Why distance matters:
The relatedness between technology development and its appropriation in smart cities

How does the distance between the development and adoption of technology determine its affordance? By referring to the sociomateriality literature, I discuss why the corporate-driven push of technologies into smart cities can lead to ineffective outcomes. This review paper then argues that technologies should be locally built, with a stronger connect between the humans in cities and the technologies being developed and implemented, in order to achieve technological affordance. Finally, I identify a number of research avenues to understand technology-human connect in smart cities.

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1. Introduction

Smart city technologies offer an array of opportunities for cities to engage in sustainable socio-technical transitions (Lex et al. 2019). Simmons et al. define transition in cities "as an innovation process in incorporating radically new reflexive governance design in shaping structural transitions within complex urban socio-economic systems" (2018, p. 242). The transition under the tag name of "smart cities," are connected to their level of advancement in adopting digital technologies. Accordingly, a smart city "counts on advanced [digital] technologies to enhance the monitoring and control of the city's critical infrastructure components and services" (Mohamed et al. 2020, p. 2). These technologies include the new generation hardware, software and network technologies help to generate enormous amount of data, which are then analyzed using artificial intelligence, thus assisting cities to plan and use resources effectively (Popham et al. 2020; Hatuka and Zur 2019; Yeh 2017).

Literature on smart cities highlights that cities across the globe face crisis, partly because population growth and outdated infrastructure limit their potential to address growing needs. Ardito et al. (2019) accordingly argue that due to the changing landscape, urban planning has become an extremely complex task, which forces urban administrators to depend on digital technologies as part of their strategy to upgrade urban infrastructure. Although digital technologies come handy for enabling socio-technical transition, they most likely fail to deliver because of the distance in smart city projects between technology creation[1] and its adoption. The technologies used for achieving transition are typically envisaged by corporate firms that push them ubiquitously into cities. Such corporate visioning has received sharp criticism in the

[1] "Technologies" and "digital technologies" are used interchangeably in this article.

literature (Kummitha 2018; Datta 2015). As Martin et al. (2018, p. 269) highlight, “urban studies scholars have developed a collective critique of the neoliberal vision of the smart city,” challenging the tendency to overlook the different types of urban fabric and place-based differences (Hollands 2008; Kuk and Janssen 2013).

While criticism in the smart city field focuses on entrepreneurialism (Kummitha 2018) and corporate visioning (Datta 2015; Kummitha and Crutzen 2017), very little attention has been given to why corporate driven top-down technology push fails to attain technological affordance. Gaver (1991, p. 81) defines affordances as implying that “the physical attributes of the thing to be acted upon are compatible with those of the actor, that information about those attributes is available in a form compatible with a perceptual system, and (implicitly) that these attributes and the action they make possible are relevant to a culture and a perceiver.” Technological affordance requires greater connect between the development and adoption of technology. Thus, it is necessary to understand the mechanisms that result in technological affordance due to the heightened importance given to technologies in urban transition. Against this background, I refer to sociomateriality literature to discuss why corporate driven technologies raise affordance related concerns. Overall, this review article aims to argue why the distance between technology development and appropriation determines technological affordance, and then identifies a number of research avenues to enhance our understanding of the human-technological connect in smart cities.

The paper is divided into four sections. In the second section below, I explain the methodology adopted. The third section discusses the implications of distance between technology development and its appropriation. The fourth section then details the concerning aspects of

technology development for smart cities. Finally, the fifth section discusses future research avenues to strengthen this stream of the literature.

2. Methodology

Answering the call for papers for the 50th anniversary issue of this journal, I conducted a systemic review of the literature published in this journal on the themes of sociomateriality and smart cities. I used search phrases such as "smart cities," "smart city," and "sociomateriality," and included papers published up to May 2019, so as to offer nuanced understanding of the relevant and most recent literature. I found a total of 54 published papers on smart cities and six on sociomateriality. Although the significant representation of smart city papers reflects the importance given to this topic, I was surprised by the low number of sociomateriality papers. To gain further insights from the sociomateriality literature, I searched in Scopus using "sociomateriality" as a search term and found 535 papers as of May 2019. I then decided to retain only those publications with at least 100 citations for further reading: 16 articles matched this selection criterion. Finally, a total of 76 publications were used for the review. This number is similar to that used in other review papers published in the journal (Kummitha 2019).

