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# Expanding Beyond Technology-Driven Factors: IoT for Smart City Services

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**Abstract.** Understanding the gaps in promoting the communal or societal benefits of the technology will facilitate the planning organization and technology designer to decide how the technology can be diffused into the market to best meet the expectation of the user and the organization. This study argues that the service user-centric technology adoption in smart cities namely online participatory technologies (OPT) should expand beyond technology-driven factors to explore the effect of personality-belief based factors. Individual-level behavior generated from people connectedness with human, society and environment are important to understand the influence of user's social personality belief on technology adoption and continuous usage. This study extends the existing research on technology adoption to reveals the importance of social personality belief fundamentals for the adoption of Internet of Things (IoT) in the interest of creating citizen-centric services in smart cities. Systematic review studies conducted to identify the factors that drive IoT adoption and to reveal the challenges in diffusing the technology in the context of smart cities. We propose a methodological solution to explore structural patterns of the citizen's relationship within the groups, for the organization to create opportunities to exploit the social personality factors for technology adoption and usage purpose.

**Keywords:** Smart Cities, Participatory Technologies, Internet of Things, Service User-Centric, Societal Benefits, Social Personality.

## 1 Introduction

The two fundamental aims of the Smart Cities are improving the service they deliver to their citizens for economic efficiency and social effectiveness in meeting the stakeholders' expectations (1). The attainment of these two goals are not only dependent on government and service providers but it hugely depends on the support provided by the citizens (1). Knowing this, citizen-centric smart cities have given rise to their efforts of finding ways to incorporate active connection, engagement and intelligence of its citizens via smart technologies for public issues identification and solutions (2). Accordingly, Smart City Service Technologies have been introduced to enhance life quality in a city and to make the city livable.

Aguilera et al. (1) claimed that the following technologies are important to promote public participation: mobile broadband, smart personal devices, government-

sponsored cloud and open-source public databases. The advancement of Internet of Things (IoT), Linked and Open Data and Crowd-sourced data and the rise of wireless internet has facilitated the creation of user-centric mobile services that exploit open data and add value by providing user-generated data (1). The emergence of smartphone-based technologies and user-centric mobile services app to support the functional value of smart cities through monitoring and improving the civil infrastructure systems is rising as the modern smartphones are equipped with various sensing, computing, communication and crowdsourcing capabilities.

The involvement of the citizens in the citizen-centric smart cities services planning is operationalized via the introduction of online participatory technologies (OPT) in which citizens are seen as intelligent sensors. OPT is defined as 'the method or tool that is used for engaging communities and organizations' (3). In this OPT, citizens function as intellectual sensor via two methods. First, real-time data gathered automatically by the city sensor from the move or interaction generated by citizens. This data is useful to create prevention, implement early action and improve decision making (2). For example, the data utilize for transportation maintenance (e.g. traffic management) and risk prevention (e.g. COVID-19 control). Second, is referring to the data provided by citizens as crowd-sourced data supplied by citizens. The spread of IoT technologies into Smart Cities allows citizens to obtain knowledge about their surroundings and to contribute with new data captured through their mobile devices. Citizens can also edit the data for example information about the damaged of public facilities, anything broken in the public area, poor public transport services etc.

Citizens are enabled and empowered to participate into the process of Smart City's data consumption and production of their own data for the benefits of the citizens, businesses and governing bodies (4). Example of a smart city project that aims data gathering, crowdsourcing, collaboration and empowering of citizens are IES Cities (1) and examples of tools utilized in EIS Cities for participatory purpose are FixMyStreet, FixMyTransport, Open City Toolkit, Mind Mixer, ClickFix and Crowdbrite. These tools provide citizens with analytical tools and citizen-centric services to solicit problems, reporting problems and form an online collaboration in city services such as the issues of public infrastructure (2). The adoption of these tools is technology-driven and citizen-centric (4). However, in most cases the technology adoption and technology diffusion drivers were explored and understood from technology-driven aspect. Less emphasize give to explore the citizen-centric aspect with respect to the unique nature of the technology implementation purpose and expected outcomes.

