Sustainable Development of Smart Cites: A Qualitative Research Design

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ABSTRACT

The smart city thought alludes to better of organising city functions and urban life, which are accepted to move production and consumption from worldwide to local, manufacturing from competitive to collaborative, and business from stakeholders to a customer point of view. Policy makers have addressed the need for sustainable development and increasing urban population density in part by using smart city theory and practices. Current smart city frameworks are best categorized as descriptive theories. There has been a gap in the literature regarding smart cities. Most past research has focussed on the societal level of smart cities, while less appears to be recognised about the management of business as part of smart cities. The determination of this paper is to present a systematic review on the state of the art of management research on smart cities. A total of 20 papers which based on midsized smart-designated cities have been discussed. Those research papers mostly collected data from government websites and city manager surveys. This paper emphasised on the policy and societal level issues which create hurdles in developing smart cities. The review on the literature of smart city framework creates the roadmap for the use in both future research and for cities planners to advance smart city development and to act as responsible stewards for stakeholders who rely on researcher's directions.

Keywords: Smart city, ICT, sustainability, smart city dimensions

I INTRODUCTION

The ratio of urban population is more than 50 % population of whole world (Cohen, 2006). By 2030, five billion people, two-thirds of the world's population, will live in metropolitan areas. Increasing population density is placing increasing demands on city services and infrastructure, and at the same time citizens are demanding sustainable development plans (Nam & Pardo, 2011b). Unplanned urban sprawl and population growth creates negative externalities in the form of deteriorating quality of life, waste disposal issues, strained government budgets, over-burdened healthcare delivery systems, pollution, crime, and traffic congestion (Chourabi et al., 2012). The need for sustainable development is driving interest by public policy makers in "smart city" concepts (Nam & Pardo, 2011b). Dozens of mid-sized cities designated as "smart" by academics, professional associations, and trade journals use a blend of concepts drawn from sustainability and smart city framework. This study intends to address the gap in the existing literature and integrate the findings of the data analyzed regarding the relationship between smart city theory and practice.

There has been no generally accepted definition for a smart city among researchers, practitioners, and the media. Each used a variety of similar terms including "sustainable city," "knowledge- based economy," "intelligent city," and "skilled city," (Hollands, 2008; Nam & Pardo, 2011a). Working definitions of a smart city generally included one or more of the following factors: sustainability, information communication technologies (ICT), governance, and human capital (Nam & Pardo, 2011b). Smart city definitions have roots in e-government and web enablement of basic cities services (Chourabi et al, 2012; Deakin, 2009; Frank, 2011; Hao, Lei, & Zhu, 2012). As smart city concepts matured, smart cities came to feature ubiquitous wireline and wireless network access, automated operational applications, web-based government services, and in some cases broadband networks funded by cities (Nam & Pardo, 2011b). Smart city definitions evolved to include the integration of network infrastructure to intelligent applications designed to improve efficiency, reduce traffic congestion, improve electric grid efficiency, automate utility meter reading, and automate a range of previously manual processes.

Public policy makers and urban planners embraced sustainable design, programs, policies, and processes to measure progress toward the smart city ideal (Chourabi et al., 2012; Millard, 2010; Nam & Pardo, 2011b). In an article describing smart city framework, Lazaroiu and Roscia (2012) argued a smart city was defined by progress toward integrating policy, technology, and education to create a sustainable city. Progress was measured mathematically using measures of environmental efficiency such as greenhouse gas emissions and energy use per citizen. This modeling process led to the development of smart city "markers," but Lazaroiu and Roscia (2012) noted that as these

markers were more deeply examined, the ability to define a smart city became less objective. For example, mathematical analysis of a city's energy output can be useful in evaluating progress toward sustainability, but researchers identified the need for a much broader conceptualization of a smart city to make the construct useful.