I reviewed all 76 papers using a multi-level content analysis approach. Content analysis is defined as "a research technique for objective, systematic and quantitative description of the manifest content of communications" (Berelson 1992, p. 18). It helps to derive analytical constructs from the text being reviewed. A multi-level approach is needed because the literature is from two different streams – sociomateriality and smart cities. The analysis focused on three specific aspects: the first related to sociomateriality, and the second and third related to smart cities. For the papers on sociomateriality, the key issue is why the distance between creation and adoption of technology raises questions regarding technological affordance, so the analysis

revolved around content concerning technology creation, its adoption, and the distance between them. For the smart city papers, the first key issue is how smart city technologies raise affordance questions, so I focused on finding why technologies are developed in one location and then applied to others, the role of corporate firms in developing the technologies, and the nature of the critique against this mode of development. The second key issue is to identify research avenues for strengthening the human-technology connect in smart cities.

3. Technology and Organizations

In this section, I will first discuss the importance of technology for contemporary organizations and society. The paper then proceeds to discuss sociomateriality and structuration and their relevance to the development and appropriation of technology.

3.1 Technology

The role of technology in advancing human development has long been advocated (Solow 1957; Barley 1986; Orlikowski and Scott 2008; Orlikowski 2007; Garud and Rappa 1994). Technologies drastically transform the way we live by advancing the effectiveness of organizations and societies (Orlikowski and Scott 2008). In the case of smart cities, digital technologies help city governments and municipalities to efficiently handle problems arising from changing urban landscapes (Kummitha 2018). Given their propensity to influence societal functioning, technologies are expected to leverage human potential and help organizations (in this case municipalities, city councils, and local governments) to actively address complex social problems. Three specific elements are crucial – technologies, organizations, and humans – and

their combined potential determines the effectiveness of socio-technical transitions once they are implemented.

Given their transformative power and relevance to improving organizational efficiency and advancing social order, technologies have received significant research attention (Barley 1986, Orlikowski 1992). There are two main research streams that connect organizations and technology: i) the technology stream, and ii) the sociomateriality stream (Barley 1986, Orlikowski 1992, 2000). While the former focuses on the development, assembly, and production of technology, the latter focuses on the social context of technology, including but not limited to technology appropriation in a social context and its effect. This paper focuses on the latter research stream.

Technology was initially considered as an artifact, whose impact on society was said to be objective. Although technologies have transformative *powers,* later research has proven that their *potential* is subjective to the social context in which they are used (Orlikowski 1992, 2000; George et al. 2012). The social context offers a necessary cognitive frame that would require technological solutions (DeSanctis and Poole 1994). Humans who are stuck in a given social problem represent the social reality and open cognitive frames, based on which effective technologies may be developed. No matter what level of expertise organizations bring to technology development, it is the discretion and needs of users that dominate the context and influence the usage of technology.

In fact, social problems offer a necessary background for developing technologies. For example, Poole and DeSanctis (1990, p. 176) highlight that "Social processes create the condition for the evolution of technologies." Accordingly, Clark and Fujimoto (1991) emphasize that the design, manufacture, and marketing of technology must address problems faced by the people. The physical setting in which humans experience the problem is considered to offer clues to the depth of a problem and possible solution paths (Schon 1983). Thus, innovative problem solving must be context specific, embedded in social systems and physical settings (Tyre and von Hippel 1997).

3.2 Understanding sociomateriality

Researchers have long focused on understanding the influence of technology on organizational growth and the role of organizations in building and appropriating technologies (Orlikowski 2007; DeSanctis and Poole 1994). It was initially assumed that technology is developed elsewhere and then adopted into a social context. This view has two premises: i) that technology influences organizations and humans objectively, and ii) that the production and usage of technology are hardly related. In other words, early organizational studies considered technology as a material factor, ignoring the role of human agency in the technology development and adoption and thus considering technology as external to the human context. However, more recent research has elevated the role of human agency from a passive beneficiary to an active creator and user (Kaplan and Tripsas 2008).

