

The concept of social sustainability offers us an approach for addressing urban informatics in two ways, namely, by acknowledging the different aspects of social sustainability and by applying the aims of social equity. Boström (2012) highlighted the significance of distinguishing between substantive aspects (what to achieve) and procedural aspects (how to achieve) in the domain of social sustainability. To explain further, substantive aspects pertain to quality of life, experienced happiness, and well-being, whereas procedural aspects relate to facets such as access to existing information about risks and sustainability (ibid.). Consequently, the connections between social sustainability and urban informatics can be related to practices and avenues of sharing information, such as informing citizens with technology about possible risks to their safety to support their well-being. Furthermore, social sustainability encompasses social equity, that is, justice and fairness for all people. One approach for investigating social sustainability and urban informatics is by applying the different aspects of social equity, namely, distributional, recognitional, and procedural equity. By focusing on these three aspects in the context of safe and secure urban environments, we could analyze in further details how urban informatics can promote citizens' experienced safety and security in urban environments while concurrently aligning with the principles of sustainable development.

This chapter discusses the relationship between urban informatics, social sustainability, and safety and security issues in urban environments. We seek answers to the following question: How can urban informatics strengthen citizens' experienced security in urban environments in a socially sustainable manner? We commence by discussing the state-of-the-art-related research and then explore the possible future directions for urban informatics in the context of safety and security, with a particular focus on citizen's perspective. Subsequently, we discuss the framework in a wider context and present the conclusions.

The contributions of the presented framework in this chapter highlight key considerations for the designing of safety and security technology in an urban context and in the overall field of urban informatics with the aim of ensuring equality among citizens. The contributions of this framework are threefold. First, it facilitates an understanding of the different domains of design in safety and security technology and urban

informatics concerning equality, including distributional, recognitional, and procedural equality. Second, it clarifies the areas where citizens' engagement is vital and where expertise on safety and security issues is required. Third, it highlights the importance of the different aspects of social equity in citizens' experiences of safety and security.

Connecting Urban Informatics, Social Sustainability, and Security

To gain deeper insights into the interplay between urban informatics and subjectively experienced security as an element of social sustainability, this chapter begins with an overview of urban informatics and its relationship with sustainability, followed by an exploration of the relationship between urban informatics and safety and security issues. This is succeeded by an overview of social sustainability.

Urban Informatics and Sustainability

Urban informatics concerns technology in urban environments. According to Foth et al. (2011), urban informatics constitutes a research domain situated at the intersection of "place, technology, and people in urban environments." Therefore, the relationship between technology that is situated and utilized in urban environments and the concurrent goals of sustainable development in urban environments presents possibilities. These possibilities have been recognized, for example, by the European Commission's approach to the twin transition, which integrates sustainability into digital transformation strategies and empowers organizations to work more efficiently and sustainably at the same time (see Muench et al., 2022). Therefore, the connections between technology and sustainability in urban environments have been acknowledged.

Recent research on urban informatics and sustainability empathizes with the environmental and economic dimensions of sustainability. This is evident in initiatives such as the development geospatial models that can facilitate the delineation of food access patterns (Chen et al., 2022),

the investigation of strategic decision-making, the utilization of spatial optimization as a component of urban informatics (Murray & Baik, 2022), and the delineation of the applications areas of geosmartness, which involves leveraging novel spatial data sources, computational methods, and geospatial technologies (Raubal et al., 2021). In addition, studies have also been conducted on the trend of data-driven cities integrating smart and sustainable urbanism for advancing sustainability (Bibri & Krogstie, 2020).

Quite recently, particularly research on energy consumption and data supporting energy reduction have been highlighted. Garlik (2022) investigated the requirements of buildings and the need for energy sustainability, resulting in the proposal of a model for enhancing building energy efficiency. Employing computational techniques and data from health-related public sources, Varde et al. (2022) suggested a prediction tool for assessing air quality to estimate pollutant concentrations in urban settings. Moreover, Lee et al. (2021) recommended utilizing urban informatics to increase the efficiency and sustainability of waste management systems and discussed the possible pitfalls of using existing datasets for making future policy decisions.

To summarize, the current directions of urban informatics research are associated with economic and environmental dimensions of sustainability in particular. However, when using urban informatics, it is critical to ensure that we recognize the actual target groups and the ones responsible for identifying them.

