Edges, Surfaces, and Spaces of Action in 21st Century Urban Environments – Connectivities and Awareness in the City

H. Patricia McKenna(✉)

AmbientEase, #541, 185-911 Yates Street, Victoria, BC V8V 4Y9, Canada
mckennaph@gmail.com

Abstract. The purpose of this paper is to introduce a philosophical and phenomenological perspective to complement, extend, and enrich algorithmic and network views of social media in support of connectivities and awareness in the city. The edges, surfaces, and spaces of 21st century urban environments are explored in relation to how social media is being used to support greater opportunities for awareness and in turn, for more meaningful engagement, learning, and participation in city life. The research design for this study employs an exploratory case study approach, a minimally viable social media space, and multiple methods of qualitative and quantitative data collection and analysis. Anecdotal evidence from informal individual and group discussions conducted in parallel with this study supports further data analysis, comparison, and triangulation. This work makes a contribution to the research literature across multiple domains and a conceptual framework is developed, operationalized, and advanced for connectivities and awareness.

Keywords: Awareness · Choice · Connectivities · Edges · Learning cities · Smart cities · Social media · Spaces · Surfaces

1 Introduction

The rapid growth of cities is posing unprecedented challenges and opportunities for society [1] and for education [2]. In response, this research explores social media technologies in relation to awareness in 21st century cities, communities, and commons [3], when used to foster meaningful urban engagement, participation, and learning. Theoretically, this work is situated at the intersection of social media and the information and communication technologies (ICTs) being developed as a strategy for cities to innovate their structures and their communities [4]. As such, this work is concerned with people and their awareness in the context of ICTs as aware technologies in the smart city. Berne [5] relates awareness to autonomy, claiming that awareness pertains to aliveness. According to Stone, Deci, and Ryan [6], autonomy "concerns the experience of acting with a sense of choice, volition, and self-determination." Awareness, as it relates to people and learning, "keeps changing all the time" and is "the totality of all experience" for an individual [7]. Using a city-focused social media space, this work focuses on people and their experience of edges, surfaces, and spaces for action in the city. Vander Veen [8]

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comments that "cities without people aren't cities at all" and perhaps Orgos, Inner Mongolia in northern China, described as the world's largest ghost city, provides an example of a city without the intended scale of people [9].

This paper is significant because it theorizes and explores awareness and the experience of city life in relation to choice and emerging understandings of the interweaving of physical and digital environments as smart cities. This awareness is particularly critical at a time when Brandt [10] for example, points to a kind of obliviousness in the United Kingdom where "nearly 100 percent" of the citizens "do not notice smart cities growing around them." Further, the philosophical, phenomenological, and theoretical work of Casey on surfaces and edges [11, 12], combined with a human geography perspective on spaces [13, 14], and urbanism thinking [15–18] are used to complement and extend the computational and algorithmic understandings of social media [19, 20] in the city. As such, this study looks at how awareness in social media-infused and technology-rich urban environments may be influencing choice and contributing to meaningful engagement, learning, and participation in city life.

Methodologically, the research design for this study employs an exploratory case study approach, a minimally viable social media space, and multiple methods of qualitative and quantitative data collection and analysis. Content analysis is employed inductively and deductively to gather insights from individuals across the city and from the research literature, respectively. Anecdotal evidence from informal discussions conducted in parallel with this study supports further data analysis, comparison, and triangulation.

What follows is a review of the research and practice literature relevant to the theoretical perspective for this paper, followed by a presentation of the methodology, the findings, discussion of implications, contributions and future directions, limitations and mitigations, and concluding comments.

2 Review of the Literature

A review of the philosophical and phenomenological literature is presented to complement and enrich the algorithmic and network perspective on edges, spaces, and surfaces in relation to people and social media in the city. In interdisciplinary fashion, a review of the human geography and urbanism literature related to theorizing on edges, space, surfaces, and the in-between is presented, followed by a review of contemporary urban environments in terms of awareness, infrastructure, and experience.

2.1 Edges, Spaces, Surfaces, and the In-Between

A discussion of the research literature on edges, spaces, surfaces, and the in-between is presented from an interdisciplinary perspective across the domains of philosophy, sociology, human geography, urbanism, the socio-material, and the legal/regulatory.

Edges. In an urban context, Lynch [15] describes the physical form of cities in terms of five elements – paths, edges, districts, nodes, and landmarks, noting that this contributes