The dichotomy between the subjective and objective nature of the world offers a cue to understand the nature of socio-technical reality. The Weberian model posits that the social

system is a result of fruitful human interactions, which considers that the overall structure is subjective in nature, created and bounded by human agency and action. On the contrary, the Durkheim model frames the social system as an independent constraint on human action, creating objective social reality. Based on the Durkheim model, organization theorists initially answered questions concerning how technological change influences social systems. Because technological development and its adoption require different levels of expertise and matching resources, organizations that succeed in offering the combination of necessary resources will eventually succeed in markets, whereas those without such resources at hand will be outperformed by competitors. Later developments in the literature have rejected such technological determinism by recognizing that the mutual relationship between technology and social system is essential. A social system will be optimized by the proper appropriation of technology within it. The sociomateriality perspective drove the research by tightly coupling social (human) and technical realities. Sociomateriality refers to the connect between social and material elements in everyday life. This perspective largely focuses on the different mental frames humans apply to the usage while adopting technologies.

To offer a nuanced understanding of sociomateriality, Leonardi and Barley (2010) propose five constructivist perspectives: perception, interpretation, appropriation, enactment, and alignment. The perception perspective focuses on how people perceive a given technology and its usefulness, thus concentrating on the usage. Perception is derived from people's attitudes, beliefs, and values, rather than the authoritative determinism of a *technological push*. Accordingly, social influence is a deterministic factor in one's choice to adopt and use a technology. For example, in an empirical study in a petrochemical company, Fulk et al. (1987)

found that the employees' likelihood of technology usage was determined by social influence. However, later studies found that although social influence initially determines one's perception on using a technology, this perception subsequently changes based on emergent understanding and learning of a given technology (Karahanna et al. 1999).

The interpretation perspective concerns how people use a technology, rather than the causes of its adoption. It emphasizes the role of "familiar frames" in assisting the user to make sense of the new technology. In other words, past usage of a familiar technology may facilitate using a new technology. Among several technological frames, the one whose elements are closely associated with the intended audience (Kaplan 2008) has a higher likelihood of achieving cognitive resonance (Giorgi, 2017). For example, Hargadon et al. (2001) highlight that the technological frame of Edison's electric light resonated among the audience by reminding them of gas, which was a familiar and a trusted technology. As another useful example, the familiar frame of Microsoft windows 2007 is useful when users start to interact with Microsoft windows 2015. Orlikowski and Gash (1994) found that in the absence of guidelines on Lotus Notes, which was specifically designed to support group tasks and collaborations, consultants only used it for general emails, based on their familiar frame. Meanwhile, Shane (2000) emphasized that a single technology was used in eight distinct ways by eight individuals he interviewed. This perspective is also supported by later studies (e.g., Gopal and Prasad 2000).

The appropriation perspective concerns whether users deviate from the designers' view on how a technology should be used (Leonardi and Barley 2010). Watson et al. (1988) found that a group-based support system intended to enhance participation equality and raise confidence during

decision making was only used by a few students to accomplish their tasks in the laboratory. While some participants used the software, others used pencil-and-paper aids or made decisions without any of them.

The enactment perspective focuses on how people use technologies, especially how work practices evolve with technological usage rather than cognition or norms. Social construction is a result of such usage. Orlikowski (2000) opines that the starting point of this perspective, unlike the appropriation perspective, is understanding human action to create structure through its interaction with technologies. By contrast, the alignment perspective focuses on how an organization restructures itself to adapt to a new technology. It further focuses on understanding how social orders and technologies configure with each other. Barley's (1990) CT scanner study highlights how a technology helped to create less hierarchical work structures among the employees of two hospitals. Edmondson et al. (2001) later found a similar pattern of surgeons, nurses, technicians, and anesthesiologists becoming less hierarchical and more collaborative.

To better understand the human-technology connect, scholars have deployed several theories including structuration theory (Sahay 1997; Orlikowski 1992, 2000), actor-network theory (Latour 1987; Law and Singleton 2003), and institutional theory (Barley and Tolbert 1997). However, given the active role agency plays in creating, adopting, and appropriating technologies and thereby facilitating the structuring process, structuration theory has gained currency (Orlikowski 1992; DeSanctis and Poole 1994; Orlikowski and Barley 2001; Singh et al. 2015).