II LITERATURE REVIEW

Smart city as a complex interactive system: Smart cities are comprised of groups of complex systems and subsystems and interrelated processes in which events in one component may have significant, sometimes unpredictable, repercussions in many other subsystems (Cocchia, 2014; Miao & Evans, 2013). Ubiquitous access utilizing using smart devices using public and private wireless networks provide the infrastructure that enables an array of digitally delivered services. Ubiquitous internet connectivity transform government processes internally across agencies and externally to citizens and businesses in complex and interacting ways (Cocchia, 2014). Wireless mobile smart devices produce "big data", which "enables real-time analysis of city life, new modes of urban governance, and provides the raw material for envisioning and enacting more efficient, sustainable, competitive, productive, open and transparent cities" (Kitchin, 2014).

Chourabi et al. (2012) posit that a smart city can be conceptualized as a large, complex set of systems and subsystems with an array of integrated processes and components. As with any complex interactive system, the smart city as a whole represents more than the simple sum of its parts. Layers of interacting applications, logic, and intelligence exists in the space between city physical infrastructure and its citizens to create and deliver the best possible solutions to the negative externalities resulting from increasing urban density. Modern smart cities differ from earlier postindustrial incarnations in that, like organisms, there is an underlying "nervous system" with both short-term and long-term feedback loops to enable communities to behave in intelligent, coordinated ways (Chourabi et al., 2012). A city's "smartness" resides not so much in one place as in the integration of digital telecommunication networks (similar to nerves), ubiquitously embedded intelligence (similar to brains), sensors and tags (similar to sensory organs), and software (similar to knowledge and cognitive competence) (Chourabi et al., 2012).

As shown in Figure 1, Chourabi et al. (2012) theoretical framework includes the following smart city subsystems and components, or factors: (a) management and organization, (b) technology, (c) governance, (d) policy, (e) people and communities, (f) the economy, (g) built infrastructure, and (h) the natural environment. Managerial and organizational systems include best practices embedded in successful business or IT projects. Technology refers to interacting systems of networks, applications, and sensors that comprise the technical infrastructure. *Governance* means a system of governmental infrastructure that is accountable, responsive, and transparent. These governmental systems enable seamless collaboration, data exchange, service integration, and communication. The *policy* component is a general institutional framework comprised not only of laws and regulations, but also of norms, actions, and behaviors that people accept as good or take for granted. These policies should promote the free exchange of information across all systems and reward innovation. People and communities refer to the need for informed, educated, and participatory citizens. "Smart governance" sets the rules and ensures outreach to all communities. The *economy* refers to a strong tax and commercial base to fund creation and maintenance of the smart city. *Built infrastructure* incorporates the ICT physical infrastructure as the necessary predicate the other seven systems need in order to operate in smart ways. *Natural Environment* refers to the fundamental smart city tenet that technology be used to increase sustainability and better manage natural resources.

III SMART CITY FRAMEWORK

The As indicated by its central position in Figure 1, smart city initiatives lie at the intersection of smart theory and smart practice. Outer factors (governance, people and communities, natural environment, infrastructure, and economy) are filtered through inner factors (technology, organization, and policy) before influencing the formation and execution of smart city.

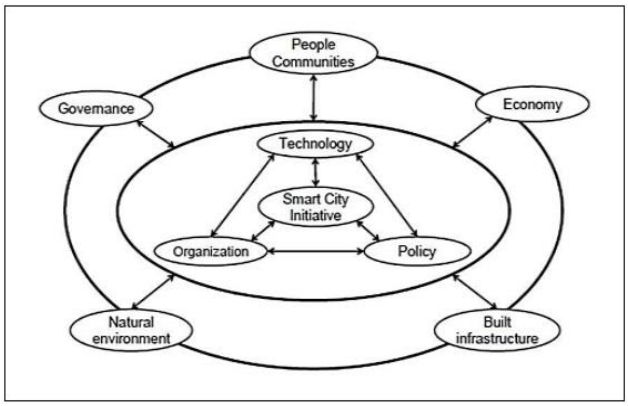

Figure 1. Smart City Theoretical Framework (Chourabi et al., 2012)

