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Examining the Adoption of Smart City Platforms In the Presence of Privacy Concerns

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Abstract: **Smart cities have been gaining prominence worldwide as a data-driven medium for urban renewal and overhaul. Rapid technological innovations, social wants, strive for effective governance and the exploding urban population in traditional cities are the primary driving forces contributing to this buzz. Though smart cities had been conceptualized to expand sustained urban yield, the accumulation and processing of large amounts of data streams are raising security and privacy concerns at both individual as well as societal levels. Significant efforts are being undertaken to safeguard inhabitants' data from possible security and privacy breaches. However, there continues to exist a lack of formal understanding of privacy concerns and the factors affecting these concerns from the perspective of a citizen. Additionally, the possibility that these privacy concerns of citizens might also impact their adoption behavior (i.e., intention to inhabit in a smart city) has not been studied yet. This paper aims to identify the significant factors that might affect privacy concerns of an individual citizen; and combines them to derive a framework examining their privacy concerns that affect their adoption behavior.**

Key Words — smart city, service integration, privacy concerns, smart technology, framework.

I. INTRODUCTION

The approach of smart cities as an urban development model is a response to the problems arising due to urban population 'explosion' in cities in the last few decades [1]. These problems include poorly managed and unstructured urbanization, inability to finance modern water infrastructure, lack of efficient transportation grid, hazardous and unsanitary housing, traffic congestion, air pollution, solid waste disposal problems among others. Therefore, the economic, social and environmental costs of buildings and managing the traditional cities have begun to outweigh their benefits. Thus, smart cities have been aimed to better utilize cumulative human, and technological capital and gain prosperity in urban agglomerations [2]. Smart cities reflect data-driven efforts to to expand sustained urban yield and improve environmental and social benefits with Information and Communication Technology (ICT) as their core infrastructure [3].

Moreover, the rapidly improving technology is aiding cities to collect data, innovate and upgrade the lifestyles of their citizens [4, 5]. For example, Singapore makes use of installed sensors and 'ubiquitous computing' to track activities from almost every aspect and corner of the city, including cleanliness of public spaces, crowd in public places and traffic movement. This data when analyzed helps authorities identify bottlenecks in the city. Singapore has also successfully implemented phased traffic lights, congestion charging, road sensors, and smart parking. Another city, the City of Riverside in California, has made significant efforts towards sustainable urban growth. The city authorities had improved traffic flow, sewer system, and electric infrastructure and replaced aging water, with the help of ICT infrastructure. These cities, along with several other such examples over the world, exhibit one thread of commonality: they are trying to fulfil the growing demand of 'smart' liveable cities.

Although this solution seems like a "paradise" which can solve all issues faced by traditional urban settlements, there has been a growing worry about the definition. Existing studies have unanimously concluded that there is as yet no prevalent and accepted definition of a smart city [6, 7]. This confusion regarding the vision and scope of the components of a smart city has created a research gap. Hence, existing literature has not yet been able to explore the factors that are critical to the success, or failure, of a smart city [8]. Moreover, this lack of proper definition results in unclear understanding about the regulations concerning the collected data and its use. Such uncertainty about the ownership and usage of data gives rise to security and privacy challenges.

A study by Elmaghraby et al. [9] has attempted to address the possible privacy concerns of future smart cities using a representational model of the interactions between person, servers, and things. Several other studies have used similar approaches to deal with trust and security issues of smart cities [10, 11]. Another study by Khan et al. [12], has identified security-related challenges and presented a security and privacy framework for 'data curation' and service administering in smart cities. The authors have studied the

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concerns from the different standpoints, i.e., security and privacy concerns when a stakeholder is either a victim or an attacker as well. Thus, existing literature has extensively studied these concerns arising as a result of interactions taking place between respective key stakeholders of the smart city, including the authorities, developer and city dwellers. However, there continues to exist a lack of formal understanding of privacy concerns and the factors affecting these concerns from the perspective of a citizen. Additionally, the possibility that these privacy concerns of citizens might also impact their adoption behavior (i.e., intention to inhabit in a smart city) has not been studied yet.

This paper aims to identify the significant factors that might affect privacy concerns of an individual citizen; and combines them to derive a framework examining their privacy concerns that affect their adoption behavior. Moreover, since a smart city is like any other information system; having three components which are, technology, people, and organizations [8], it is imperative to study how these factors along with their impact on privacy concern can comprehensively impact adoption decision of an individual. Adoption decision in the context of a smart city would be a decision regarding whether to be a 'smart city' dweller or not.