to heightening attention and enriching experience. Drawing on the work of Dutch sociologist, De Jonge, on the *edge effect* [21], Gehl [18] applies the concept to urban areas "where the preferred stopping zones also are found along the borders of the spaces or at the edges of spaces within spaces." Gehl [18] notes that edge zones "offer a number of obvious practical and psychological advantages as a space to linger" concluding that "events grow from inward" as people move from inside a building, to outside, along the façade, and "from the edge toward the middle of public space." Gehl [18] cites the work of Alexander [22] in the context of "the edge effect and edge zones in public spaces", noting that, "if the edge fails then the space never becomes lively." Casey [11] provides an analysis of edges and discusses whether places have edges from a philosophical and phenomenological perspective. Defining places as "any spatial spread ranging from a bioregion or a national territory to a human settlement of any kind," Casey argues that places must have edges in order to be coherent. Casey identifies a relationship for places and edges, claiming that they interact and concluding that places indeed have edges, in the form of boundaries. Further, Casey adds that, "places as well as events" including experiences, "come fully edged." Casey adds that boundaries pertain to other entities including persons, groups, and so on. Characteristics of boundaries are identified by Casey as indeterminate, absorptive, and osmotic, as distinct from borders, as more fixed, precise, and distinct. Casey indicates that, "porous and vague is to allow, and sometimes to facilitate movement" [11] and that porous also denotes, to take in and to give out [12]. Where Casey notes that places intersect, Wapnick [23] reminds us that it is at the intersections that innovation occurs.

Thwaites, Mathers, and Simkins [24] note that "the two adjacent realms of the edge are not independent but are mediated by it and this means that edges have intrinsic permeability in their capacity for connectivity between realms." Thwaites et al. [24] cite Jacobs [25] who stated that, "the best streets have about them a quality of transparency at their edges." According to Casey [12] edges are also associated with margins and points of access. It is worth noting that this conceptualization of edges and boundaries gives way to the potential for extension to interactions with social media, the Internet, and other aware technologies.

Surfaces. Discussing urban form in terms of *settlement form* or the physical environment, Lynch [15] refers to "the spatial arrangement of persons doing things" and "the resulting spatial flows of persons, goods, and information and the physical features which modify space in some way significant to those actions" citing "enclosures, surfaces, channels, ambiences, and objects." Lynch [15] refers to continuity as "continuance of edge or surface" using the examples of "a street channel, skyline, or setback." Lynch further claims that "citizens converse, using the surfaces of the city." Schmitt, in Future Cities [26], notes that by looking beyond the surface of a building, a city, or landscape, much more invisible information becomes available that can be used for design and planning purposes.

Spaces. Lévy [27] interprets the concept of spaces as environments and spatialities as actors in the urban context while defining inhabiting as "a successful encounter between space and spatialities." As such, "the various spatialities and the multiple spaces that constitute a society are made compatible and take advantage of each other in a dialogical interaction" [27]. Thwaites et al. [24] cite Madanipour [28] who noted

that, "in practice, public and private spaces are a continuum, where many semi-public or semi-private spaces can be identified, as the two realms meet through shades of privacy and publicity rather than clear cut separation." Advancing space as "practice, problem, and theory", Lévy [13] notes that people are space, that "we are constantly changed by space", and that "we constantly change it through our acts." Further, Lévy [13] claims that we experience and create "contact, remoteness" in between "different kinds of nearness." According to Lévy, people are multi-sensorial; are able to interact with the world in multiple ways; and interact "through immaterial vectors" as in, telecommunications and the Internet as space, contributing to the importance of space in the digital society [13]. Baude [14] articulates how the Internet is a real space that responds to our need to overcome a range of things including distance and time. Baude argues that the space of the Internet is a new type of space and an innovation of space that is continuing to be evolved and remade based on our emerging uses.

In-Between. Casey considers that the in-between is not confined to the surface but rather, "has a depth of its own that is part of the surface itself" [12]. Speaking of transitional edges, Thwaites et al. [24] note that, "in the streetscape, this edge environment is widely recognized as having an important function in framing and forming space in between buildings", citing Jacobs [25]. Casey [12] argues that edges "open up possibilities" and "come in a plurality of types" and that "when we are in the midst of any activity we are *in-between* edges," as in, interspace. Casey speaks of "edges of things and events and persons that together constitute the in-between" where activities happen.

2.2 Awareness, Infrastructure, and Experience

Hildebrandt [29] points to the importance of "how the emerging ICT infrastructure reinvents us" and that "affordances such as a certain degree of autonomy cannot be taken for granted." As such, Hildebrandt [29] adds that "actual re-engineering and active participation in the design of the novel architecture of everyday life" are required, providing the context for a discussion of the practice and research literature on awareness, infrastructure, and experience.

Awareness. In an organizational and organizing context, Orlikowski [30] commented that, "I think people forget they have a choice" and in instances where "people recognize they have a choice they might not act on it" because "the consequences of that choice are often tough." Indeed, Orlikowski [30] states that "I'm not even sure people are aware that they have a choice" pointing to the importance of context and the identification of three components – "It's awareness, choice, and action." Reflecting on this interview with Orlikowski [30], Scharmer identifies a link between her work and "that of Arthur, Varela, Rosc, Bortoft, and Nan" in relation to "the different qualities of awareness from which we can choose to act."

Lévy [13] argues that it would be "an error to assign the smallest scale to the individual just because the human body is tiny in comparison with a city." Features such as mobility, multi-dimensionality of the senses (multi-sensorial sensors), and technology-enabled bodily movement "through immaterial vectors" give rise to a vast potential for reach and influence so that humans "are not reducible to the size of their bodies." Here the

intersection between people, technologies, and information gives way to emerging and expanding considerations for awareness and action in the city.

