Smart City Development: A Business Process-centric Conceptualisation

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Keywords: Smart Cities, Smart City Development, Business Process, Process Change, Systems Integration.

Abstract: Smart city development has been proposed as a response to urbanisation challenges and changing citizen needs in the cities. It allows the city as a complex system of systems to be efficient and integrated, in order to work as a whole, and provide effective services to citizens through its inter-connected sector. This research attempts to conceptualise smart city, by looking at its requirements and components from a process change perspective, not a merely technology-led innovation within a city. In view of that, the research also gains benefits from the principles of smart city development such as systems thinking approach, city as a system of systems, and the necessity of systems integration. The outcome of this study emphasises the significance of considering a city as a system of systems and necessity of city systems integration and city process change for smart city development. Consequently, the research offers a city process-centric conceptualisation of smart city.

1 MOTIVATION OF RESEARCH

Only 30 metropolises in the world have accommodated 10 percent of the global population (e.g. Nam and Pardo, 2011b; Chourabi et al., 2012). In other words, 25 percent of the world's population is living in 600 cities. Therefore, the city authorities have to deliver high-quality services to growing numbers of citizens (Schaffers et al., 2012). In other words, access to real-time data and flexibility of city systems is required to create and deliver services in today's urban areas (Vojdani, 2008). Hence, to promote sustainable living, it is necessary to change the traditional urban activities, functions, and processes, which are mostly performed within the city sectors, operating in silos. It means the city authorities have to manage their cities in a smarter way (Javidroozi et al., 2014). In fact, interconnectivity through various sectors of city systems is a significant issue for city leaders (Liu & Peng, 2013) that can be addressed by integrating city systems and changing cross-sectoral city processes (Nam and Pardo, 2011b).

Nevertheless, while Business Process Change (BPC) is central for systems integration, and it is the most important aspect of Smart City Development (SCD) (Javidroozi et al., 2015); to date, very little attention has been paid to the role of BPC in SCD. Accordingly, the concept of the smart city, which is still understudied (Budhiputra and Putra, 2016 and Dameri, 2017), does not emphasise the central role of BPC for developing smart cities. Yet, research on the concept and challenges of SCD has commenced. For example, Chourabi et al. (2012) proposed a framework for principles and success factors of SCD; this was one of the first attempts to address the knowledge gap regarding SCD challenges (Chourabi et al., 2012). However, their focus was on technology perspective, while as argued by Nam and Pardo (2011a), technology on its own cannot develop smart cities. Likewise, Liu & Peng (2013) argues that SCD should not blindly persist on a technological layer, but also on policies and standards. However, current technological solutions for smart cities conduct the cities to become technology-enabled cities not necessarily smart cities (Walter et al., 2015). Similarly, Barth et al. (2017) discussed the concept of smart city based on various definitions and mostly their understanding that named it 'informational city'. According to this concept, smart city is studied in seven areas including economy, politics, information and knowledge infrastructures, spaces, location factors, people's information behaviour, and problem areas. Hence, their framework is useful to study informational aspects of smart city initiatives.

Hence, further studies are required to explore SCD beyond the technological realm to reduce process

Javidroozi, V., Shah, H. and Feldman, G.
Smart City Development: A Business Process-centric Conceptualisation.
DOI: 10.5220/0007382203460353
In *Proceedings of the 8th International Conference on Operations Research and Enterprise Systems (ICORES 2019)*, pages 346-353
ISBN: 978-989-758-352-0

integration issues, so that the first step is to conceptualise the meaning of smart city and its requirements from BPC viewpoint, which is the most important factor for city systems integration.
Through a literature analysis this research attempts to provide a business process-centric conceptualisation for SCD.
The next section of this research provides a literature review in the context of SCD and conceptualises its necessity. Then, the research will analyse various definitions of smart city and attempts to explain a business process-centric concept of SCD, based on an understanding of a city as a system of systems and necessity of city systems integration.