3.3 Technology and structuration

The interplay between technology and organizations has been an interesting research area of organization studies (Orlikowski 1992, 2000; DeSanctis and Poole 1994; Orlikowski and Yates 1994). Structuration theory offers nuanced understanding of the influence of technologies in organizations. It was first adopted to understand the social context of technology as early as the 1980s (Barley 1986; DeSanctis and Poole 1994; Poole and DeSanctis 1992). Orlikowski (1992) and others used the theory to argue that technologies shape action, and thereby create social structures. Giddens' structuration is employed to understand the connection between technology and social action (Barley 1986), the role of social practice (Orlikowski 2000), and material aspects of technology (Archer 1995). The dualism of society–individual and agency–structure is a central feature (Jackson 1999).

One of the fundamental questions that has inspired structuration research is why people respond differently to the same technology. Studies have sought to understand how individual attitudes, beliefs, and values influence their level of technology adoption, thereby resulting in varying levels of impact. Research has examined the role of human agency in the appropriation of technologies into routines and in achieving technological affordances. Both the potential of human agency and the surrounding social context influence the potential implications of technologies (Barley 1986; Bijker et al. 1987; Orlikowski 1992). Actors operate in a given social order or structural context, and accordingly attribute different meanings to the material properties of a technology (Orlikowski and Gash 1994, Lyon 1994).

Giddens advocates viewing structure through a duality lens: “by the duality of structure I mean that the structural properties of social systems are both the medium and the outcome of practices that constitute those systems” (1979, p. 69). Barley (1986) affirmed that the process of structuring involves an interplay between structure and agency whereby process shapes human action, and vice versa. Thus, human agency and structure facilitate each other through their intertwined relationship. Knowledgeable human agents enact the structure; thus, we should regard structure as both a constraint on and an enabler of human aspirations (Giddens 1976). This understanding reinforces that structure is not static but a continuous process enabled by the actions of human agency.

The duality principle emphasizes that social structure is created by human action, which then serves to foster future human action (Kuk and Janssen 2013). In this view, structure is an abstract property of a social system where “man actively shapes the world he lives in at the same time as it shapes him” (Giddens 1984, p. 21). Following Giddens, Orlikowski and Robey (1991) emphasize that technology constitutes an important component of structuration. Accordingly, the development or use of technology is claimed to be central to the process of structuration, thus necessitating understanding of the role of human agency in creating technology and then allowing the structure to be institutionalized.

Structuration theory places human agency and technology as mutual enablers (Orlikowski 1992). Regarding the enabling process, early research made a crucial contribution by highlighting that, in a social context, the effect of advanced technology is less a function of the technology itself than of how it is used and appropriated by users (DeSanctis and Poole 1994). For example, several studies have found variance in attitudes toward or usage patterns of the same technology

across groups. Thus, the mutual influence that characterizes the *duality of structure* (Giddens 1976, 1979, 1984) is seen as a crucial process. Structure formation results from the ongoing relationship between agency and technology (Barley 1986). Structure is said to be a process that institutionalizes duality. Given their objective nature, technologies do not function if not incorporated into everyday practices (Barley 1986, Orlikowski 2000).

Human agency is the focal actor in the development and appropriation of technologies. Although human agents have different backgrounds and levels of expertise, representing varying power dynamics, the social context in which a technology is created bears the burden of its co-creation, attributing a variety of meanings to the technology (Orlikowski 1992). In summary, when organizations develop technologies without taking local realities into consideration, this creates problems when they are appropriated in a different place to their development location. I find that this trend is prevalent in smart city industry, where technologies are typically developed elsewhere and force-fitted into cities to help them navigate the rapid urbanization process.

4. Technological utopia – A contextual analysis of smart cities

Cities' progressive development toward becoming smart cities is driven by the intent to adopt digital technologies (Mora et al. 2019a). These technologies offer local governments the necessary tools to engage with and respond to the needs of urban dwellers (Hatuka and Zur 2019). Residents with access to digital platforms will use them to enhance their participation in urban governance. There are four specific sets of technology users in smart cities. The first set comprises those who manufacture these technologies, which could be employees of the corporate firms, who operate smart city projects on behalf of city governments. In large smart cities,

corporate firms generally deploy the digital technologies and use the big data they generate to detect trends, which help government representatives to make informed decisions. Second, when technologies are locally driven, communities and citizens develop these digital technologies to aid government administration (Kummitha, 2019). The third set of users comprises government representatives who use these technologies to detect trends and better plan city-level services. Fourth are the communities that use the technologies developed by corporate firms and by local developers. For instance, they often use the digital platforms to engage in a dialogue with government authorities and share their data in order to enhance efficiency at city level.