A typology of techno-effects was introduced by van den Berg and Leenes [31] to expand what they consider is a limited focus of techno-regulation that, "overlooks non-legal forms of intentional influencing on the one hand, and implicit, unintentional forms of technological influencing on the other." The first typology involves the concepts of *pervasive technologies*, *nudge*, *affordances*, and *techno-regulation* plotted in relation to the level of choice and compulsion on the one hand, and the level of user awareness, where the intention to influence behavior is present. The second typology features the concepts of *scripts*, *anthropomorphisation*, *the media equation* ("eliciting social responses to technology"), and *techno-regulation* plotted in relation to the level of choice and compulsion, and the level of user awareness, where the intention to influence behavior is unintended, implicit, and automatic. Hildebrandt [29] claims that "by providing a framework that goes beyond the usual dichotomy of effective or ineffective technological measures" van den Berg and Leenes "have opened a new field of research" important for "democratic legislators, courts and citizens as well as designers, producers and users of technological artefacts." Acknowledging that the study of techno-effects is "no straightforward matter", van den Berg and Leenes [31] caution that "predicting techno-effects always ought to be a contextual, technology-dependent matter" given the characteristics of different technologies along with variation of use by technology and user group.

Infrastructure. Cohen [32] identifies three generations or waves of the smart city with the current or third wave as Smart Cities 3.0 involving co-creation. Where 1.0 focused on the technology-driven smart city and 2.0 is city-driven, Cohen sees promise in a combination of all three. Leveraging 2.0 to enable and encourage urban entrepreneurship, Cohen advises that "cities must move from treating citizens as recipients of services, or even customers, to participants in the co-creation of improved quality of life." Expanding upon the notion of stocks and flows of goods and services, Lévy points to the importance of "stocks of experience and acting capacities" of people in urban spaces [13], a possibly relevant way of thinking about awareness and further endorsement for the emphasis placed on action and choice by Orlikowski [30]. Dourish and Bell [33] remind us that infrastructures are "normally taken for granted" and that "new technologies inherently cause people to reencounter spaces." Inverse infrastructure described by Egyedi and Mehos [34] as ad hoc, user-driven, adaptive development from the bottom up, broadens the potential scope of agency and involvement [35] and opportunities for awareness, choice, and action.

Experience. Dourish and Bell [33, 36] refer to the transformations that are emerging in terms of how "we experience and interact" as computation increasingly moves "off the desktop and into the world" around us "as an aspect of the everyday environment." The world of embedded and wearable technologies is explored by Dourish and Bell in relation to implications "for encounters with space" where space is held to be an infrastructure for both technology and the "experience of the world" [33]. Thwaites et al. [24] claim that "the properties of permeability and transparency are closely related" where the latter "enables us to experience the interplay of 'here' and 'there' by means of features which allow us awareness of nearby settings."

2.3 Summary

In summary, complex issues pertaining to aware technologies in urban environments give rise to the need for philosophical and phenomenological perspectives on edges, surfaces, spaces, and the in-between to complement and extend algorithmic and network perspectives. Additionally, the urbanism literature provides insight for leveraging social media interactions and discussions in the city in relation to awareness, infrastructure, and experience. As such, this review of the literature provides the theoretical perspective for formulation of a conceptual framework, depicted in Fig. 1, to guide exploration of the research questions for this study in terms of connectivities and awareness involving choice and action.

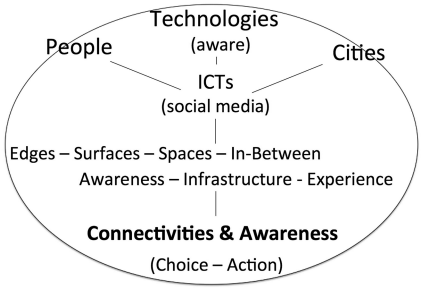

Fig. 1. Conceptual framework for awareness, choice, and action in 21st Century Urban Spaces

Research Questions.

Q1: Do edges, surfaces, spaces, or the in-between contribute to greater awareness in relation to choice in contemporary urban environments?
Q2: How do social media and other aware technologies support opportunities for action and choice in contemporary urban environments?
Q3: What is the nature of the relationship between connectivities and awareness for choice and action in contemporary urban spaces?

Propositions corresponding to the research questions are as follows.

Propositions.

P1: Edges, surfaces, spaces, and the in-between contribute to greater awareness in relation to choice in contemporary urban environments.
P2: Social media and other aware technologies contribute to emerging understandings of urban infrastructures fostering opportunities for action and choice in contemporary smart city environments.
P3: The experience of evolving urban infrastructures contributes to greater connectivities in support of greater awareness, influencing choice and action in the city.