2 NECESSITY OF URBAN INNOVATION

In 1900, only 14 percent of the world's population lived in cities. It is expected that 70 percent of the world's populations will live in the cities by 2050 (Schaffers et al., 2012; Tomas et al., 2013). Therefore, cities are involved with urbanisation challenges in terms of employment (especially for the young population), rise in crime rate, ageing population, deficiency of infrastructure (which causes transport and housing problems), security, energy efficiency, waste management, traffic congestion, air pollution, carbon emissions, and climate change (Nam and Pardo, 2011a; Chourabi et al., 2012; Schaffers et al., 2012; Liu and Peng, 2013; BSI, 2014b). IBM (2012) has also explained the challenges of current cities in 11 areas of traffic, energy, retail, healthcare, airport, social services, communication, education, rail, public safety, and economic development.
In addition, as a consequence of rapid urbanisation, the fundamental human needs (including safety, love, self-esteem, self-actualisation, and physiological needs (Maslow, 1943)) have been enhanced. The right to live in clean and green environment, to receive efficient and on-time health and social care, to be freely and conveniently mobile, to be economically grown, to be easily informed, connected, and communicated, are some examples of modern human demands, which are usually unseen or remain as unmet, especially in urban environments.
Thus, people face difficulty in living in the urban areas, so that the city authorities need to develop livability for the citizens by making all components of a city smart (Marciniak and Owoc, 2013; Mosannenzadeh and Vettorato, 2014).
In a non-smart city timely services are demanded by citizens, but the resources (e.g. finance, information, human) for planning, designing, funding, and operating them arrive later. Consequently, decision-making will be postponed and there is no immediate service for the citizens. However, in a smart urban environment, the city authorities have immediate access to information; they interact with citizens, answer their enquiries, and resolve their problems immediately, efficiently, and effectively. The citizens also benefit from easy access to offices virtually rather than through physical offices with long queues (Harrison and Donnelly, 2011).
As reported by Copenhagen and Cleantech Cluster (n.d.), a city cannot be called smart when the following weaknesses exist:

- There are too many surpluses in it (e.g. in using cars, in water, food, and energy consumption);
- Different sectors are not using each other's information and processes;
- There is not easy and enough mobility for citizens, information, energy, and capital; and
- All stakeholders (e.g. city authorities, private sector, knowledge institutions, and citizens) are not part of the decision-making process.

Most of these components emphasise that a smart city is more about cooperation than competition. It is also about long-term planning, not short-term achievements (Townsend, 2013).
Some other benefits of SCD are as follows:

- Massive improvement in crisis management by integrating data and processes of all sectors, agencies, and systems, such as healthcare, fire service, police, Red Cross, ambulances, and shelter providers. For example, in Rio De Janeiro, city authorities in collaboration with IBM dramatically improved the flooding crisis management by predicting heavy rains 48 hours in advance. They integrated and visualised 30 of the cities' public agencies to build an operation centre with access to real-time data from police, weather, traffic, energy, water, and healthcare services. Consequently, real-time information from football matches to road accidents are provided to citizens through social media applications. In the event of severe weather conditions, text messages are sent to particular persons, and appropriate actions are taken. (Copenhagen and Cleantech Cluster, n.d.; Nusca, 2011). It was also used for managing Olympic Games 2016;
- Understand and access to the repeatable behavioural patterns of a city, including the ability to preview the impact of changes by

manipulating key factors. It can also help to detect abnormal behaviours for individual citizens, for example by analysing the characteristic pattern of water consumption, it is possible to detect that a garden hose has been left leaking in a particular house (Harrison and Donnelly, 2011);

- Providing fully connected and integrated urban facilities that work together efficiently and answer the citizens' needs in real-time (Liu and Peng, 2013; BSI, 2014c). For example, in a smart city, parking spaces are connected to smart parking meters and navigation systems that guide drivers to find available spaces in real-time.
- Providing real-time information for citizens and authorities by all sectors as a whole (Harrison and Donnelly, 2011; BSI, 2014b; BSI, 2014c), for example:
  - In energy consumption, managers can evaluate and make the best decisions at the peak times and encourage citizens to quickly reduce their energy consumption;
  - In mobility, managers can handle the transportation problems more effectively. For example, the information generated by road-tolling points can be used to manage congestions in real-time. Citizens, police cars, and ambulances can also choose the best routes in real-time;
  - In the economy, for instance, real-time information of shoppers' behaviour and their patterns can be utilised by businesses to make decisions regarding their supply, pricing, and quantity of the products;
- Turning wastes into resources (Copenhagen Cleantech Cluster, n.d.); and
- Reducing cost of urban services and optimising them (Tomas et al., 2013).