Although initial investments into smart city projects have come from governments, private firms quickly moved into the space to benefit from growing urban needs. For instance, Camboim et al. (2019) highlight that in the Barcelona smart city project, despite initial interest from the government, it was the corporate sector that immediately seized the initiative and benefited significantly from tax breaks and new rules on both land and financial incentives. In India, although the national government initially offered about USD 7 million to each smart city under its plan to create and promote 100 smart cities, the overall aim is to attract private firms to invest and help city-level governments to withdraw from urban development. As a result, there is criticism in the literature that the corporate-driven technology visioning of smart cities fails to meet the growing needs in cities (Kummitha 2018; Mora et al. 2019a;).

One of the problems with the corporate-driven approach is that corporate firms, driven by their profit motives, approach cities to sell the very same technologies they developed for different cities; this neglect of local realities raises questions about technological affordances (Kitchin

2014). As McFarlane and Söderström (2017, p. 2) emphasize, current smart city plans have tended to picture each city as a "blank canvas upon which powerful sophisticated technology can simply be overlain and made to work in straightforwardly useful, new ways." Consequently, smart city technologies often ignore place-based differences and the local cultural and community context (Praharaj et al. 2018). The general justification for the technologies being force-fitted into cities is that firms are generally equipped with the necessary knowledge to generate technologies. Cohen et al. (1972), for instance, emphasize that firms are a bundle of solutions in search of problems. This view places firms at the center of solving problems, through application of the infinite knowledge vested in their employees. Similarly, smart city technology development typically results from mental frames or technological concepts derived by the employees of such organizations, most often by the corporate consultants who travel to different cities to grasp knowledge that they then transfer to the concerned corporate office where the technologies are created. Carlson (1992) argues that technology development is not always related to problem solving, as the inventors may not have correctly understood the problem; rather, they construct the problem based on their unique skills and ideas for developing technologies. This very skill set limits the effectiveness of technologies in different urban landscapes.

Pinch and Bijker (1984) highlight that technology exists because of the negotiations that take place among people of diverse nature in the society. However, the process adopted to develop technologies in smart cities has most often been restricted by the manufacturing firms' level of understanding and sense making. When the technologies are developed without considering local context, the different people who work in these firms may bring different levels of mental frames

to the development process. However, through a process of negotiation, "consensual validation" may be attained (Munroe 1955; Leonardi and Barley 2008; Howcroft and Wilson 2003). As technology development has largely been an in-house practice for these firms, where employees from different divisions come together to develop technologies, multiple frames are perceived during their usage by the users as the society is polarized in nature where people from different backgrounds use such technologies (Giorgi 2017; Leonardi 2011; Seidel and Mahony 2014; Tschang and Szczypula 2006). However, urban problems are context specific and have local flavor. Addressing these problems is a complex process, and they may not be understood by the sense making of organizational employees whose knowledge is used to develop technologies.

As a city combines people from different groups with a variety of interests, social polarization places actors at different levels. Actors do not hold the same bargaining power in developing a technology (Zuboff 1988; Barley 1986). Consequently, as Leonardi and Barley (2010) emphasize, certain sections may pressurize others to appropriate a given technology. In such a context, technologies gain legitimacy through use of force and dominance (Garud and Rappa 1994; Zuboff 1988; Barley 1986). When technologies are developed without considering local relevance or actors, then their misrepresentation of local realities can create further polarization. For example, Leonardi and Barley (2010) highlight that scholars have ignored the politics involved in the development and appropriation of technologies. Due to social polarization and the failure to accumulate local-level knowledge in developing technologies, urban communities hold different levels of bargaining power at various stages of technology development and appropriation. As the extant literature highlights, in the event of a mismatch between a new technology's intended and actual use, users generally adapt or metamorphose the technology to

facilitate their activity (Pollock 2005; Tyre and Orlikowski 1994; Orlikowski 1996). However, the literature further emphasizes that it is hard to change the technologies once they enter the social context in which they are expected to work (Basalla 1988). The connection between social settings and technologies is heavily drawn by the sociomateriality literature.