3 Methodology

The research design for this study employs an exploratory case study approach incorporating multiple methods of quantitative and qualitative analysis. This study spans a 7-month timeframe from mid 2015 into 2016, across multiple small to medium to large sized cities in Canada and extending to northern Europe. Interest and involvement was sought from people 18 years of age and older. In parallel with this study and beginning 5 months earlier, anecdotal evidence was gathered over a 1-year period through informal individual and group discussions with people across the city. The methodology is described in more detail in Sects. 3.1, 3.2 and 3.3 in terms of the process used, sources of data collection evidence, and the analysis of data.

3.1 Process

This study invited a cross-section of people in the city in the use experience of an interactive, city-focused, minimally viable social media environment. Study participation accommodated individuals across six categories: city officials, business, community members, educators, students, and visitors to the city.

After registering for the study and sharing minimal demographic data (e.g., age range, urban location, and self-identification in one or more of the six categories), participants were assigned an anonymous alpha-numeric identifier and invited to share information about their city pertaining to noticing and ideas. Content contributed to the social media webspace was available for viewing, comment, and interaction by participants in real time. Follow-up, in-depth interviews and an optional online survey were used to explore the research questions under study.

3.2 Data Collection

This study utilized multiple methods of quantitative and qualitative data collection, including webspace activity, a semi-structured online survey, and in-depth interviews. Interviews focused on use experience with the social media webspace, content creation, and questions related to smart and aware cities. Anecdotal evidence [37] was gathered from people across the city in parallel with this study, through informal group and individual discussions conducted in local coffee shops, online/phone, and in urban workshop and other informal group spaces.

3.3 Analysis of the Data

Quantitative data analysis included the use of descriptive statistics. Content analysis was employed inductively for qualitative data emerging from interviews and discussions and deductively, drawing on terms from the research literature to guide data analysis. Anecdotal evidence from informal discussions gathered in parallel with this study supported further data analysis, comparison, and triangulation. Overall, data were

analyzed for an n = 16, spanning age ranges of people in their 20 s to their 70 s, and included a gender representation of 55 % male and 45 % female.

4 Findings

Findings are presented in Sects. 4.1, 4.2 and 4.3 in relation to the research questions, focusing on the three propositions explored in this study. A summary of findings is provided in Sect. 4.4.

4.1 P1: Edges, Surfaces, Spaces and the In-Between: Awareness

Common throughout interviews and discussions with individuals and groups was the concern with the face-to-face and the non-physical and how the two realms work together. For example, a city councilor emphasized that "its important to think of technology as a tool" and as an aid and an augmentation that "allows us to have a safer more vibrant city." An educator pointed to physical spaces in the city, such as a fountain, to bring people out and together. And a community member identified a range of intersecting modes of transport that can be used to move from point A to point B. A local community placemaker talked about ad hoc, pop-up events, stating that, "we like to do those to demonstrate how a space can change" and to "look at any given space and analyze what's working and what isn't and what could improve it."

The importance of multi-purpose spaces was identified by one participant who stated that, "the survival of cities is that they are these multi-purpose spaces." Thinking about surfaces in the city, an educator questioned whether the corporate advertising on a local building display screen could be "seen differently" in terms of purpose. A government official used Oldenburg's [38] notion of a third place to refer to coffee shops as the space in-between "home and work." This in-betweenness is further described as the connectivity that occurs between people. Referring to routes of connection in Toronto, a community member noted that "you have so many different choices" of getting from point A to point B, "depending on the weather, the traffic, who you are with." So, "the city allows you to make choices about how you are going to get from A to B" and additionally, "its not just allowing you to make choices" but enables "customizing your own experience." For example, "a series of underground liveliness" including tunnels and walkways were described where, "the city is allowing you to play in it" contributing to a "game aspect." From a technology perspective, a business-person spoke of connectivity enabled by GPS (global positioning systems) within the city as outside-in and more recent GPS developments within buildings in the city as inside-out. With the increasing pervasiveness of connectivity, this individual observed that "everyone could work at home but they choose not to" as witnessed by the emergence of businesses renting shared urban workspaces.

4.2 P2: Social Media and Aware Technologies: Infrastructures for Action

A city councilor recalled that, "we held our first interactive e-TownHall" featuring a discussion of the strategic plan for the city. So, in addition to the face-to-face meeting at City Hall, "we were able to get feedback from people sitting at home who were watching the livestream video." The councilor later commented that the social media space would be "one place where we will be looking to use online tools" in the development of a youth engagement strategy. The space of conferences was described by an educator in terms of bringing people together from around the world. When a conference session uses a speaker background screen of Twitter feeds it was acknowledged that, "you've got 500 people at a conference but you've actually got 5000 that are participating in that conference through the Twitter feed." In the case of the interactive e-TownHall meeting, a city councilor noted that, "not only did we have a packed house in person" there was "also, an overflow room" that "had hundreds of people watching the video, tweeting, sending direct messages that we could respond to." As such, social media was described by the city councilor as able to, "definitely create discussion and connections." An urban placemaker used the example of a blog as social media where a post about "library boxes" resulted in unexpected interest and interactivity, contributing to an interweaving of Twitter activity, Google mapping, new connections, engagement and participation, 'things' in the form of books, and video sharing.