## **2 Research Question**

Although the technology-driven factors are crucial for successful implementation of the technology, however recognizing the difference in the functional necessities of the IoT, it is equally important to embrace the influence of other non-technology driven factors. The demand for technology adoption solution varies from IoT to IoT based on various factors such as technology competencies, providers supports, government

interventions and user involvements. Expensive infrastructure and advancement of technology are unserviceable without proper end-user adoption. It is a bigger challenge when there is not enough support from the users to use technology or to add value to the data. Hence, to truly streamline the adoption process of a technology that developed for the benefits of the people, it is crucial to understand what exactly the end-users want, whether they are ready to opt a smart solution, what may influence them to adopt and continuously use the technology, and how their needs or experience in using the technology can be prioritized. Hence, in this review article, we explore the following research question:

*"What considerations should planning organizations take into account when they are promoting the adoption and use of online participatory tools?" What overlooked? How to fill in the gap?*

### **3 Gaps in Understanding IoT Adoption: Overlooked Challenges**

The introduction of technology can hold a number of unique benefits for users. Across the studies, we can see that several factors have been consistently examined and found to be predictive of the decision to adopt IoT in smart cities. Individual factor (personal innovativeness), product factors (relative advantage, cost), interface factors (trust in the government and/or provider of the technology, perceived expectations of others in one's social environment) are the common factors referred for IoT adoption (5–7).

However, studies of IoT adoption in 'smart cities' primarily focus on generic IoT (8) or category of IoT such as mobile application but very few studies focus on the specific function of the IoT. As a result, we have a limited understanding of the unique factor that influence the respective technology or cause barriers to the adoption of the technology. From the literature review, we found that many cities are failing to influence the citizens to adopt the technology while some are struggling to keep the face of the technology usage among the citizens, while technology diffusion is frequently disrupted. One of the key challenges facing the sustainable adoption of IoT is understanding the stimulus that encourages citizens to adopt and continuously support the use of the IoT (4,8). Facilitating the technology adoption in smart cities in term of citizens involvement will help the local stake authorities to succeed with the technology adoption and diffusion. Moreover, expanded holistic technology adoption framework should be developed to understand unique IoT adoption in the context of smart cities.

In the context of OPT, the pervasive connectivity of the smart technology for communal benefits is the strength of the technology that should be utilized for stimulating technology adoption and diffusion (9). Hence, this study proposes the importance to identify the community-based value as a personality effect on technology adoption and feasibility in optimizing this factor should be explored. A thorough mapping of the factors listed in the study of IoT against the literature review conduct-

ed in this study brings us to the conclusion that feel of responsibilities towards community are ignored in the IoT studies in smart cities context although these factors form the foundation of the smart cities ecosystem. Moving in this path, this study explores the significance of personality-specific belief that focus on citizen's 'sense of community' in technology adoption frame.

### **3.1 Personality-specific Belief: Sense of Community**

One of the extensively applied concepts to understand the connections of individuals to social groups is a sense of community (feel of responsibility). The development of these psychological elements on oneself lies in their involvement in community activities (10). A sense of community is usually related to the pride of belonging to a place and can be influenced by the perceived livability. It is associated not only to other citizens but to the commonly shared norms, norms of reciprocity, social order, and, codes of behavior (11). The citizen with this personality quality adopts into the aggregated civic society concept: participation and civic sociability in organized activities (Putnam, 1993; Dempsey et al., 2011). Macke et al., (11) claimed that "sense of community is fundamental for understanding innovation, institutional dynamics, and value creation" in smart cities context.

Based on the literature studies conducted in this study, we propose that sense of community affects the attitudes of users to act for the harmonies of the community in their area. The stronger the sense of community is, it is predicted that the users will demonstrate higher social responsibility and emotional commitment to protect their surroundings and promote the nature and societal benefits for the better living of the community. Studies proved that people with a higher sense of community are more likely to engage and participate in the development of the city and likely adopt the innovation that supports the development of the surroundings (7,11). Wang et al., (7) found that sense of community at the individual level affect the adoption behavior of the developers.