Social Sustainability and Safety

Sustainability has environmental, economic, and social dimensions. These three dimensions of sustainability are intertwined, and therefore, the impact of activities that focus on one dimension extends to other dimensions as well. However, even though the relationships among these dimensions are generally assumed to be compatible, the social dimension seems to garner less attention. Furthermore, social dimensions pose particular difficulties in terms of realization and operationalization for policymakers (Boström, 2012; Colantonio & Dixon, 2010). To address this

challenge, the city of Vancouver established a framework known as Vancouver's Social Development Plan (Vancouver Plan, 2022). The framework defines social sustainability through foundational principles (reconciliation, equity, and resilience) and thematic areas (climate protection and restored ecosystems, equitable housing and complete neighborhoods, and an economy that works for all). One cross-cutting topic within the plan is secure housing and spaces (see Vancouver Plan, 2022). According to Dixon (2011, p. 11), security in the context of social sustainability is defined as the state in which "individuals and communities have economic security and have confidence that they live in safe, supportive and healthy environments."

To clarify the term social sustainability, Boström (2012) examined social sustainability goals and classified them into *substantive goals (what to achieve)* and *procedural goals (how to achieve)*. He categorized as substantive goals basic needs, inter- and intra-generational justice, equality of rights, and access to social infrastructure, mobility services, local services and facilities, green spaces, and the like. As procedural goals, Boström (2012) identified the following:

- access to existing and accumulated information about risks and sustainability
- facilitation of participation in the different stages of decision-making processes
- proactive stakeholder communication and consultation throughout the process
- empowerment as a result of taking part in the process
- participation in the selection of topics to be discussed and the definition of problems
- determination of solutions, monitoring of policy- and plan-making processes, and setting of standards

When looking at the procedural aspects mentioned above, the connection between information about urban environments and information related to experienced security (e.g., access to existing and accumulated information about risks and proactive stakeholder communication and consultation throughout the process) becomes evident. In addition,

similarities between urban environments and human-centered technology design (e.g., empowerment as a result of participating in the process and the facilitation of participation in the different stages of decision-making processes) become apparent (see International Organization for Standardization, 2019). Quite recently, attempts to incorporate social dimensions and promote social sustainability have been made in research on urban safety and security. Candia and colleagues (2018) argued that since social sustainability is defined as the ability to guarantee good accessibility to all city functions, social sustainability bears a connection to safe and accessible urban mobility. In addition, the Organisation for Economic Co-operation and Development (OECD) indicates that urban safety and security improve quality of life, which is connected to social sustainability.

Furthermore, urban informatics and social sustainability are interconnected in their identification of data sources. Dixon (2011) presented a matrix to assess social sustainability, which involved identifying the data sources necessary for the assessments related to people, affordability, health and well-being, and sense of community. These data sources included internal data, survey data, neighborhood statistics, crime statistics, and economic and social data (ibid.). We argue that urban informatics can provide rich data despite the challenges involved.

Furthermore, Colantonio (2009, 2011) underscored that the definition of the term social sustainability is constantly and dynamically changing, depending on when and where it is referred to. In addition, the traditional measurements of social sustainability metrics, such as employment or education, are being completed with soft and less measurable concepts such as well-being, happiness and quality of life, opportunities for participation, or demographic change (ibid.). In this chapter, we turn the focus on equity between citizens.

One approach to promoting social sustainability lies in applying the principles of social equity, which we refer to here as distributional, recognitional, and procedural equity. Distributional equity signifies a fair allocation of the outcomes of material goods among all members of society (see Meerow et al., 2019; Schlosberg, 2007). In the context of urban development, this may refer to "equitable access to goods and infrastructure, environmental amenities, services, and economic opportunities,"

(Meerow et al., 2019, p. 797) with an emphasis of the fact that "distribution of undesirable land uses (disamenities) or pollutants across the urban environment is equally important and has long been a focus of the environmental justice scholarship and activism" (Meerow et al., 2019, p. 797). Recognitional justice refers to the equal acknowledgment of and respect extended to different identities and associated social statuses (Schlosberg, 2007). The third principle of social equity, namely, procedural equity, is closely connected to both recognitional and distributional equity. An individual's or group's membership and participation in decision-making are integral to the equitable distribution of material goods. Without procedures of recognition, an individual or group is unable to participate in the community; without such participation, their unique needs for social goods cannot be recognized either (Meerow et al., 2019). We argue that these different forms of social equity, namely, distributional, recognitional, and procedural equity, provide a solid framework for urban informatics that aims to ensure and support social sustainability development in urban environments.