4.3 P3: Urban Infrastructure: Connectivities and Awareness for Action

The importance of an elaborate fountain in an urban space was described by an educator in terms of how people gather in this space, take notice, speak to each other, pause, and interact. The fountain was described as a touchstone that "brought people out" where they would say, "did you see that, did you see, look at how neat that is." The fountain also contributed to 'fun' and "made people talk." The erecting of temporary overflow spaces by the city, in multi-purpose fashion, outside a main sports event in Toronto using a giant jumbotron television screen was identified by a community member as "bringing a city together," accommodating up to ten thousand people in an urban space. A European educator described a "mobile cloud-based app to capture and share insights, feedback, and knowledge" as a "simple, cost efficient" mechanism for "instant awareness" intended for "business, design, infrastructure, learning, safety, sport, and tourism." An urban placemaker described "ways to animate a space" using the example of a city parkade with embedded sensor technology that "plays different sounds as you go up based on where you are in the stairwell" and the "lighting changes." An educator in Finland commented that, "one thing I really like about the city is that it is compact" with "smart construction, including lights" aiding flows of traffic and pedestrians.

In the context of a discussion about inverse infrastructure initiatives, a technology entrepreneur articulated the plight of taxi drivers paying high fees in adherence with regulatory requirements, now confronted with a largely unregulated Uber travel movement. An individual in the tourism sector argued that the Uber travel movement is

creatively "piggybacking on someone else's infrastructure in a way that is win win." An engineering student identified an interest in speaking with local government and community members to look for "an opportunity maybe for making the city a little smarter" motivated by the hope of changing "people's minds so they follow a more green way." A business technology entrepreneur highlighted the importance of the "smart city thought process" as a "wonderful thing that connects all the pieces," including "people, community." Another educator suggested, "lets spend less time *finding* the connection" and more time "actually *making* it," adding that people "choose to live somewhere" attracted in part by "smart infrastructures" and more livable lifestyles.

4.4 Summary

In summary, Table 1 provides an overview of findings pertaining to the research questions and the three propositions under exploration in this study in relation to connectivities, awareness, choice, and action. Proposition 1, encompassing edges, surfaces, spaces, and the in-between, was found to contribute to connectivities, awareness, choice, and action in the city. Similarly, Proposition 2, encompassing social media and other aware technologies was also found to contribute to these four elements, as was Proposition 3, encompassing urban infrastructures such as mobility, public spaces, and multi-purposefulness.

Table 1. Proposition findings: connectivities and awareness for choice and action in the city.

	Connectivities	Awareness	Choice	Action
P1: Edges, surfaces, spaces, in-between	✓	✓	✓	✓
P2: Social media, aware technologies	✓	✓	✓	✓
P3: Urban infrastructures	✓	✓	✓	✓

5 Discussion

A discussion of the findings is presented in Sects. 5.1, 5.2, and 5.3, organized in terms of three components: connectivities; awareness; and the infrastructural elements of edges, spaces, and surfaces for action and choice. A summary of the discussion follows in Sect. 5.4.

5.1 Connectivities

Where urban spaces bring people together and encourage talking and interaction, the possibilities for connectivities were found to extend to other urban spaces as evidenced by the e-TownHall example provided by the city councilor, enabling participation through video connection, Twitter, and other social media spaces. The example provided by an educator of conference presentations accompanied by live Twitter feeds,

demonstrated the potential for global connectivities involving many people in addition to those physically attending the event. The sports event where the city created a temporary, community-accessible overflow space for thousands of people, aided by jumbotron screens broadcasting the inside event to the outside audience, demonstrates the adaptive and ad hoc creation of urban public spaces for interaction, community connection, and any number of creative initiatives. Pop-up, ad hoc events organized by urban placemaking networks, in conjunction with city officials and many other people in the community, demonstrate temporary alterations and interactions with infrastructure, enabling emergent connectivities with the potential to influence action, awareness, and choice, going forward.

5.2 Awareness

Engaging people in discussions about noticing, idea generation, and the use of social media and other aware technologies in the city revealed considerable interest in awareness about the city, smart technologies, and the smart cities phenomena. Where urban spaces can be designed to bring people together and encourage talking, connection, and interaction, the possibilities for awareness also emerged around the interweaving of such spaces with social media and other aware technologies. In a world where increasing numbers of people carry or wear a mobile device of some type, the potential for additional awareness generation emerges. For example, the blog about "library boxes" generated action and awareness in the form of tweets, photos, video, Google maps, and other mixed media. Thinking about surfaces in the city, an educator commented that the corporate advertising on a local display screen could be enhanced for more informative purposes beyond advertising, "if it was used differently." Used differently, public display screens can become spaces for deeper information sharing, content generation, awareness, interaction, and action.

