

What is a Smart City for information systems research in Africa? Review protocol and initial results

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Abstract

The concept of a “Smart City” has been approached from different perspectives by researchers from different fields in recent years. In the process, various characteristics of “smartness” have been proposed and explored. While there are elements in common, the different ways of understanding the term “Smart City” reveal different assumptions about cities and their inhabitants, contextual differences, as well as disciplinary biases. There is the danger that the loose use of the term might create misunderstandings and dissent.

This paper sets out a protocol for a systematic review of research into information systems for Smart Cities. We report initial findings of the review, analyse the ways in which a Smart City is defined by information systems researchers and investigate the possibility of a consensus definition. We also interrogate the smart city efforts of five African cities (Cairo, Cape Town, Johannesburg, Lagos and Nairobi) to understand the relevance of the definitions used by researchers to practitioners.

Keywords

Smart City; Intelligent City; Systematic Literature Review; Information System; Information Service; Africa

19 Introduction

The concept of the smart city is employed as an umbrella term for a range of technological, governance, management and ecological concerns about urban living. The characteristics of a “smart city” are often enumerated by researchers who identify governance, transportation, economic activity, people, and the natural and built environments amongst the targets for city “smartness” (Giffinger et al., 2007, Yigitcanlar et al., 2008, Chourabi et al., 2012, Caragliu et al., 2011, Neirotti et al., 2014).

Smart cities have also been defined in terms of the “performance” of the city (Giffinger et al., 2007) where smart city outcomes include sustainable economic growth and a high quality of life (Caragliu, Del Bo, & Nijkamp, 2011). Many definitions recognize people as a central component of urban life (for example Chourabi et al., 2012; Giffinger et al., 2007; Neirotti et al., 2014). Although for some the focus is on the needs and preferences of elite knowledge workers (Yigitcanlar et al., 2008), others are concerned with all the people in the urban environment and how they can take advantage of the benefits of smart living (Caragliu et al., 2011; Odenaal, 2003) and overcome problems of digital divides (Partridge, 2004).

A common thread that cuts across various definitions is an expectation that information and communication technologies (ICT) play a significant enabling role in the creation of smart cities. Some researchers however considers ICT’s role narrowly by defining a smart city in terms of sensors and networks (Washburn et al., 2010; Roche and Rajabifard, 2012) and where the role of ICT is to provide for what might be termed “digitally connected living” where citizens have access to the necessary applications, hardware devices, network infrastructure, and the e-skills to use information resources. Others are focused on the extent to which city services are being automated, informed or transformed through the use of technology (Lee and Lee, 2014), with current efforts largely pointing to a role for ICT in providing for “informed living” – the state where information systems facilitate both the use of information to support decisions and actions in people’s daily lives and the generation of information as a consequence of those decisions and actions (Giffinger et al., 2007; Velosa and Tratz-Ryan, 2013). Given all the varying conceptualizations of the smart city, the question arises as to whether it is possible to arrive at a consensus definition of a “Smart City” that can inform information systems research into the development of Smart Cities in the African context?

We contribute to answering this question, by examining how information systems researchers understand smart cities, and how these conceptions relate to the approaches being taken by city governments in Africa to make their cities smarter. We present preliminary results of a systematic review of definitions of Smart Cities used in IS research, and consider how the literature-based conceptions of Smart Cities are reflected in smart city efforts underway in five African cities (Cairo, Cape

Town, Johannesburg, Lagos and Nairobi). The paper concludes with our reflections on the results obtained thus far and a discussion of our future research.

20 Systematic Review Protocol

To address our objective of identifying a definition of Smart Cities to guide research into the role of information systems in Smart Cities, we carried out a systematic literature review, in a manner similar to other systematic literature reviews in the software engineering space (Kitchenham *et al.*, 2009; Gutierrez *et al.*, 2013).

The research questions that the review addresses are:

- 1) For researchers in information systems, what is a Smart City?
- 2) Is it possible to identify a consensus definition of a Smart City for information systems research?
- 3) How do the definitions in use relate to the nature of the research being undertaken?

Search strategy

A challenge in conducting the review was the cross-disciplinary nature of Smart City research. Even though our interest was in definitions appropriate to information systems research, working with the literature within a specific discipline (such as information systems) would have excluded a wide range of relevant research. For this reason we made use of databases that cover multiple disciplines to source articles, as well as those specific to information systems. The databases selected were Scopus, Science Direct, ACM Digital Library, AIS Electronic Library, Africa Portal, and Sabinet.

The search terms for the study were based on the research questions. We searched for “smart city” and “information system”. We restricted the search to articles in peer-reviewed scholarly journals, transactions or conference proceedings on the assumption that peer-review would ensure a level of quality. We included conference papers and transactions because of the newness of the field.