Furthermore, according to Standard PD 8101: 2014 (BSI, 2014c) a large number of SCD benefits, such as integrated city services, agile planning, financial improvement, security and resilience enhance the citizens' quality of life and provide high-quality services for them. Nevertheless, the meaning of smart city and the necessities of this development should be fully understood.

3 SMART CITY CONCEPT

"Smart city" is not a new phrase. It has been adapted from the phrase "smart growth" by companies such as CISCO, IBM, and Siemens, which utilised information systems technology for operation of city systems since 2005 (Alawadhi and Scholl, 2013; Marciniak and Owoc, 2013). "Smart growth" movements commenced in the late 1990s for policy innovation in urban planning (Bollier, 1998; Anderson et al., 1998).

A common expression defines the smart city as "new public service innovation from bike sharing to pop-up parks" (Townsend, 2013). It has also been defined by a large number of researchers in various aspects of the city. For example, Schaffers et al. (2012) rely on technological innovations and discuss that smart city improves inhabitants' quality of life by utilising IT solutions. In contrast, Nam & Pardo (2011) pointed out that technology is not a crucial factor in SCD. They emphasised "process" as the most important factor in developing a smart city because the fundamental element of a smart city is the transformation of the way that services are delivered. In addition, Nam and Pardo (2011a) pointed out that three main smart city dimensions, which are technology, people, and institutions must be smart. They have classified terms such as digital city, information city, virtual city, and ubiquitous city in technology dimension. The terms knowledge city, learning city, creative city, and human city are also classified under the people dimension, and the terms smart growth and smart community in institutional dimensions that governance, policies, and regulations affect them. However, this dimension is mostly obtained by achieving the other dimensions as well as changing the business processes.

Based on the aforementioned aspects, smart city has been defined by researchers and experts. Table 2 summarises these definitions along with their main focusing aspect(s). Hence, conceptualising smart city from a business process viewpoint requires further discussion regarding the essence of 'smart', 'city', and their principles, which are discussed in the following sections.

3.1 The Notion of 'Smart' in the Context of This Research

The meaning of 'smart' depends on the application and the way of usage. The term 'intelligent' appears in all definitions of 'smart' in various contexts. However, smart means something more than intelligent (Allwinkle and Cruickshank, 2011), especially in the context of a city (Nam and Pardo, 2011a). In addition, the term 'smart' is more comprehensive and user-friendly than intelligent (Nam and Pardo, 2011a).

Table 1: Existing definitions for smart city and their significant focus.

Smart city definition	Significant focus	Reference(s)
A city that monitors and integrates conditions of all of its critical infrastructures	Technology and IT infrastructure	Hall et al., (2000)
An integration of systems and their interrelationship that make the system of systems smarter	Systems integration	Dirks & Keeling (2009)
The use of smart computing technologies to make the critical infrastructure components and services of a city, which include city administration, education, healthcare, public safety, real estate, transportation, and utilities more intelligent, interconnected, and efficient	Technology and IT infrastructure	Washburn and Sindhu (2009)
A city well-performing in a forward-looking way in various characteristics, built on the smart combination of endowments and activities of self-decisive, independent and aware citizens	Visions of well-being in the future (People)	Giffinger and Haindlmaier (2010)
Combining ICT & Web 2.0 technology with other organisational, design and planning efforts to de-materialise and speed up bureaucratic processes and help to identify new, innovative solutions to city management complexity, to improve sustainability and liveability	▪ Process ▪ Technology	Toppeta (2010) cited in Nam & Pardo (2011)
A place for utilising technology to process large amount of data to produce real-time information, knowledge, and intelligence	Technology	Schaffers et al. (2012)
A place in which there is enough communication between people and city systems, enough mobility, and no excess of consumption	▪ People ▪ Systems integration	Mortensen et al. (2012)
A conceptual urban development model based on the utilisation of human, collective, and technological capital for the enhancement of development and prosperity in urban agglomerations	▪ Technology ▪ People	Angelidou (2014)
An ICT-based infrastructure and services environment that enhance city intelligence, quality of life and other attributes (i.e. environment, entrepreneurship, education, culture, transportation, and so on)	Technology and IT infrastructure	Anthopoulos & Fitsilis (2014)
ICT-based technology connected up as an urban infrastructure to resolve various urban problems, such as public service unavailability or shortages, traffic, over-development, pressure on land, environmental or sanitation shortcomings and other forms of inequality	▪ Technology ▪ People	Lee et al. (2014)
Smart city can be viewed as "a continuum in which local government officials, citizens and other stakeholders could think about and implement initiatives that attempt to make a city smarter…"	People	Gil-Garcia et al. (2015)