5.3 Edges, Spaces, and Surfaces for Action and Choice

The social relevance of urban edges [17] was found to extend and become interwoven with edges, spaces, and surfaces for action involving the use of social media and other aware technologies. For example, the realization emerged that conference spaces have the potential to attract many more visitors when presenters open presentations to social media spaces such as Twitter. As such, the space for action, experience, and choice broadens, enabling new forms of engagement, learning, and participation. In a moment of realization about the interactive e-TownHall meeting, a city councilor commented that, "so in that way, that is an interactive experience that makes the city more real for those people." Discussion of the Uber travel movement in the context of inverse infrastructures enabled information sharing and new awareness and insights to emerge.

Urban spaces were found to become multi-purpose beyond traditional, physical notions, to incorporate the innovations in space afforded by the Internet, social media, and other aware technologies. Indeed, content generated in multi-purpose urban spaces opens the way for further multi-purpose potentials. As the spaces, edges, and surfaces

of the physical are made to connect and interweave with the spaces, edges, and surfaces of the online or the 'immaterial', the intermingling of realms enrich and enliven each other, enhancing connectivities on the one hand and the potentials for awareness, choice, and action on the other. This intermingling offers opportunities for the evolving and enriching of relationships and partnerships across the city where barriers may previously have existed.

5.4 Summary

In summary, this work explored the potential for shedding light on, beneath, beyond, and around urban edges, surfaces, spaces, and in-between-ness in relation to emergent infrastructures of connectivities and awareness enabled through social media and other aware technology experiences, interactions, and activities in the city. Findings highlighted in Table 1 (Sect. 4.4) point to the interweaving of different types of infrastructures in the city and to the enmeshing of people and technologies within, between, and beyond urban edges, spaces, and surfaces. The four parameters – connectivities, awareness, choice, and action – are affirmed with a check for each of the three propositions. As such, this study highlights and reaffirms the importance of the people, technologies, and cities dynamic of smart cities [39, 40], shedding light on the importance of human awareness, choice, and action about the use of aware information and communication technologies (ICTs).

This exploration of edges, spaces, surfaces, and the in-between identifies new possibilities for action and choice in relation to connectivities and awareness. As such, this work operationalizes the conceptual framework for urban connectivities and awareness depicted visually in Fig. 1 (Sect. 2.3) as an approach intended for broader use in the city. This work extends edge, space, and surface theorizing in urban environments to social media, Internet, and other aware spaces enhancing connectivities and awareness in the smart city. As actors in the urban context, new understandings of people as forming part of, and contributing to, the critical infrastructure in smart cities emerges. As such, Dourish and Bell's [36] *infrastructure of experience* finds a home in smart cities and it is this human infrastructure, consisting of the critical components of connectivities and awareness, that serves to possibly moderate and provide balance for concerns with techno-effects [31] and the theme of this Human Choice and Computers (HCC12) conference – *technology and intimacy: choice or coercion*.

6 Contributions and Future Directions

This paper makes several contributions relevant to research and practice. First, this work contributes to the research literature across multiple domains, including but not limited to awareness, choice, and smart cities. Second, a conceptual framework is developed, operationalized, and advanced for awareness, choice, and action in 21st century urban spaces. As such, this framework offers a perspective on connectivities and awareness featuring an interweaving of aware people using aware technologies, as a way of possibly mitigating 'techno-effects' and concerns with the choice or coercion

dilemma. Third, in developing new understandings of the potentials associated with the interweaving of connectivities and awareness across physical and electronic spaces, this work is expected to open discourse areas for awareness research in relation to 21st century cities. As such, this work identifies future directions and opportunities for practice and research.

6.1 Future Directions for Practice

Awareness, Choice, and Action. Offering an alternative view of the concept of edges, edgefulness, surfaces, spaces, and the in-between in the context of aware people using aware technologies, this work offers insight into the potential for choice and action in urban environments. As such, opportunities emerge for initiatives fostering more meaningful engagement, learning, and participation in city life.

6.2 Future Directions for Research

Awareness, Choice, and Action in 21st Century Urban Spaces. The conceptual framework for awareness, choice, and action in 21st century urban spaces advanced in this paper is intended for broad use by: educators, researchers, city officials, and many others. This framework will benefit from further use and development going forward, with the potential to open the way for new research and practice approaches and opportunities.

Awareness and Choice in Smart Cities Research. Insights emerging from this paper contribute to opportunities for further development of contemporary urban theory and to a discourse space related to awareness and smart cities.

7 Limitations and Mitigations

Limitations of this work associated with small sample size are mitigated by in-depth and rich detail from a wide range of individuals across small to medium to large urban centers. The minimally viable social media webspace presented challenges that were mitigated by additional information sharing during in-depth interviews. Anecdotal evidence collected from informal individual and group discussions conducted in parallel with this study, contributed added rigor through further data analysis, comparison, and triangulation and is considered to be an important source of data by Trochim [41] and others [37].