Inclusion and exclusion criteria

An initial search of Scopus revealed that in the years 1995 to 2007 there were only five papers published that used the term “Smart City” and at most one paper in any given year. We therefore searched only on articles published from January 2009 to May 2014 (inclusive). Papers were included for review only if they were peer-reviewed and written in English, addressed the theme of how information systems (broadly interpreted) contribute to the development of Smart Cities and were accessible via the university’s library holdings.

Papers were excluded if they reported duplicate results from another paper, if information systems were peripheral to the study, if the concept of a smart city was peripheral to the study, or if the research was carried out in rural rather than urban contexts.

Data collection

The searches were performed between the 16th May 2014 and 28th May 2014. For each paper included in the study, the following information was recorded in a spreadsheet:

- Author(s) and Year of publication
- Title and Journal details
- Abstract
- Any explicit Smart Cities definition
- Any implicit Smart Cities definition and the text to support that interpretation

Our process resulted in 90 papers being identified for title and abstract review. The abstracts were reviewed by the two authors individually for inclusion according to our criteria. Discrepancies were discussed and agreed on. Sixty papers met our inclusion criteria.

21 Initial Analysis and Results

The analysis presented here was carried out on the first 30 of the identified papers, limited only by time constraints. A complete analysis is still under way and will be reported in due course. Information about the papers is summarized in Table 2.

Table 2: Summary of Included Papers (n=30)

	Number	Percentage
Year of Publication		
2009	1	3.3%
2010	2	6.6%
2011	2	6.6%
2012	6	20%
2013	11	36.6%
2014	8	26.6%
Publication Type		
Conference Proceedings	11	36.6%
Journals	18	60%
Book Chapters	1	3.3%
Focus of Paper		
Smart city technologies	21	70%
Smart city services	9	30%

Definitions in use

Once the abstract review was complete, each included paper was read in detail by one of the co-authors to identify whether the paper included an explicit definition or conceptualization of the idea of Smart City. Where there was no explicit definition we looked for a definition implied by how the term was being used or referred to. Seventeen papers had explicit definitions, of which seven were the author's own definitions and ten were references to other researcher's definitions. In a further ten papers we could identify implied definitions. In three papers we could find no definition and could not identify an implied definition.

The ten papers that cited definitions took them from varied sources. The following authors' definitions were cited: Cook and Das (2005), Nam and Pardo (2011), Komninos *et al.* (2011), Sharma *et al.* (2010), Washburn *et al.* (2010), Giffinger *et al.* (2007), Toppeta (2010), Chourabi *et al.* (2012), Caragliu *et al.* (2009). Each was cited by one of the papers with the exception of Giffinger *et al.* (2007) which was cited in two of the papers. In addition there were references to Smart Spaces based on definitions by Kallmann and Thalmann (1998) and Kortuem *et al.* (2010) as well as the Ubiquitous City or "U-city" which is apparently defined by legislation in Korea (Shin *et al.*, 2012).

We classified explicit and implicit definitions according to whether they were focused on technology (T) or services (S). That is definitions of smart cities that prioritized the role of technology in smart cities were coded T, while those that prioritized the provision of services by the city, with technology playing a facilitating role (if any) were coded S. We then examined the extent to which the definition was narrow (N) or broad (B). A technology focused definition was coded as N if it referred to the provision of or demand for a single technology and B if it referred to the provision of, or demand for multiple technologies. Service-oriented definitions were coded as N if they referred to the provision of, or demand for a single service and as B if they referred to the provision of or demand for multiple services.

Of the 27 explicit and implied definitions, 17 had a service focus and 10 had a technology focus, while 19 were classified as broad and 8 as narrow. This means that information systems researchers tend to understand smart cities as being about the provision of a broad range of services. Figure 1 summarizes the varying definitions of smart cities in Information Systems research with examples.

Figure 1: Examples of Smart City definitions in use in IS research

T/B (n = 5)	S/B (n = 14)
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Broad	<p>“a connected community that combines broadband communications infrastructure” (Al-hader <i>et al.</i>, 2009)</p>	<p>“a metropolitan area can be classified as smart when safety, enhanced public services, healthcare monitoring, green sustainability, intense social interaction, and efficient transportation systems become available to any citizen wherever he is located.” (Piro <i>et al.</i>, 2014)</p>
Narrow	<p>T/N (n = 5) “Smart City is a program focused on modernization and reconstruction of existing engineering networks, to create a common information space of the territory.” (Duravkin, 2010)</p>	<p>S/N (n = 3) “provide opportunities to transform the relationship between government and citizens in a new way” (Ghatak and Singh, 2010)</p>

