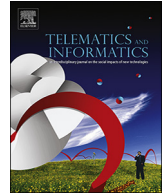


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Potential pitfalls of smart city development: A study on parking mobile applications (apps) in Hong Kong

Ruiqu Ma^a, Patrick T.I. Lam^{a,*}, C.K. Leung^b^a Department of Building and Real Estate, The Hong Kong Polytechnic University, Kowloon, Hong Kong Special Administrative Region^b Department of Electronic and Information Engineering, The Hong Kong Polytechnic University, Kowloon, Hong Kong Special Administrative Region

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ABSTRACT

Smart cities are built upon information and communication technologies (ICTs) to enable a broad range of advanced services. Through a comprehensive literature review, this study identified four pitfalls brought by the pervasive application of ICT, including information insecurity, privacy leakage, information islands, and digital divide. Therefore, a questionnaire survey together with 27 interviews was conducted in Hong Kong to investigate how the public perceived these pitfalls within the context of mobile apps providing real-time parking information which form a major part of smart mobility. System insecurity and privacy leakage were found to arouse worries among the app-users while their awareness of protecting personal data was found to have room for improvement. Islands of real-time parking information occur as a result of the lack of collaboration among private carpark operators. Digital divide existed widely among the disadvantaged groups and the problem cannot be solved by mere provision of ICT facilities. Overall, technologies alone cannot make a city smart or smarter. It is the suitable way in which ICTs are used to serve all citizens that matters.

1. Introduction

Currently the concept of Smart City (SC) has come to the forefront as a modernistic approach to facilitating citizens' life. Although there is no general consensus on the definition of SC, it is widely acknowledged that SC is featured by the intensive use of ICTs (Neirotti et al., 2014) which enable citizens to understand, experience and manage cities more efficiently and conveniently by the provision of diverse electronic and online services. ICT is important in the smart city development, and should not be viewed as an end itself but a solution towards specific problems confronting a city. Its effectiveness is not only determined by the wide development of hardware but also management issues (Lam et al., 2009). A pre-occupation with the benefits of SC may lead to an underestimation of possible negative effects of advanced technologies being deployed in a city to make it smart solely for the sake of technology (Graham and Marvin, 1996; Caragliu et al., 2013). As proposed by the theory of Social Construction of Technology (SCOT), technology becomes valuable only if its use is embedded within the true social context (Murphie and Potts, 2003). Otherwise, all efforts supposed to make a city smart will be in vain. For example, the winner of World Smart City Award in 2013, Rio de Janeiro, having spent a huge investment in ICT applications, has been criticized as a 'flawed' smart city project because of the risks of system crashes at the city level and individual privacy intrusion (Poole, 2014), and its failures in tackling social inequalities (Gaffney and Robertson, 2016).

"Smart cities are not a panacea for all ills, and they bring their own problems" (Edwards, 2016). Information insecurity is one of the

* Corresponding author.

E-mail addresses: ruiqu.ma@connect.polyu.hk (R. Ma), bsplam@polyu.edu.hk (P.T.I. Lam), chi.kin.leung@polyu.edu.hk (C.K. Leung).

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problems that are aggravated in smart cities where information technologies are intensively deployed. The increase of Internet of Things (IoT) devices deployed in smart cities poses security threat in Hong Kong. It was found by the [Hong Kong Computer Emergency Response Team \(HKCERT\) \(2017\)](#) that the number of botnet events (during a network of interconnected IoT devices is compromised by attacks) rose remarkably by 77% from 2635 in the third quarter of 2016 to 4656 in the fourth. It was due to the “Mirai” malware, the top botnet accounting for 41% of the total. “Mirai” targets IoT and uses infected IoT devices (e.g. wireless routers and digital video recorders) to make a distributed denial of service (DDoS) attack to a large scale. From its first outbreak in October 2016 to March 2017, “Mirai” had infected about 2000 connected devices in Hong Kong ([Ho, 2017](#)). If more IoT devices are used without cautions, it is hard to imagine how many hackings the city needs to cope with and how to maintain proper city functions.

The approach of SC also poses threats to citizens’ privacy when personal data is collected and used without transparency and prior consent of the data owners. In Hong Kong, Octopus card, which enables electronic payments in all public transport means and most retailers, is one of the world’s most used commercial smart cards. It handles more than 14 million transactions daily ([Octopus Cards Limited, 2016](#)). However, without the consent of cardholders, the Octopus Cards Limited collected personal information including citizen ID numbers, passport numbers, month-and-year of births ([South China Morning Post, 2010](#)). In 2010, the smart card company admitted selling personal data of one million Octopus cardholders to private entities for HKD 44 million. This issue aroused criticism and distrust within the society since once being leaked, privacy can never be remediated.