In general, the word 'smart' is usually applied to define something as clever or intelligent, which thinks and acts quickly in difficult situations (Cambridge University Press, 2014). It has also been defined as a fashionable and upmarket when applied to a place (Oxford University Press, 2014). In technology, 'smart' refers to automation, such as self-configuration, self-optimisation, and self-protection. Smart homes and smart buildings are also related to a technology perspective that utilises connected sensors, mobile terminals, and embedded and inter-communicated devices (Klein and Kaefer, 2008). Smart systems are also connected and integrated systems that can analyse and describe situations and make decisions intelligently. Thus, smart systems comprise more capabilities than smart technologies. In fact, they include smart technology plus a high degree of reliability, efficiency, sustainability of the system as a whole, high security especially in extraordinary conditions, full integration, and an intelligent operational management (Akhras, 2000). Based on this argument, when 'smart' is applied to a 'city' that particular city should be fashionable, upmarket, clever, intelligent, and able to act quickly in complex situations and it can be achieved by agile, flexible, interoperable, and integrated processes.

3.2 City: System of Systems

As the current improvements in an individual city operations and providing services achieved by technology innovations and engineering-based attempts are not enough to have a smart city, the city should be seen as a system of systems, in which city sectors/organisations/systems interact, communicate, and share information with each other (Harrison and

Donnelly, 2011; Liu and Peng, 2013). These systems embody the city various sectors, such as transport, education, energy, healthcare, and so forth. The result of the collaboration between these systems provides efficient, effective, and real-time services for citizens. For such cross-sectoral collaboration, technology ameliorates the change from traditional services to smart city services. However, technology is only an enabler (Javidroozi et al., 2015). In developing a smart city, everything within the city including people, businesses, technology, processes, data, infrastructures, consumption, spaces, energy, strategies, management, and so forth should become smart. It is sometimes referred to as 'smart everything', meaning that these components should be connected, supporting each other, and using each other's data, with no waste. This is supported by a 'systems thinking' approach (Javidroozi et al., 2015; Medina-Borja, 2015). This argument is also supported by the systems thinking approach.

Based on a systems thinking approach, everything is related to everything else, so that everything should be connected to everything else, to get the benefits of a change in the whole system, so that improvement in one part affects the other parts (Checkland, 1981, 1999). The city as a 'system of systems' should also adhere this rule, so as to provide smartness for everything within the city, especially city sectors and systems (Harmon and Trends, 2010; Mortensen et al., 2012). In other words, understanding the components and factors for SCD requires an approach to systems thinking theory (Davidson and Venning, 2011), which reflects a city as a system of systems. According to this view, the whole city system comprises many systems (sector), which include their own data, processes, technologies, and people working together to enhance their performance and achieve their goal.

3.3 Systems Integration: A Necessity for Smart City Development

Viewing a city as a system of systems leads to cross-sectoral communication within a city. Consequently, cross-sectoral business processes, which are a part of the city system should be flexible, dynamic, agile, and connected to the relevant systems of a city (Vojdani, 2008). Moreover, information should be easily usable, shareable, and connected across the city sectors (Barth et al., 2017). Citizens should also interact with each other and with everything else, including technologies, devices, and offices, in an intelligent and smart manner. They should act as an integral part of the economic, social, and cultural development of the city, and they should know how to use and interact with the smart facilities of their smart community (Allwinkle and Cruickshank, 2011). Therefore, everything that is required for delivering a service should be connected to each other.