The Smart City Framework presented in Table 1 defines the intersection between smart city theory

and practice as identified in this study. The Smart City Framework is used in Table 1 to report the incidence of smart city initiatives by city and by category, respectively. To characterize smart city initiative types, the Smart Cities Framework was developed iteratively by aggregating and distilling information from smart city theory. As shown in Table 1, Smart City Framework includes three major dimensions and seven sub-dimensions. The major dimensions were technological innovation, governance, and human capital. The technology dimension was subdivided into environment, transportation, and ICT infrastructure sub-dimensions. The role of ICT is related to the development of smart initiatives within all smart city drivers, but it has also a clear relationship with the challenge of sustainable development in urban environments (Lombardi et al., 2012; Meijer & Rodríguez-Bolívar, 2015) for all citizens, looking for a participation as wide as possible (Vanolo, 2014; Luque-Ayala & Marvin, 2015). The governance dimension was divided into direct budget and partnerships/economic development sub-dimensions. The human capital dimension was divided into people and living sub- dimensions. The Smart City Framework had significant overlap with a multi-national analysis of smart city practices recently completed by Neirotti, De Marco, Cagliano, Mangano, and Scorrano (2014).

Table 1. Smart City Framework

Dimension	Sub-Dimension	Smart Initiative Type
Technological Innovation	Environment	Smart Buildings
		Resources Management
		Smart Grid
		Renewable Energy
		Water Conservation
	Transport	Traffic Management
		Inter-Modal Access
		Smart Passenger Cars
	Infrastructure	Physical Plant
Governance	Direct Budget	Policies to Promote Access and Safety
	Partnerships/ Economic Development	Business Formation
		Clean Job Creation
Human Capital	People	Inclusion
		Education
	Living	Culture and Well-being

The detailed explanations of terminologies mentioned in this table are discussed as follows:

Technological Innovation. Smart cities strive to develop ubiquitous, accessible, available, integrated, and efficient ICT networks to deliver sustainable development and capture efficiencies (Chourabi et al., 2012; Hollands, 2008; Nam & Pardo, 2011b). The ICT infrastructure integrates hardware, software, and network technologies to create real- time awareness through sensors, databases and software to seamlessly optimize individual processes into an integrated whole (Nam & Pardo, 2011b). Smart technology is mobile, virtual, and ubiquitous.

Environment. The environment sub-dimension was further organized based on observations into smart buildings, resources management, and planning sub dimension types. Seventy-one percent, smart cities had one or more initiative in the resource management sub-dimension type. Resource management initiatives were dominated by energy efficiency initiatives, such as tax rebates, direct subsidies, and loans to install more energy efficient lights, motors, and insulation.

Transport. The transport sub-dimension overlaps with environment in the sense that both involve improvements in energy efficiency, but differs in terms of strategy, tactics, and underlying infrastructure addressed. Several smart cities, in conjunction with local universities, such as the University of Michigan and University of California at Berkeley, and automakers were involved in research studies to develop a smart highway system to reduce traffic congestion and save energy (Cepolina & Farina, 2012). An example of traffic management systems was a toll system with day part pricing that had tolls as much as 100% higher during peak usage periods.

ICT Infrastructure. The ICT infrastructure sub-dimension refers to mobile, internet-based, ubiquitous, integrated, and accessible ICTs to deliver optimized city services and leverage existing transportation infrastructure (Nam & Pardo, 2011b). Chattanooga, TN was an example of a city that invested directly in building physical broadband capacity using tax dollars. The majority of the study sample relied on the private sector to build internet and wireless infrastructure.

Governance. Nam and Pardo (2011b) reduced the eight factors identified by Chourabi et al. (2012) to three: technology, human capital, and governance. Governance is a multidimensional construct placing

equal importance of technology, organization, policy, and context dimensions. Packages of consonant policies aimed at innovation and sustainability are essential ingredients for smart city development. Direct budget and partnership/economic development sub dimensions were developed to differentiate between cities budget items and expenditures by non-governmental entities.