Technology Focus

Service Focus

Relationship between research and definitions

In order to compare the definitions with the nature of the research being carried out, we also classified the research being done in each paper according to whether it was technology or service focused and whether it took a broad or narrow perspective. Thus we classified a paper as technology-focused (T) if it investigated the consumption or delivery of a technology or technologies and service-focused (S) if it investigated the consumption or delivery of a service or services. We then examined the extent to which the research being undertaken was narrow (N) or broad (B). A technology focused paper was coded as N if it researched the provision of or demand for a single technology and B if it researched the provision of, or demand for multiple technologies. Service-focused papers were coded as N if they researched the provision of, or demand for a single service and as B if they researched the provision of or demand for multiple services.

Of the 30 papers, 9 had a services focus and 21 were technology-focused while 15 were classified as narrow and 15 were classified as broad. This means that despite the information systems researchers making use of definitions of smart cities that are service oriented and broad, the majority of research being carried out is focused on technologies, rather than services.

Thirteen of the papers were doing research that was consistent with the definition in use. Five papers were reporting broad, services-focused research and making use of a broad, services-oriented definition of smart cities. Four papers were reporting narrow, technology-focused research and making use of a narrow, technology-oriented definition.

Fourteen of the papers were doing research that was inconsistent with the definition in use. Of these, six papers were reporting broad, technology-focused research, while making use of a broad, services-oriented definition for smart cities. A typical example of this would be the paper by Piro et al. (2014) which discusses the technology and network architectures required to make a smart city viable, while defining a city as smart when “when safety, enhanced public services, healthcare monitoring, green sustainability, intense social interaction, and efficient transportation systems become available to any citizen.”

Thus far we have encountered only one paper that has a narrow, technology focus while making use of a broad, service-oriented definition of smart cities. The Poulton and Roussos (2013) paper examines modelling and simulation tools used by the London ambulance service (a narrow, technology focus) while implying that city smartness relates to using ubiquitous technologies to react to human dynamics in the city in providing for human needs (a broad, service orientation).

The broad service definitions view the smart city as one that enhances quality of life by informing (in the sense of Zuboff, 1988) the city’s services i.e. providing residents with an *informed living* experience (Lee and Lee, 2014). The technology focused definitions reflect *digitally connecting living* as the foundation of the city where a networked infrastructure provides a platform for city residents to enjoy anytime anyplace access.

22 Smart City Plans of African Cities

To determine whether the above smart city conceptions relate to the approaches being taken in Africa, we examined the smart city plans of five African cities. These cities were selected based on their being large (by population), having a GDP per capita of at least US\$1500, and on relevant information being uncovered during our desk-top research.

Johannesburg (pragmatic; the definition is academic)

The City of Johannesburg has adopted Caragliu et al.'s (2011) definition for a smart city as one where "investments in human and social capital, and traditional (transport) and modern (ICT) communication infrastructure, fuel sustainable economic development and a high quality of life, co-exists with the management of natural resources, through participatory action and engagement". In operationalising this, the city has projects underway to address digitally connected living as the prerequisite to informed living.

Cape Town (strong on service)

The City of Cape Town's Integrated Development Plan⁸ makes no explicit reference to a Smart City but speaks to a service orientation focused both on transforming the way that local government works and delivers its services, and the way the entire society operates. The plan references the Opportunity City (economic development and mobility), the Safe City (crime prevention and management), the Caring City (housing and healthcare), the Inclusive City (service management and community facilities) and the Well-Run City (transparency and administrative efficiency).

Lagos (any definition will do)

At the other extreme, Lagos has been described as a "self-service city" (Gandy, 2006) where the residents have largely given up any expectation of services being provided by the city management. Instead, residents are defining a smart city for themselves through entrepreneurial networks to provide everything from water to technology hubs. Lagos participated in the IBM Smarter Cities Challenge from which emanated recommendations to use technology solutions to better manage traffic and co-ordinate emergency services in the city.⁹ The implied understanding of Lagos State Government's collaboration with the private sector to build Eko Atlantic city on the outskirts of Lagos, is that a Smart City is a "modern" spaces for business and leisure for the middle and upper classes and tourists. Here we find that, in the absence of government leadership in defining a smart city for the local context, international technology and construction providers step in to present their own technological definition, often at odds with the needs and preferences of the poorer sectors of society (Walker, 2014).