The idea for a new technology involves not just a solution but also the construction of a problem. Though many cities face similar problems regarding traffic, pollution, green spaces, poverty, and citizen empowerment, the urban landscape differs from one city to another, creating the need for customized technological solutions. However, in reality, the same technologies are used in different smart cities. Leonardi (2011) articulates that when innovators discuss solutions prior to identifying problems, this results in innovation blindness. Accordingly, when innovates focus on solutions instead of problems, then they end up supporting their own technological frames rather than connecting the technological frame in the problem context and showing their potential match. This trend is predominantly visible in smart city technologies, which are largely imposed into local systems without understanding the context. Smart city technology vendors have been promoting "one size fits all smart city in a box" technologies (Kitchin 2014, p. 10). This approach makes no effort to understand the uniqueness of local reality, people, and culture. One such key technology is IBM's Intelligent Operations Center, which includes several technology sub-systems originally designed for Rio de Janeiro (Brazil) and subsequently sold to different cities (McNeill 2015). Further, IBM has offered consultancy services on transforming cities as smart cities.

Townsend (2013) expresses concern at multinational corporations controlling smart city planning, given their aim to achieve economies of scale by simply replicating the same technologies everywhere. In fact, the global presence of multi-national firms facilitates the transfer of technologies from one city to another (Buuse and Kolk 2019). Vanolo (2016) accordingly argues that local knowledge has been overlooked in smart-city-based technology development and adoption. Consequently, these digital technologies often fail to achieve technological affordance. As these technologies are not tailored for the local context, the effects of their local interpretation may also raise concerns. For instance, analysis and reporting of the big data collected by digital technologies may be driven by human biases (Popham et al. 2020). Meanwhile, the algorithms generated by artificial intelligence may discriminate against certain social groups and raise privacy concerns (McDermott 2017). One possible outcome is the governing authorities ignoring the residents of urban slums, which Longo et al. (2017) term "digital invisibility."

Algorithms are made by people and they make choices. Thus, such algorithms may overly simplify the situation and ultimately guide administrators to make inefficient policies (Bunders and Varro 2019). Human interpretation of the situation may ensure that decisions are subjective in nature. Kummitha (2020) shows how technologies are used to different ends in smart cities to control a pandemic. He highlights that humans mediate the usage of technologies based on the political and institutional context in which they are implemented. Hollands (2015) further highlights that technological solutions may not, in fact, be necessary for certain urban problems. However, the questions of when and how city administrators should override the trends generated by technologies remain largely unanswered in the literature. Smart governance

requires smart administrators that can use these technologies in an appropriate manner (Clarke and Margetts 2014). However, the literature articulates that smart city administrators do not generally have the necessary skills and competence to manage these technologies on their own (Winden and Buuse 2017). For instance, Ranchod (2020) highlights that administrators in South African cities have not acquired the necessary skills to generate, integrate, and use big data for decision making. The lack of such competence often results in project failure (Nam and Pardo 2011).

When smart city technologies are created by corporate firms, they hardly take local knowledge into consideration. Corsini et al.'s (2019) bibliometric analysis revealed that public participation and community involvement have not received any attention in the construction and operation of smart-city-based technology projects. Accordingly, Meijer et al. (2016) criticize smart city technology providers for attempting to copy good practices, and argue that they should create their own institutions to strengthen human capital in cities, which would help them to create technologies locally. As discussed in the sociomateriality literature, technologies may fail to achieve appropriation in cities, when they are force fitted without taking the local context into consideration.

Further, in smart cities, technology is seen as an end in itself, rather than a means to achieving the larger ends of addressing real city problems (Kummitha and Crutzen, 2017; Trencher 2019). As Sepasgozar et al. (2019, p. 106) contend, "Due to a strong corporate influence on smart city development, the discourse on smart cities has been dominated by promotional and marketing information over the last twenty years." The active participation of corporate firms causes

communities to worry about their freedom and privacy (Moustaka et al. 2019). Kostakis et al. (2015, p.124) argue that the "citizen perspective is often ignored in the smart city discussion. While technology is a powerful tool that helps improve urban infrastructure, citizen engagement is essential to make cities truly sustainable and livable." In fact, referring back to the sociomateriality literature, the corporate firms that develop smart technologies in one city and force-fit them into different cities make no effort to understand local realities and cultural context, which is a precondition to achieve affordances. The users in different cities may use the technologies based on their own perception, rather than as the developers intended, thus failing to use them to best effect out.