Urban Informatics, Safety, and Security

In this chapter, the terms safety and security are defined as follows. Safety is the prevention of unintentional accidents, and security is the prevention of intentionally unpleasant activities by people. In the context of safety, the objective is to be shielded from accidents such as floods, fires, and traffic accidents, whereas, in the context of security, the aim is to be safeguarded from dangers such as robbery, rape, or mugging (see Candia et al., 2018). According to the new Oxford Dictionary of English (n.d.-a, -b), safety refers to the "the state of being protected from or guarded against hurt or injury; freedom from danger," whereas security is defined as the "state or condition of being or feeling secure. Freedom from care, anxiety or apprehension; absence of worry or anxiety; confidence in one's safety or well-being. Freedom from danger or threat" (ibid.). When considering urban informatics and our approach in this chapter, the experienced security of citizens and the differences between the terms safety and security are influential.

We argue that by acknowledging the different aspects of safety and security, we could utilize urban informatics accurately, and that the distinction between the two concepts is vital when considering the different stakeholders responsible for identifying and recognizing the target groups for critical information. Furthermore, the employment of technology has changed urban environments, as it enables the personalization of urban space (e.g., Green, 2019; Ratti & Claudel, 2016; Townsend, 2013), data flow, and interaction between an individual citizen and urban technological systems. All these factors influence urban informatics, sustainability, safety, and security, since urban informatics encompasses issues related to both sustainability and security issues.

Feeling safe in an urban space is a complex phenomenon. Different contextual and situational factors exert multiple impacts on one's experienced security. Contextual factors include the age and gender of those using the urban space, while situational or place-based factors, whether it is nighttime or daytime, significantly determine the extent to which age, ethnicity, or gender play out as factors affecting the feeling of safety or insecurity. Surveillance and security technology deployed in public spaces may provide a partial solution; however, even these solutions tend to be ethnicity- and gender-specific (Ball et al., 2017). In the field of security research on urban environments and urban events, security has been a focus of urban research, particularly related to urban public spaces (Ceccato et al., 2013; Klauser, 2013). Furthermore, in mass events, security has primarily been investigated from the perspective of organizers (Coaffee et al., 2011; Gordon et al., 2016; Hall et al., 2020) or the focus has been placed on the technical development of security systems (Cerny & Donahoo, 2016; Zollman et al., 2019).

A glance at the current research on urban informatics and safety and security issues makes evident the emphasis on a technology-oriented approach. In addition to citizens, visitors and tourists are quite often a target group for investigations on safeness (see e.g., Jasrotia & Gangotia, 2018; Tripathy et al., 2018). In addition, technologies such as artificial intelligence (Srivastava et al., 2017) and drones (Vattapparamban, 2016) have been investigated as tools for ensuring security. Quite recently, as a result of rapid environmental damage and impact of climate change,

different types of warning systems have been developed (Barba et al., 2012; Zhang et al., 2021).

According to Sinkiene and colleagues (2012), urban safety research is currently dominated by social science theories, and different kinds of approaches are necessary to broaden the research domain. This notion is in line with Barker's view of the need for criminology and urban studies (Barker, 2017), considering safety is a fundamental component of the relationship between humans and the environment (Senda, 2015). Furthermore, Viswanath and Mehrotra (2008) argued that no single discipline can achieve the safety and security of urban public spaces and that the discourse must be located within a broader framework. They also emphasized that public participation constitutes the key issue and that the environment should be designed and built for a diverse range of users and genders.

De Silva et al. (2017) investigated urban safety by focusing on walking speed and environmental cues, outlining that people have a tendency to walk faster in areas demarcated as unsafe and that they walk faster during the night than they do during the day. Earlier, Nasar and Jones (1997) stated that the presence of people or groups of people reduce fear because busy places are perceived as areas where people would be less likely to be attacked. Phadke (2007) investigated the right to the city and its public places and social justice movements and raised the question whether security technology could be the only solution. Bengtsson (2018) highlighted the impact of spatial structure on communities and crimes. Ratnayake (2017) argued that spatial environments might influence an individual's feelings of fear and criminal behavior.

To sum up, safety and security issues constitute a component of social sustainability. Furthermore, to guarantee socially sustainable development in urban informatics and, finally, socially sustainable development in cities, the principles of social equity provide an applicable approach to achieve such development. Therefore, the principles of distributional, recognizable, and procedural equity offer a solid ground for developing urban informatics in the future with the aim of supporting citizens' experienced security.