Cairo (competing definitions)

Cairo's Vision 2050¹⁰ defines a smart city as "global, green and connected" where city administration, housing, environment, transportation and water and sanitation are raised to an "international level". A big concern for Cairo is overcrowding in the city centre and the plan focuses on how to move people out to the periphery of the city, and to support this initiative with transportation. There have been attempts to build "new cities" on the outskirts of Cairo, but they have not attracted residents. The "new cities" are clearly targeted at the middle and upper classes and tourists. Critics characterise Cairo as an "extreme case" of informal development. Visions of the upgraded "ring road" in the Vision 2050 document as a sleek high-speed highway, contrast sharply with anecdotes of how communities have worked to "break into" the ring road at multiple points by building illegal stairs and off-ramps. So while Cairo appears to have a stronger city government than Lagos, the espousal of definitions of smart cities that focus on "modern" facilities aligned to middle-class values appears to be fuelling resistance from residents who are working to create their own understanding of what the city might be.

Nairobi (crafting a local definition)

⁸ http://www.capetown.gov.za/en/IDP/Documents/IDP_final_for_setting_Council_Approved280512.pdf accessed 20 June 2014

⁹ <http://www-03.ibm.com/press/us/en/pressrelease/41296.wss> accessed 2nd June 2014

¹⁰ http://www.urbangateway.org/sites/default/ugfiles/8635_42944_AymanEl-hefnawi.pdf accessed 2nd June 2014

The Nairobi City County (NCC) is in the process of developing the Nairobi Integrated Urban Development Master Plan (NIUPLAN) for 2014 to 2030, with assistance from the Japan International Cooperation Agency (JICA)¹¹. Here the smart city is addressed through six “thematic groups”: (1) transportation, (2) governance and institutions, (3) environment, (4) land use and human settlements, (5) population, social systems and urban economy and (6) infrastructure. A draft master plan for the telecommunications sector¹² sets out the developments needed in telecommunications. Much of the plan is concerned with digitally connected living by improving ICT infrastructure. Thus Nairobi’s understanding of a Smart City as revealed in these documents varies from the very broad, service-orientation of the NIUPLAN, to a telecommunications sector document that supports digitally connected living. A contrasting technology focus is taken by the IBM Smarter Cities Challenge where Nairobi is advised that “new technologies and approaches are required to modernise the city’s systems and to make it a better place to live, work and do business” and where technology solutions for dealing with traffic congestion, power supply, emergency response and central record keeping are outlined.

Smart city perspectives in Africa

Past research has shown that the Smart City application domains that are pursued by cities depend on factors including the economic development, structural urban variables such as the geographical location, and population density (Neirotti et al., 2014). Our initial impressions are that, in Africa, where there are coordinated government efforts to identify an appropriate smart cities definition or to locally define what it means to be smart, we find a focus on the ICT infrastructure required to facilitate digitally connected living, followed by a focus on service provision. ICT infrastructure is seen as necessary to deliver services and to create equity of access for residents. Services that are identified as priorities relate to local conditions: disaster management in Nairobi, power and public safety in Johannesburg, transport and crime in Cape Town.

In the absence of city leadership to identify an appropriate definition or to locally-create one, private companies step in to present their own, supplier-driven definitions. These are more technology focussed and reflect the specialisms of the companies concerned. Such initiatives are allowed to flourish in some cities, with government support, but are less likely to be concerned with local needs and preferences and more likely to serve the interests of the elite (Walker, 2014).

Hollands (2008) makes the point that the “definitional impreciseness” of smart cities masks a range of assumptions about cities, their functions and the roles of people within them. Where cities espouse smart city definitions that are underpinned by economic growth or entrepreneurial discourses, cities “can become not only more economically polarized, but also socially, culturally and spatially divided by the growing contrast between incoming knowledge and creative workers, and the unskilled and IT illiterate sections of the local poorer population”.

23 Conclusion

How do IS researchers define smart cities and is it possible to identify a consensus definition? Our preliminary review (30 of 60 papers meeting our inclusion criteria) found that definitions adopted by IS researchers are largely focused on the smart city services that contribute to informed living. However, a consensus definition is not yet evident. Conceptualization of smart cities and further analysis of the definitions in the remaining 30 papers is ongoing. The lack of consensus in the academic literature is mirrored in city plans where we found definitions of smart cities varying from service- to technology-focus. Moreover, despite researchers adopting definitions focused on smart city services, empirical studies into adoption of smart city services, the benefits of informed living, and the challenges involved in implementation of smart city initiatives focused on informed living are few.

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¹¹ <http://citymasterplan.nairobi.go.ke/index.php/niuplan/background> accessed 4th June 2014

¹² [http://citymasterplan.nairobi.go.ke/docs/131008%20Telecom\(WGMeeting\).pdf](http://citymasterplan.nairobi.go.ke/docs/131008%20Telecom(WGMeeting).pdf) accessed 4th June 2014

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