Andreani et al. (2019) argue that smart city technology is employed to construct a technology vision for cities. They further highlight that when the objective revolves around optimizing urban systems, then the technology will invariably take over the process, sidelining both creative and human aspects. Because super-efficient technological action leaves little room for human action, the top-down nature of technology development and implementation provokes concerns about agency participation and the larger interests of society. Greenfield (2013) shows that the corporate designers of Songdo smart city (Korea), Masdar smart city (UAE), and PlanIT Valley smart city (Portugal) all eschewed local knowledge. Such top-down technology visioning has yielded significant benefits for the corporate firms in terms of maximizing their profit potential. Thus, the connect between the humans in cities and the technologies being developed and implemented remains a major research gap regarding smart cities.

Further, cities are ever evolving. The combination of social, political, economic, and cultural aspects determines people's behavior. As the city fabric changes, the need for technology and its

effects on the urban context significantly transform. Due to the resulting mismatch between the development and adoption of technology, many smart city technologies provided by corporate firms prove to be ineffective. The social, cultural, and technical difficulties at the grassroots level are largely driven by the top-down imposition of technologies, as the ever-changing urban landscape overrides the tech-utopian vision that corporate firms envisage. For example, as part of its smart city promotion strategy, IBM's vision for Philadelphia included a dedicated mobile application, which was expected to create employment opportunities for the unemployed. The vision was fully based on outsider knowledge and was overridden by local poverty and messy reality of poor governance. In practice, the mobile application hardly played any role in achieving this vision. Because IBM had very little knowledge about the local context and failed to include local people in planning its technology development and setting the objectives and aims, its technology vision and techno-based solutions ultimately proved to have little relevance (Wiig 2015).

Having recently realized that corporate-driven technologies are much less effective than promised, a number of governments have started to explore bottom-up technology development by offering more avenues for citizens to create necessary technologies (Kummitha and Crutzen 2019). Accordingly, recent literature emphasizes the increasing prominence of interactive governance (Bode and Firbank 2009) or collaborative governance (Nilssen 2019), also known as the quadruple-helix model (Kummitha and Crutzen 2019), whereby public and private networks are built to create technologies. For instance, in the Jenga business model proposed by Brock et al. (2019), companies encourage end users and customers to co-create technologies. These recent developments aim for better understanding of the technologies developed based on

grounded knowledge and how they are appropriated. We need researchers to conduct further studies on the human-technology connect in smart cities and its potential impact on society.

5. Future research avenues

Sociomateriality based discussion on smart cities raises a number of concerns about the potential of smart city based technologies. In order to gain nuanced understanding of socio-technical transitions in cities, I propose three research avenues to guide future studies on the development and appropriation of technologies. These avenues comprise organizational context, societal context, and multi-level interactions.

Organizational context

Smart technologies have been lauded for addressing urban problems. However, given the complexity of urban problems, technological interventions alone may not suffice. Overly focusing on technologies and diverting municipal budgets to technological solutions may be counterproductive to addressing other problems pertaining to citizens empowerment, poverty reduction, slum development, etc. For instance, Minetur's (2015) recent report highlights that the smart city strategies adopted by firms are largely disconnected from urban planning strategies. Thus, further research needs to focus on how city governments balance between different types of needs. It is important to understand how conventional urban planning may be better connected with technological visioning. For example, studies could explore how technology may be useful for slum development, poverty reduction, or enhancing women's safety in urban areas.

Understanding the local social and cultural context is a precondition for attaining technological affordance. As DeSanctis and Poole (1994) highlight, social problems represent social reality and offer necessary cognitive frames for technologies to be invented. However, affordance can be difficult to achieve when technologies are forced into smart cities. Future research could investigate what kinds of mechanisms corporates and governments should implement to ensure that the local context facilitates the adoption of such technologies, so as to achieve positive effects on the urban context.

Smart city technology developed by firms recalls the artifact-based discussion on technology, which considers technologies to have transformative powers on their own. However, for technologies that have been put into effect in city-level governance, it remains unclear how the organizational context influences their use (Orlikowski 1992, 2000; George et al. 2012). Governing agencies might employ these technologies in the manner intended by their developers, or they might modify them prior to appropriation to address the particular problems of their cities. Different cities have different ways of doing things, largely rooted in local phenomena. Users' discretion in how to employ a particular technology is a source of value.