II. LITERATURE REVIEW

A. Smart City

A city is being seen as 'smart' when it involves use of 'smart' computing technologies such as the use of ubiquitous computing [13]. Researchers have viewed current urban crises as an driver of the smart city initiatives. The nucleus of a smart city initiative lies in its self-monitoring and self-response system. IBM's working definition has described a smart city in terms of three key features: instrumented, interconnected, and intelligent [14]. Capture of real-time real-world data using sensors is part of the instrumentation. This captured data is then transmitted across multiple processes, systems, and organizations using interconnected networks. This massive interconnection also enables integration of most, if not all, services of a smart city under one platform, and thus facilitates drawing of intelligent insights to improve quality of city life.

B. Smart City Frameworks

Smart city frameworks have been developed by researchers as well as industry practitioners to describe the scope of innovations in a smart city project. Such a framework has helped to conceptualize an integrated system consisting of interactions between the smart city stakeholders (city IT services personnel, city departments, city authorities, third-party developers and citizens [15]) and the factors critical for the success of the initiative. For example, the Cisco Internet Business Solutions Group (IBSG) has developed a four-layer framework with flow that enables stakeholders to "push" through and evaluate decisions [16]. While IBSG has built its framework, which shows a decision flow through the four layers; another study by Chourabi et al. [17], has developed a framework to explain the relationships between eight factors critical to the success of smart city initiatives. This understanding of these factors would help to compare how cities are conceiving their smart cities, integrating departments and platforms, and their corresponding issues.

C. Smart City as an Information System

A study by Nam et al. [8] has discussed about the features of the smart city concept and has aligned it to the three main components (technology, people, and organizations) of an information system. This has been possible because a smart city aims at integration of infrastructure, services, and effective governance for institutional improvement and citizen participation. Consequently, the smart city idea shares similar advantages as well as challenges that a typical information system would encounter.

Technological Challenges

ICT infrastructure is an essential component of smart city initiatives. Though the idea of extensive use of ICT for successful smart city projects has been shown to be lucrative, actual implementations have exhibited ambiguous impacts. Ebrahim & Irani [18] studied the challenges in using such technologies for smart cities, and their observations showed that the problem areas lie in initial IT infrastructure development due to lack of skill set and work culture among employees required for proper integration of services, lack of inter-departmental communication and unclear understanding of IT applications and future opportunities as well as high operational costs.

Organizational Challenges

Organizational challenges could crop up at two stages: first could be during the initial stage of smart city development, while the second could be after people start using facilities in the smart city and how the authorities manage the infrastructure after that. There aren't many existing studies which have explored the first stage of challenges in the context of smart cities. Hence, a study has explored them in the context of e-government initiatives and IT project management [17]. The authors have explained that though smart city initiatives are contextually different from traditional IT projects and e-government initiatives, but smart city initiatives are also born from government visions. Further, challenges encountered in the latter stages are mostly regarding governance, and policy-making.

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Social Challenges

Smart city initiatives could have a significant impact on citizen's way of life. Involving citizens could be as important as technology and policy-making. Therefore, it is important to overcome the challenges of digital divide and encourage participation and partnership, and acceptance of "digital way of life".

D. Privacy Concerns in the Smart City Context

In a bid to overcome the challenges faced by traditional cities, 'smart city initiatives have been developed by governments over the world. One of the most important critical success factors for such an initiative are the volume and kind of data captured from within the city in real-time. This has been made possible with the extensive use of sensors and IoT frameworks [4], thus aiding Big Data analytics to create 'smarter' cities. However, this along with the lack of standardized understanding of policies and regulations have also contributed to a growing concern about individual privacy. Additionally, privacy concern of an individual is also a function of his behavior and intention to disclose personal information online. This has prompted researchers as well as practitioners to shift their focus to security and privacy challenges in the context of smart cities.

III. THEORETICAL BACKGROUND

In a smart city where data is being collected in real-time from every nook-and-corner of the city and every activity is monitored all the time, the concerns are mainly expected to develop depending on two major factors: amount of data of each individual that is being collected, and the type of data being collected from that individual.

Amount and type of individual data

Smart cities need to be continually sensing the environment in a ubiquitous manner enabled by Wireless Sensor Network (WSN) technologies. Interaction of these devices along with the seamlessly blended sensors and actuators in a 'communicating–actuating network' creates the Internet of Things (IoT) in a smart city and thus, generated an unprecedented amount of information. This information gets shared across aggregated platforms to help data scientists analyze and identify problem areas within the city [4]. Presence of sensors in every corner of the city allows them to capture and track activities of all citizens. Researchers have identified that over-collection of data, i.e., amount of data of each individual getting collected, has a severe impact on the individual's privacy concerns. This impact is even more significant when the type of data getting collected is 'sensitive.'

Proposition 1 (P1): Privacy concerns in the smart city context about the amount of individual's data being collected is higher when the perceived benefit is low.