Framing Urban Informatics into Wider Contexts of Sustainability and Experienced Security

As discussed above, urban informatics, social sustainability, safety, and security are entangled in various ways. To gain a deeper understanding of these connections, we integrate different aspects of social equity, which are underpinned by social sustainability, into urban informatics. We then reflect on these dimensions—distributional, recognitional, and procedural—within the two focused domains of urban informatics application, namely, safety and security (see Table 2.1).

Urban informatics and distributional equity aim to provide information to all equally, ensuring access to each and every individual. This

Table 2.1 Urban informatics and the aspects of social equity

	Characteristic of urban informatics in context of safety	Characteristic of urban informatics in context of security
Distributional equity	Post Ad hoc Resilience Accessibility Data literacy Media literacy Real-time Rapid changes Accuracy Support in the case of emergency	Prevention Ad hoc Accuracy Support well-being and quality of life
Recognitional equity	Coverage Critical target groups Valid data sources Recognition of responsible stakeholders Recognition of the involved parties	Coverage Recognition of responsible stakeholders
Procedural equity	Ad-hoc participatory processes Short-term structures Collaboration	Proactive participatory processes Long-term structures Collaboration

principle guarantees that access to information is ensured. Apparently, not only should devices and networks be available to all citizens but information should also be delivered in an understandable manner, for example, by using language that the reader can easily understand. The climate change experts in the latest report by IPCC (2023) highlight this aspect of language issues, arguing that in urgent cases, providing critical information in the citizens' native language is critical. In addition, ensuring proactive communication is essential. Therefore, when designing technologies such as censoring and warning systems, the urban poor, who lack access to appropriate technology, should be included in the design process.

Urban informatics and recognitional equity place emphasis on the recognition of target groups and the clarification of those who are responsible for this identification, particularly in ad-hoc situations. This responsibility is of paramount significance. In the latest IPCC report (2023), experts highlighted that even if local communities have been the target groups of urban informatics, attention should also be paid to target groups at the regional level. For example, extreme floods and wildfires usually occur in a broader area beyond the boundaries of a single local and geographically bordered community. Consequently, it is critical that the different stakeholders at the regional level have the ability and skills for collaboration.

Urban informatics and procedural equity aim to safeguard the two other social equities. In practice, this means that the structures and processes of urban informatics that are related to safety and security are designed in such a manner that the distribution of information is ensured and all the involved parties are recognized.

The distributional and recognitional aspects of social equity are quite often ensured by public authorities and are expert driven. In addition, it is typical for safety issues to be overseen by authorities, whereas security issues, along with procedural aspects of social equity, are more citizen-driven matters.

Discussion and Conclusion

This chapter discusses the connections between sustainability, security, and urban informatics from the citizens' perspective. Recognizing these connections is significant for several reasons that are connected to each other. First, the current environmental challenges, such as climate change and threat to biodiversity, are acknowledged along with their impact on citizens' everyday life. Second, as the amount of data in urban environments grows, processes and accessibility issues are addressed to ensure equality and democratic decision-making processes. Third, security is one of the domains of urban development, and part of that is subjectively experienced security, which is a component of citizens' well-being. The social dimension of sustainability is connected to equality and provides an approach for addressing related issues. Meanwhile, distributional, recognitional, and procedural processes of urban informatics present a framework for achieving the aim of ensuring the security of urban citizens through the utilization of urban data in different contexts.

The drawing of these connections between sustainability, security, and urban informatics is in alignment with earlier findings on social sustainability and smart governance of cities presented by Marsal-Llacuna (2016), who argued in favor of citizen-centeredness of city policies and local governance and underscored the need for indicators for measuring the safeguarding of citizens' rights in the city. By incorporating distributional and recognitional aspects of social equity into urban informatics, with experts shouldering responsibilities and authorities overseeing safety issues, we could facilitate social sustainability in safety issues. In the context of security issues and the procedural aspects of social equity, by adopting more citizen-driven approaches, urban informatics could promote experienced security in urban environments.

So far, a majority of urban informatics development and research has focused on environmental or economic sustainability issues rather than social sustainability. Furthermore, despite the recent attempts to shift from technology-driven to human-driven design and development in urban informatics, challenges remain. Simultaneously, the need for accurate, relevant, and valid information that is accessible and easy to

understand before, during, and after the accident or incident is evident. By focusing on the characteristics of urban informatics with an emphasis on distributional, recognitional, and procedural processes and by ensuring social equity in these processes, we could enhance subjectively experienced security, which constitutes an integral component of the well-being of citizens.

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