8 Conclusion

In conclusion, through the use of an edges, surfaces, and spaces lens incorporating an interdisciplinary perspective, this work contributes to a discourse on the importance of fostering opportunities for awareness among people about cities and smart technologies. Using a minimally viable social media space, this study introduces an emergent environment for exploring connectivities and awareness in contemporary cities. This work makes a contribution by advancing a theoretical perspective to complement and enrich computational, network, and algorithmic views of social media by extending edge, space, and surface theorizing in urban environments to social media, Internet, and other aware spaces for enhancing connectivities and awareness in the smart city. Second, this work contributes to the research literature across multiple domains, such as awareness, choice, and smart cities. Third, a conceptual framework is developed, operationalized, and advanced for awareness, choice, and action in 21st century urban spaces offering a perspective on connectivities and awareness that features an interweaving of aware people using aware technologies, as a way of possibly mitigating 'techno-effects' and concerns with the choice or coercion dilemma. Fourth, in developing new understandings of the potentials associated with the interweaving of connectivities and awareness across physical and electronic spaces, this work is expected to open discourse areas for awareness research in relation to smart cities. Finally, this work identifies future directions and opportunities for practice in terms of *awareness, choice, and action* and for research in terms of a *conceptual framework for awareness, choice, and action*, and *awareness and choice in smart cities research*.

An important take away from this work is the emphasis on the importance of people, physical spaces, and the innovation of space afforded by social media, the Internet, aware technologies, and the Internet of Things (IoT). Taken together, this highly interwoven dynamic – people-technologies-cites – gives way to the potential for more balanced approaches and opportunities for action and choice enabled by connectivities and awareness. This work will be of interest to practitioners and researchers and will have implications for culture, policy, privacy, and sharing. Educators, city officials, urban planners and developers, awareness researchers, and anyone concerned with innovating infrastructures and relationships in support of vibrant, sustainable, and livable communities and cities will be attracted to this work.

References

1. Chourabi, H., Nam, T., Walker, S., Gil-Garcia, J.R., Mellouli, S., Nahon, K., Pardo, T.A., Scholl, H.J.: Understanding smart cities: an integrative framework. In: Sprague Jr., R.H. (ed.) Proceedings of the 45th HICSS, pp. 2289–2297. IEEE, Maui (2012)
2. Johnson, L., Adams Becker, S., Estrada, V., Freeman, A.: NMC Horizon Report: 2015 Higher Education Edition. The New Media Consortium, Austin (2015)
3. McCullough, M.: Ambient Commons: Attention in the Age of Embodied Information. The MIT Press, Cambridge (2013)

4. Nam, T., Pardo, T.A.: Smart city as urban innovation: focusing on management, policy, and context. In: Estevez, E., Janssen, M. (eds.) Proceedings of the 5th International Conference on Theory and Practice of Electronic Governance, pp. 185–194. ACM, New York (2011)
5. Berne, E.: Games People Play: The Psychology of Human Relationships. Penguin, New York (1964)
6. Stone, D.N., Deci, E.L., Ryan, R.M.: Beyond talk: autonomous motivation through self-determination theory. J. Gen. Manag. **34**(3), 75–91 (2009)
7. Merton, F., Booth, S.: Learning and Awareness Digital Edition. Routledge, New York (2009)
8. Vander Veen, C.: Without smart, connected people there are no smart cities. GovTech, FutureSturcture (2015). http://bit.ly/1B9FbWO. Accessed 14 Sept 2015
9. Richter, D.: Welcome to Ordos, China: The world's largest "ghost city". The Bohemian Blog (2014). http://bit.ly/Nzvxqf. Accessed 15 Sept 2015
10. Brandt, J.: Oblivious in the UK? Nearly 100 percent do not notice smart cities growing around them. SmartGridNews (2015). http://bit.ly/1VVmyfu. Accessed 14 Sept 2015
11. Casey, E.S.: Do places have edges? A geo-philosophical inquiry. In: Daniels, S., DeLyser, D., Entrikin, J.N., Richardson, D. (eds.) Envisioning Landscapes, Making Worlds: Geography and the Humanities. Routledge, London (2012)
12. Casey, E.S.: Edges and the in-between. PhaenEx: J. Existent. Phenomenological Theor. Cult. **3**(2), 1–13 (2014)
13. Lévy, J., Beaude, B., Poncet, P., Noizet, H., Laurent-Lucchetti, B., Bahrani, F., Maitre, O., Bataille, T., Tiphine, L., Yan, L., Tursic, M., Rommany, T.: EPFLx: SpaceX Exploring Humans' Space: An Introduction to Geographicity. Massive Open Online Course (MOOC), edX, Fall. EPFL, Lausanne (2015)
14. Beaude, B.: Internet: a unique space of coexistence. In: Lévy, J., Beaude, B., Poncet, P., Noizet, H., Laurent-Lucchetti, B., Bahrani, F., Maitre, O., Bataille, T., Tiphine, L., Yan, L., Tursic, M., Rommany, T. (eds.) EPFLx: SpaceX Exploring Humans' Space: An Introduction to Geographicity Massive. Open Online Course (MOOC), edX, Fall. EPFL, Lausanne (2015)
15. Lynch, K.: The Image of the City. MIT Press, Cambridge (1960)
16. Lynch, K.: Good City Form. MIT Press, Cambridge (1989)
17. Jacobs, J.: The Death and Life of Great American Cities. Random House, New York (1961)
18. Gehl, J.: Life Between Buildings: Using Public Spaces. Island Press, Washington (1980)
19. Hansen, D., Shneiderman, B., Smith, M.A.: Analyzing Social Media Networks with NodeXL: Insights from a Connected World. Morgan Kaufmann, Burlington (2011)
20. Qi, G.-J., Aggarwal, C.C., Huang, T.: Community detection with edge content in social media networks. In: O'Connor, L. (ed.) Proceedings of the IEEE 28th International Conference on Data Engineering (ICDE), pp. 534–545. IEEE, Arlington (2012)
21. De Jonge, D.: Applied hodology. Landscape **17**(2), 10–11 (1967)
22. Alexander, C.: A Pattern Language. Oxford University Press, Oxford (1977)
23. Wapnick, E.: Why some of us don't have one true calling. TEDxBend talk (2015). http://bit.ly/1Rp8b2c. Accessed 4 Oct 2015
24. Thwaites, K., Mathers, A., Simkins, I.: Socially Restorative Urbanism: The Theory, Process and Practice of Experiemics. Routledge, New York (2013)
25. Jacobs, A.B.: Great Streets. MIT Press, Cambridge (1993)
26. Schmitt, G.: Information cities. iBook as part of the Future Cities MOOC (Massive Open Online Course), Part II – Livability (2015). http://bit.ly/1U8JaHT. Accessed 1 Oct 2015
27. Lévy, J.: Inhabiting. In: Lee, R., Castree, N., Kitchin, R., Lawson, V., Paasi, A., Philo, C., Radcliffe, S., Roberts, S.M., Withers, C.W.J. (eds.) The Sage Handbook of Human Geography, vol. 1, pp. 45–68. Sage, Newcastle (2013)