Direct budget. Smart cities budget investments should support the technology base-most notably government service delivery via departmental web sites-to promote government efficiencies and reduce costs. Types within the direct budget governance sub-dimension were derived from the theoretical framework of Nam and Pardo (2011b) and Chourabi et al. (2012). Governance sub-dimensions include web-enabled government services, open government, and safety types.

Partnerships/economic development. For nearly all smart cities in the study sample, smart initiatives focused on economic growth and promoted efficiencies through public/private partnerships. Economic Development Agencies typically initiated, developed, and managed smart initiatives and nearly half of all initiatives could be characterized as economic development. Economic development initiatives ranged from large-scale public investments to small-scale job incubators and venture capital financing. The partnerships/economic development sub-dimension was subdivided into entrepreneurship and innovation, productivity growth, and local and global connection types. The majority of smart initiatives under partnerships/economic development involved clean job creation, clean business formation, and start-up capital for sustainable businesses.

Human capital. Hollands (2008) observed that creative solutions arise from creative minds. Smart cities must attract and retain college educated citizens, build educational institutions, and support businesses that train and employ knowledge workers. Well-educated individuals are attracted to renowned educational facilities, a vibrant arts scene, and other quality of life factors. a city to be smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructures fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance" (Caragliu et al., 2011).

People. While most of the smart city initiatives in the study were initiated by Economic Development Agencies, people-related smart initiatives emanated from either energy utilities or partnerships with city government. Nearly a dozen smart initiatives involved classes for learning how to manage businesses and homes using less energy.

The following examples illustrate typical education initiatives. Columbia, Missouri smart city offers all businesses and consumers Free Energy Audits to educate citizens regarding new energy efficient technologies that reduce energy consumption and work with citizens to finance and install energy efficient lights, and heating and air conditioning systems. Bellingham, Washington smart city, through the Sustainable Connection- Energy Efficiency initiative, offers all businesses and consumers free education on the economic and environmental benefits of switching from heating oil to natural gas or solar energy solutions. Services include free energy classes, energy audits, and financial incentives for conversion to energy efficient heating and lighting. Fort Collins, Colorado smart city, through the ClimateWise initiative, offers all businesses and consumers free education, on-site environmental consulting/audits, and financial benefits for replacing older lights and motors with more efficient technologies to reduce per capita annual energy usage. Few programs or practices for scholarships, internships, or mentoring programs were available under the smart rubric, which was unexpected given the people-orientation in the literature (Florida, 2005; Hollands, 2008).

Living. The Living dimension figures prominently in the literature (Nam & Pardo, 2011b) and was included in the Smart City Framework despite the lack of reported initiative data. More than 50% cities promoted or subsidized activities that meet the smart definition living initiates, such as building Arts Centers to host the ballet or opera. However, there were no instances in the data in which cities managers, smart designators, or the media referred to those activities as part of a "smart" initiative or activity. The Living dimension was included because the recruitment and retention of a college educated workforce requires cities managers to meet their lifestyle needs even if the relationship to smart theory is not explicit, building Arts Centers is an essential element for city planners and managers too consider as part of an overall strategy.

Smart cities benefits fell into the following four broad categories, all of which involved sustainability on some level: energy efficiency, clean economic development, internet access, and energy education (Zanella, et al, 2014). Smart city initiative benefits directly reflect the benefits of environmental sustainability in general, which include cleaner air, better health, lower costs, and reduced pollution (NRDC, 2015). Smart cities policies were designed with economic benefits in

mind but also benefitted in other ways. There were four categories into which smart cities benefits could be divided: energy efficiency, clean economic development, internet access, and energy education. These benefits could be obtained by investing in several dimensions of initiatives that could create returns. These initiatives typically encompassed some form of financial subsidy or support in order to encourage private sector upgrades to clean technology or investment by private sector businesses into technology that supported smart cities policies.