Another pitfall of SC development in Hong Kong is the syndrome of information islands persisting in the form of isolated information centers and incompatibility among different systems, organizations and government departments. There is not a one-stop Hong Kong database portal until perhaps 2023. Lots of public data such as transport and building information are managed by entities using various standards. This brings inconvenience to the citizens and hinders innovation in the era of big data. A study on Smart City Blueprint for Hong Kong ([Office of the Government Chief Information Officer, 2017](#)) stated that one of the key challenges of becoming “smart people” lies in the fact that existing services are backed by their own ICT infrastructures which are duplicated, hence preventing integration of the data use and transfer across the related Bureaus/Departments.

As smartphones enable a broad range of smart services now, groups of people without smartphones may be excluded from the benefits brought about by smart cities. It was reported by the Hong Kong Thematic Household Survey Report No. 59 that the percentage of people ‘aged 10 and over’ owning smartphones during the 12 months before enumeration was 83.0% in 2015, and those ‘aged 65 and over’ only accounted for 35.4%, retired persons 43.1%. The inability of accessing smartphone exists among the elderly in Hong Kong. Besides that, the problem of digital divide also exists in some distant places in Hong Kong due to poor-quality Internet access. In Lamma Island, dozens of complaints were raised since 2015 towards the intermittent and extremely slow broadband speeds averaging about 0.5 megabits per second. This results from the lack of an optical fiber cable access there ([Karacs and Westcott, 2015](#)). “*The gap is going to get bigger and bigger, and it will affect families and businesses, posing digital inequality for the people living on those islands.*” says an IT sector legislator in Hong Kong.

Most existing studies of smart cities are mainly about the development of technological advances and the success stories achieved in global cases, and few of them looked at the downsides to alert city stakeholders (especially city managers) to take more caution against potential pitfalls. This study was therefore carried out to analyze possible deficiencies in the smart city development within a contextual and specific scope of investigation. Firstly, potential pitfalls were identified together with their causes and effects based on a comprehensive literature review. Then a questionnaire survey targeting Hong Kong citizens as ICT end-users was undertaken to investigate the public perceptions about the potential pitfalls identified. This was followed up by 27 interviews with relevant people (6 for information islands, 21 for digital divide) to probe further into the rationale behind the phenomenon, resulting in several recommendations to improve the current situation. Given the importance of mobility and the general desire for smooth traffic flows in Hong Kong, this study used smart parking system as a case to demonstrate the potentiality of pitfalls identified. From the analysis, pitfalls regarding the safe use of smart services and the lack of competence in harnessing smart devices, such as personal privacy leakage and digital divide, were highlighted as more prevalent than expert/practitioner-oriented issues such as system information insecurity and information islands. This study concluded with the recommendation of mitigation measures against the potential pitfalls and made suggestions on the roles of the government in particular.

2. Literature review: Potential pitfalls of smart city development

Being inspired by the above observations, a comprehensive search was performed on the Web of Science database in combination with ScienceDirect and Google Scholar, using ‘smart city’ as the keywords, theme and title to retrieve relevant English literature during 2000 to 2017 from the SCI and SSCI database. Given the multidisciplinary nature of the topic of SC and the aim of this research, the study areas were narrowed down into urban studies, environment studies, geography, economics, public administration, planning development and management, excluding articles with specific technical domains such as energy fuels, water management, and electronic engineering. Eighteen papers were obtained with the selection of ‘highly cited in field’ in the Web of Science. Similar steps were performed in ScienceDirect and Google Scholar to supplement suitable but less-cited papers as they were quite recently published. The last phase was a content analysis by reading through the articles to identify common pitfalls brought about by SC as mentioned in the papers. Despite the expected scarcity of publications discussing the adverse effects of SC, fifteen expert articles from key journals (e.g. *Cities*, *Telematics and Informatics*, *Journal of Cleaner Production* and *GeoJournal*) and a book by [Townsend \(2013\)](#) were found to help identify four common pitfalls, i.e. system information insecurity, privacy leakage, information islands, and digital divide (their sources are shown in [Table 1](#)). They all touched upon the social issues in SC. In order to better understand the pitfalls identified, it is necessary to conduct a more in-depth socio-technical analysis to see how people interact with new technologies within

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