28. Madanipour, A.: Public and Private Spaces of the City. Routledge, London (2003)
29. Hildebrandt, M.: Prefatory remarks on part 1: law and code. In: Hildebrandt, M., Gaakeer, J. (eds.) Human Law and Computer Law: Comparative Perspectives. Perspectives on Law and Justice 25, pp. 13–22. Springer, London (2013)
30. Scharmer, C.O.: Awareness is the First and Critical Thing: Conversation with Professor Wanda Orlikowski. MIT, Sloan School of Management, Cambridge (1999)
31. Van den Berg, B., Leenes, R.E.: Abort, retry, fail: scoping techno-regulation and other techno-effects. In: Hildebrandt, M., Gaakeer, J. (eds.) Human Law and Computer Law Comparative Perspectives. Perspectives on Law and Justice 25, pp. 67–88. Springer, London (2013)
32. Cohen, B.: The three generations of smart cities. FastCompany Exist (2015). http://bit.ly/1Pgr1aV. Accessed 15 Sept 2015
33. Dourish, P., Bell, G.: Divining Our Digital Future: Mess and Mythology in Ubiquitous Computing. MIT Press, Cambridge (2011)
34. Egyedi, T.M., Mehos, D.C. (eds.): Inverse Infrastructures: Disrupting Networks from Below. Edward Elgar Pub, Cheltenham (2012)
35. Angus, A., Lane, G., Roussos, G.: Public goods: using pervasive computing to inspire grassroots activism. IEEE Pervasive Comput. **13**(2), 44–51 (2014). http://bit.ly/1ONDjpT. Accessed 1 Mar 2016
36. Dourish, P., Bell, G.: The infrastructure of experience and the experience of infrastructure: meaning and structure in everyday encounters with space. Environ. Planning B: Planning Des. **34**(3), 414–443 (2007)
37. Cubitt, S.: Anecdotal evidence. NECSUS: European Journal of Media Studies (2013). http://bit.ly/1TKTda7. Accessed 21 Mar 2016
38. Oldenburg, R. (ed.): Celebrating the Third Place: Inspiring Stories About the "Great Good Places" at the Heart of Our Communities. Da Capo Press, Cambridge (2001)
39. Nam, T., Pardo, T.A.: Conceptualizing smart city with dimensions of technology, people, and institutions. In: Bertot, J., Nahon, K., Chun, S.A., Luna-Reyes, L., Atluri, V. (eds.) Proceedings of the 12th Annual Conference International Digital Government Research Conference: Digital Government Innovation in Challenging Times, pp. 282–291. ACM, New York (2011)
40. McKenna, H.P.: Rethinking learning in the smart city: innovating through involvement, inclusivity, and interactivities with emerging technologies. In: Gil-Garcia, J.R., Pardo, T.A., Nam, T. (eds.) Smarter as the New Urban Agenda: A Comprehensive View of the 21st Century City. PAIT Series, vol. 11, pp. 87–107. Springer, New York (2016)
41. Trochim, W.M.K.: The qualitative debate. Research Methods Knowledge Base (2006). http://bit.ly/1OXsFCz. Accessed 20 Oct 2015