## **4 Method/Approach**

A systematic literature search was conducted to set the direction of the research by identifying the factors that commonly used to study IoT and mapped that against the emerging factors of adoption in smart cities. The contribution of this study is building and integrative framework elaborating technology adoption comprising technology and human-driven factors for participatory based IoT. Further literature analysis on the human-centric factors allows us to understand the human-driven factors based on various classification. This is important to strategies the solution to enhance IoT adoption and diffusion in the context of smart cities.

## 5 Theory

A number of theories have been used to explain the factors that influence technology acceptance and adoption at the individual level. 'Theory of Reasoned Action' (TRA) (Fishbein and Ajzen, 1975) and 'Theory of Planned Behavior' (TPB) (Ajzen, 1991) explain behavior about beliefs for acceptance of technologies. 'Technology Acceptance Model' (TAM) (Davis, 1989), the 'Unified Theory of Acceptance and Use of Technology' (UTAUT) (Venkatesh et al., 2003), and its successor (UTAUT2) (Venkatesh et al., 2012) are other technology acceptance theories that dominate IS adoption research. However, in this study, we argue that the common technology acceptance factors as described in the above technology adoption models are not adequate predictors of service user-centric technology adoption in smart cities. The Rogers diffusion model (12) was also challenged when scholars argued that people are more likely to engage in socially responsible behavior when they derive pleasure and satisfaction from this behavior compared to their obligation (13). Hence it is important to understand the process behind the technology adoption and diffusion that takes the user through the journey of becoming aware of the technology, accepting the technology after assessing it against various influencing factors, fully utilize the technology and continuously use the technology. Scholars stated that currently, there are still very few studies that explore the adoption of IoT from a multiple theory perspective (14).

In this study, we proposed that technology adoption theory should be married with Social Theory. In the context of this study, motivation theory will be relevant to identify the factors that motivate the citizens to adopt and use the OPT. Studies have found that sense of community have behavioral consequences and these effects are noticed to operate at the individual level (11). Hence, this study proposes to embed the lens of motivation theory into technology adoption and diffusion model to explore the inspiration for citizens to adopt and continuously use the technology for own benefits, social identity and self-satisfaction derive from helping others within the smart city boundary.

## 6 Discussion: Solution to the Challenges

We foresee from the literature that the individual-level behavior developed from the communities of interconnected people may serve as stimulation for technology adoption in smart cities. The theoretical connections between social networks and sense of community have been shown in some recent studies by evaluating the sense of belonging and social identify (7,11,15). Therefore, in this study, we suggest exploring the effects of individual-centric factors that developed from their network to speed-up the adoption and to assure sustained usage of the user-centric technology. This study suggests urban planner and social researchers find a method to analyze the social interaction that forms the sense of community. This will be useful to generate a constructive understanding of how the sense of community can be nurtured for innovation adoption, idealization and continuous usage. Thus, the smart city technology

developer, designers, government and other stake agents must carefully emphasize with the diverse set of users of their everyday experiences in using the IoT technology. The users' needs or experience should be mapped across various factors including demographic challenges, personal needs, personality beliefs, social needs, social networking and etc. In this study, we also propose the utilization of social networking analysis to identify the structure and pattern of the citizen networking that influence them to adopt and actively use OPT for citizen-centric service design.

## 7 Conclusion

While the technical capability of the participatory IoT in facilitating the adoption for functional purpose is important, the communal benefits of the technology attraction to the users (citizens) should be considered as well. We propose that the citizens as the city service users must be aware of, and also perceive, the collective benefits of particular smart city services technologies to forcefully participate in customer-centric service design. They must be able to experience the benefits of their participation in accomplishing improvement in their surrounding communities' quality of life that could lift their self-satisfaction. Many scholars claimed that customer-centric smart city service design has great potential to change or uplift societies. However, the success requires active participation of the service users in co-creating the social values for themselves and their community. Hence understanding service users' perceptions about the technology from technology-driven and citizen-centric are equally crucial for adoption and continuous usage of this service user-centric technology. This study reflects on the theoretical expansion in the discussion as well as the future implications of this study on research and practice related to service user-centric IoT adoption.

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