Currently, Local Government Authorities have implemented technological solutions for automation and improvement of their business processes, and providing agile, flexible, and more efficient city services. However, using smart and innovative technologies is not the single requirement of a smart city. A seamless connection (integration) between city sectors/systems is required to improve sustainability and efficiency in offering public services.

Four necessities for SCD, including systems integration, investment, collaboration of stakeholders, and technology have been indicated in Mosannenzadeh and Vettorato's (2014) smart city framework, shown in Figure 1. However, as stated by Kanter et al. (2009) and Kamal et al. (2013), the technology should be a part of an integrated system across various sectors to provide a smart environment and facilitate more joined-up and citizens-centric services.

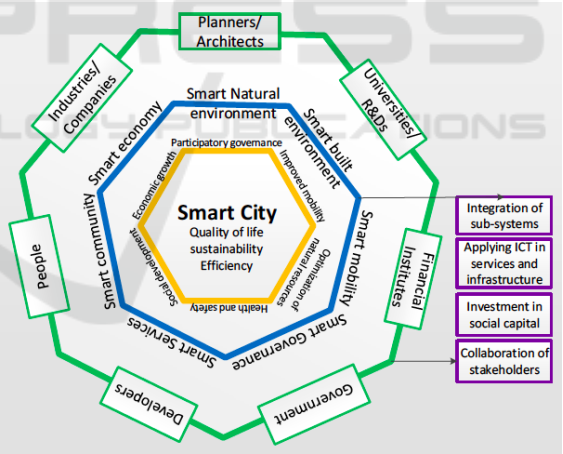

Figure 1: A conceptual framework to define smart city (Mosannenzadeh and Vettorato, 2014).

Based on Mosannenzadeh and Vettorato's (2014) framework, SCD is triggered by the necessities of urban innovation (yellow layer). Moreover, the framework emphasises that systems integration, which is located between the components of smart city (blue layer) and stakeholders of SCD (green layer), plays a central role in SCD.

Relevantly, standard PAS 181: 2014 (BSI, 2014a) has developed a Smart City Framework (SCF), shown in, Providing some guidelines and principles for SCD.