It is also important to understand how different departments in firms or ventures come together to accumulate the information required to manufacture technological prototypes. Key issues include whether firms use their in-house expertise, or make collaborations with different social actors, or also include users in decision making. It would also be worthwhile understanding the participation of urban communities in technology development.

Social context

As social context sets the platform for technological affordance, the effectiveness of smart city technologies is difficult to ascertain. Future research should focus on understanding the impact of different technologies on cities and how the social and cultural contexts in different cities influence the same technology and its level of affordance.

Discussion around force-fitting technologies into smart cities raises an interesting question about how communities respond. Hardly any research has focused on how various social groups respond to this development, and there is very little understanding of how communities and pressure groups respond to or resist smart technologies or technological utopia. Future research could take this forward.

Although social influence is claimed to be a deterministic factor in technology adoption (Fulk 1987), hardly any urban studies research has explored how social influence allows cities to adopt particular technologies. The literature largely focuses on the corporate influence on adoption of smart technologies, and largely neglects the influence from communities and pressure groups. Thus, we need to know how they pressurize city governments to adopt specific technologies. It would also be useful to understand how city governments that use a specific technology due to pressure from communities or pressure groups then change their perception of the technology based on learning during its usage.

Other interesting questions include how users in city governments use new technologies, and whether they employ mental frames from technologies that are already in use, for instance by applying knowledge they have acquired by using computers to use smart-city-based technology. The earlier examples of the electric light and Microsoft windows 2007 may be useful for researchers to understand how existing cognitive reasoning helps in the adoption of new

technologies. Another relevant question is how different cities customize the same technology sold by corporate firms. Studies could investigate how individual values and beliefs influence cities' adoption or use of such technologies. For instance, the nature of the city and the way its people see technologies may influence a city government's approach to technology adoption.

Multi-level interactions

Technologies generally result from the interactions among conflicting social groups residing in cities. However, for smart city technologies, most of the development is undertaken by corporate firms, which then apply the same technologies to cities differing in nature without considering the local context (Kitchen 2014; McFarlane and Soderstorm 2017). For instance, cities that consulted IBM ultimately implemented the same IBM technologies with little local customization. In most smart cities, local authorities and communities hardly participate in the negotiation process for developing the necessary local technology, nor is any consensus sought from them. However it is not yet clear whether the users in local administrations or communities modify such technologies to ensure a match with their needs or with existing organizational and social practices.

A similar line of research is how the cities that have started to promote community-driven technologies, take the local context into consideration. It would be interesting to study how they encourage different players, including corporate firms, startups, and small and medium-sized enterprises, to take local context into consideration in the development and appropriation of technology. In this context, the quadruple-helix model may be useful (Kummitha and Crutzen 2019). Because the urban problems faced by different cities differ significantly, varying levels of technological solutions are needed in each local context. Physical settings and the social and

cultural habits in urban areas offer varying levels of insight into potential paths for developing customized technologies in the local context (Tyne and von Hippel 1997; Praharaj et al. 2018).

During collaborations over technology development and knowledge accumulation, powerful actors such as corporate firms, with abundant resources at hand, may enforce their own technological visioning (Yates et al. 1999; Orlikowski et al. 1995; Leonardi and Barley 2010). Thus, it would be interesting to understand how these collaborations remain inclusive of the views of different key players. Several governments are experimenting with innovative measures such as conducting hackathons or creating living labs. Future studies could explore the processes through which policies change and how communities come forward to create technologies.

Another valuable research agenda is how smart city technologies contribute to our understanding of dualism – where society and individuals work together to build technologies or where humans use their agency to form a structure called technology (Jackson 1999; Giddens 1976). Further understanding is also needed of how structure in cities facilitates the technology creation process and how various actors use this process to invent and appropriate technologies.

Conclusion

In this review article, I drew on sociomateriality literature to argue that the greater distance between technology development and its adoption in smart cities, the less effective the outcomes. Besides ongoing critique of the corporate-driven approach of pushing technologies into cities, there are growing calls to promote the enhancement of citizens' skills and competence, placing them in a better position to develop and appropriate locally developed technologies. The sociomateriality perspective employed in this paper helped enhance our understanding of human-

technology connect in smart cities. This paper seeks for future research that would analyze the human-technological connect in order to understand the effectiveness of technologies in smart cities.

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