IV RESEARCH GAPS IN SMART CITY

Cities' experience to impacts from some climatic events such as: an increase of sea level, flooding from changes in river streams and bigger risks of heat islands because of greenhouse effects (Pittock, 2017). Thus, this last can be measured one of many areas challenges' factors. However, when we talk about urban areas, demographic changes, technological, economic, social and environmental development issues must be principally featured that generate substantial constraints for the cities.

Smart city theory suggests that smart cities invest in initiatives that promote sustainable growth (Nam & Pardo, 2011b). A qualitative research design is suitable for smart cities development study, which is appropriate for this type of exploratory research (Leedy & Ormrod, 2015; Patton, 2002). Pragmatism is based on the idea that "ideas or principles are true in so far as they work" (Savin-Baden & Major, 2013). Smart city theory is in its infancy and the term smart cities has come to have many meanings for researchers, practitioners, and the media. There is little research on smarty city theory or smart initiatives and no validated instruments with which to gather data. Researcher emphasizes the importance of trying different methods based upon existing literature on smart city development frameworks (Savin-Baden & Major, 2013). The lack of clear definitions and accepted constructs makes pragmatism an appropriate qualitative research approach.

The literature suggested that smart city theory was being used to design and implement smart initiatives to promote sustainability in smart cities (Chourabi et al., 2012; Hollands, 2008; Nam & Pardo, 2011). Smart city theory also suggested solutions for social, political, and organizational problems of urbanization using innovative management, policy, and technology (Nam & Pardo, 2011). There was a gap in the existing literature regarding the types of smart initiatives being implemented, their anticipated benefits, and their relationship to smart city theory. Existing literature also did not recognize the linkage between smart city theory and sustainability theory, but rather focused on environmental sustainability as a component within smart city theory.

The goal was to link smart city theory with smart city practice, thereby further elaborating smart city theory that means "what constitutes a smart city". Future research might use data from this study to measure the efficacy of various smart initiatives.

To characterize smart city initiative types, the Smart City Framework was developed iteratively by aggregating and distilling information from smart city theory, 144 smart initiatives in the 14 smart city sample, and data collected from the Smart City Manager Survey (SCMS).

V CONCLUSION

This paper focuses on the smart city prior literature and integrated framework on smart city by Chourabi, et al (2012). Smart city framework displays that cities have a number of options that can help promote sustainable practices. Environment and governance are the dimensions within which the most initiatives emerged, and these initiatives typically involved educating the population in order to create a more energy efficient city. Subsidies and rebates are also available to the population to help them put into practice what they learned about clean energy, as these subsidies and rebates helped the population to upgrade better insulation and more efficient lighting and motors. Smart city framework could be expanded to include non-financial metrics to measure intangible benefits not adequately understood by practitioners (Alawdah, 2017).

Smart cities successfully implement initiatives in technological innovation, governance, and human capital to deliver improvements in sustainability and economic growth (Taylor & While, 2017). These initiatives are leveraged by use of advanced technology, the presence of higher education, and thoughtful use of government incentives. As such, research on smart cities has drawn attention from scholars and practitioners alike. This paper presents that there are many gaps on the dimensions of ICT and smart city development such as the environmental sustainability, ICT Infrastructure, smart transport and economic development, which are useful and should be encouraged. More importantly, this study suggests that there are many overlaps between the three key smart city dimensions (technological innovation, governance, and human capital), which indicates the need for a multidisciplinary, interdisciplinary, or transdisciplinary collaboration approach to integrate theory and practice to maximize the potential for real positive impacts on sustainability. The review

on the literature of smart cities framework creates the roadmap for use in both future research and for cities planners motivated to advance sustainable city development and to act as responsible stewards for their stakeholders who rely on researcher's judgment.

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