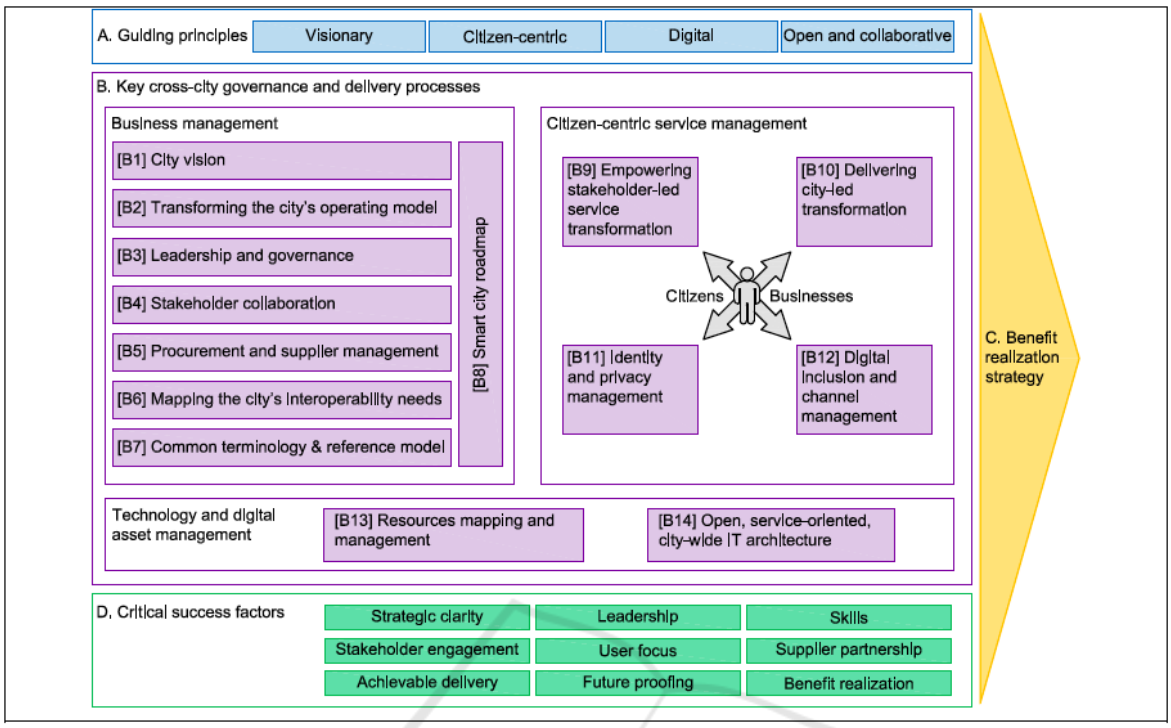

Figure 2: A high-level structure for Smart City Framework (SCF) (BSI, 2014b).

As described in this standard, establishing a joined-up environment across city silos is necessary for SCD. Thus, SCF suggests a set of practical guide notes, including business management, service management, technology, and digital asset management, on how to address the challenges of systems integration for developing a smart city. Likewise, according to PAS 181: 2014 (BSI, 2014a), transforming the traditional operating city model, from being performed by vertical silos of functional-oriented service providers to a modern integrated model, which operates city through innovation and collaboration across those vertical silos is achievable by integrating city systems. Stakeholder collaboration, cross-sectoral leadership/governance, interoperability within the city, and efficient procurement processes can also be achieved by integration of city systems and by changing city processes.

3.4 A Business Process-centric Concept of Smart City

As discussed in the previous section, the citizens' needs must be met by seamlessly connected services that are delivered by using all information and knowledge generated by the sectors, and this can be achieved by cross-sectoral city systems integration (Kanter et al., 2009b; Kamal et al., 2013). As a result, systems integration is the most important necessity for developing a smart city, because it is a key task in nearly all areas of SCD (Kanter et al., 2009b; Arnold et al., 2015). Moreover, since BPC is the most important requirement of systems integration (Javidroozi et al., 2014, 2016), it will be an integral component of the modern integrated future cities (Liu and Peng, 2013; Aelenei et al., 2016). Hence, consideration of BPC as part of SCD ensures that a city can offer seamless services to citizens in real-time, through inter-connected business processes across the city sectors (BSI, 2014a). Thus, smart city developers have to think about BPC rather than technology implementation, because technology cannot improve the performance by enabling poor, ineffective, wasteful, and disengaged business processes.

Consequently, a BPC-centric definition of smart city for is articulated as follow:

"A smart city is a system of systems in which city process change have been accomplished, in order to integrate cross-sectoral city systems, enabling access to real-time information and knowledge by all the city sectors, providing integrated services, and enhancing livability, workability, and sustainability for the citizens".

According to this definition, in a smart city, the city systems are seamlessly connected to each other, are sharing data and business processes, and are using each other's resources efficiently and effectively.

4 CONCLUSIONS

Fast growing urbanisation in the world has necessitated SCD. Nevertheless, developing smart cities is not only about implementing and using smart and innovative technologies. The technology should be a part of an integrated system, but changing cross-sectoral city processes is the most important area of activity, in order to provide accessible, efficient, effective, and real time services to citizens of future cities. While current SCD related literature mostly focus on technological and people aspects, this research emphasised the significance of BPC and proposed a business process-centric concept for SCD by highlighting the SCD fundamentals such as considering city as a system of systems, systems thinking approach, and the necessity of city systems integration.

Hence, emphasising on one of the significant aspects of systems integration for SCD, this research added to a growing body of literature on SCD, city systems integration, and city process change. However, since SCD is a newly emerged and growing domain in both academic and practical settings, further research and developments are required for extension and comprehension of this field. Future directions of research would also be on addressing BPC for SCD by identification of the challenges, success factors, tools, and techniques that are useful to effectively change city processes.

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