Moreover, sensors are not the only way of collecting data in smart cities. In almost all the examples of smart cities, authorities have been found to have created apps for smartphones to provide convenience to citizens. These apps can track location data of citizens, access photo galleries, access address books, access calendars through smartphone usage alone. Hence, users' tracks and every aspect of their lives are exposed to someone who has real-time access to such data. This sensitive data needs to reside only with someone who has been trusted with the data; and a data breach can prove to be highly risky. Thus, it can be inferred that the type of data getting collected would also impact the privacy concern of an individual.

Proposition 2 (P2): An individual's intention to move in and stay in smart city is higher, even if amount of individual's data being collected is high, only when the perceived benefit is high.

Intention to Adopt the Smart City Platform

Intention to accept living in smart cities is thus expected to depend on the amount and type of data of each individual being collected as well as the rising privacy concern of the individual.

Perceived Benefits

Perceived benefits refer to the perception of the positive consequences that are expected to come if the individual agrees to disclose information. This variable is expected to have a moderating effect on the causal relationships between independent and dependent variables. A well-known theory in literature, termed as "privacy paradox," has suggested that users have been found to face a dilemma in every situation of whether to disclose information or not, with respect to what they perceive the benefits associated could be [19]. This study has categorized perceived benefits to mean either personal (individual) benefits or public (societal) benefits.

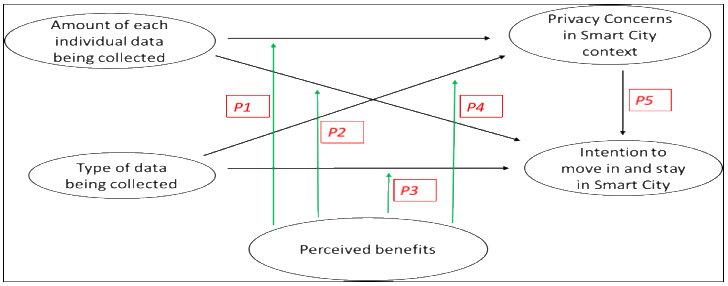

Figure 1: Proposed framework

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Proposition 3 (P3): An individual's intention to move in and stay in smart city is higher in situations irrespective of the type of data being collected when the perceived benefit is high.

Privacy Concerns

Privacy is the right that an individual enjoys in order to be left alone without any interference from other members of the society and governments [20]. Privacy concerns in the smart city context have become an important area of research for academicians and practitioners alike because of the extensive use of technological advancements for digitally accessing and analyzing data. Users' privacy concerns develop when they fear loss of personal information to outsiders and because they can be tracked all the time to get information whose ownership is not yet well understood [21]. Thus, it is necessary to study the source and cause of privacy concerns to be able to address them and make people accept the notion of smart cities. Privacy concern is thus a dependent variable.

Proposition 4 (P4): Privacy concerns in the smart city context about the type of data being collected are higher when the perceived benefit is low.

'Privacy Concerns' and 'Intention to Move in'

Privacy concerns have been found to negatively impact users' intentions to adopt an IT/IS technology in location-based services [22]. Thus, it is expected that similar relationship will hold in the smart city context as well.

Proposition 5 (P5): Privacy concerns in the smart city context will have a negative impact on the intention to move in and stay in smart city.

Consequently, the following research design shown in Figure 4 has been developed to study the impact of the new concept of data-driven cities on an individual's privacy concerns. This framework examines citizens' privacy concerns that affect their adoption behavior.

IV. CONCLUSION

The smart city concept has gained much attention in the last decade to enable sustainable and efficient urban management and development. Smart cities across the world are thriving on one common aspect, which is the ICT environment. The changing technology has helped by generating of enormous amount of data from installed sensors and conducting analytics of the collected data to determine if there is any unusual behaviour or anomalies. The progressive increase in the use of sensors and actuators has caused the volume of data produced has grown exponentially. This data has provided insights about lives of citizens in different smart cities.

While this huge amount of rich data has enabled the use of Big Data analytics, it has also raised a number of concerns about various ethical uses of data, and issues related to data quality, and data security Finally, since the capabilities of technologies will move progressively at an even faster rate in the future, their roles in shaping governance in smart cities are expected to become increasingly vital.

Therefore, we develop a conceptual understanding the privacy-related antecedents of adoption behavior of a citizen. This paper has identified the significant factors influencing the privacy concerns of an individual and integrated these factors to build a framework for a formal understanding of factors influencing adoption decision. We argue that, for instance, while privacy concerns about the type of data being collected will be higher when the citizen perceives overall benefit to be low; the same individual's intention to move in and stay in smart city is higher, even if amount of individual's data collected is high, only when he perceives higher benefit.

We believe these propositions will encourage other IS researchers to look at security and privacy challenges in a smart city environment from a fresh perspective that will help industry practitioners to develop fair practices and policies to address the concerns of citizens.

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