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Smart Cities: Contradicting Definitions and Unclear Measures

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Abstract: Cities are contemporary metropolises that concentrate human and social activity; engineered to support and develop the physical environment and the people within it, Smart cities, we are led to believe, are the immediate future, where smartness is perceived as a characterisation of advancements or digitalisation, in government, mobility and sustainability. Therefore it is not surprising that many organisations are marketing their smart solutions and products, often to a ubiquitous extent and so called smart cities are striving to outperform each other. But how are smart cities actually being defined and how is performance being measured in an era where there is increasing access to unprecedented amounts of foreseen data? This paper identifies the plethora of the smart city definitions and categories evidenced from the literature and shows that 'Smart cities' lacks a robust coherent definition, with many contradicting facts within what constitutes a smart vision. Notably, almost every attempt from organisations, the European Union or cities themselves has failed to define 'smart' in objective terms that can be accepted globally. Certainly, they all are negotiating with a range of descriptors and smart ways to improve the city. Even the UK's attempts to develop a clear definition and set of standards for smart cities (i.e. PAS 180 and PAS 182) appears to suffer from fundamental differences in how the semantic content of a 'smart' city is defined. This paper demonstrates the necessity for a single 'Smart Cities' definition that deals with both the physical and digital using shared parameter value(s) that can be adopted and scaled amongst different localities and within a range of urban contexts adjusting according to existing city condition(s) and vision(s) setting the paradigm for further innovative research in this area.

Keywords: Smart cities

1. Introduction

The smart cities concept emerged in academic literature during the last decade, initiated by the Clinton foundation in 2005, where former US president challenged network equipment maker Cisco to use its technical know-how to make cities more sustainable [1]. Since this time Cisco has become involved in constructing: (1) Songdo in South Korea, developed with consulting engineer Arup and Partners to encourage and foster sustainable design practices through incorporation of the latest technologies that reduce energy consumption and increase energy efficiency, utilization of recycled and natural materials and generation of clean or renewable electricity (www.songdo.com); (2) PlanIT valley, Portugal, developed with Siemens, with consulting engineer Buro Happold to combine intelligent buildings / transport / built environment information / energy systems with enhanced mobility, parking and emergency services (Living-PlanIT-SA, 2013).

There has been an incremental increase in interest from a range of other stakeholders' who have become involved with, and pioneered, the smart city agenda. IBM being one notable company that has contributed to the 'Smart City' debate (p3, Falconer and Mithcell. 2012). Other examples include Dubai which is said to exemplify 'The Smart City' concept through incorporation of new initiatives, such as the Media city, internet city, knowledge village, healthcare city [2]. Lastly Masdar city, Abu Dhabi, UAE, developed by Mubadala Development Company and designed by Fosters and Partners which is being branded as the world's most sustainable eco-city with innovation apparently embedded in its core [3].

However, there still appears to be somewhat of a disconnection with overall citizen interpretations and expectations of what the prefix 'Smart' actually means. Therefore it is not surprising that smart cities are not taking off as expected and are therefore not truly realizing the projected potentials (p1, Dohler, 2011). This may merely be because stakeholders are generating their interests imprecisely from an unshared vision for what Smart Cities could stand for. This poses significant risk in terms of misinterpretation from those involved in the smart cities agenda disrupting achievement of the end goal – in this case making cities increasingly smarter. That said the concept of smart cities has undoubtedly created dialogue, debate and competition between cities and their stakeholders around the globe which is good. In turn this is engendering those involved to utilize indicators and metrics for the purpose of measuring their smartness. Unfortunately if these indicators are to be robust they should be built around a shared understanding of what smart means and due to the different challenges and responses of each city these smartness indicators must be comparable, although refined to take into consideration the local context and granularity of each place. In order to do this there is a need for a universal definition (or at least a shared understanding) of smart cities with clear aims specified in order that any deviation based on contextual diversity can be highlighted.

In part fulfillment of this aim this paper presents a methodology for analysing the plethora of definitions (and associated semantics that have been fostered) that now contribute toward a confused city portrait on what the term 'Smart' is or could be (Section 2). This is applied in Section 3 where key results are shown. A concluding discussion follows in Section 4.

2. Methodology

The methodology adopted herein proposes that definitions of ‘Smart Cities’ found within the literature can be broadly categorized into three Themes:

- Theme 1 – Information Communication Technology – ICT (Section 3.1)
- Theme 2 – Resilience and Sustainability (Section 3.2)
- Theme 3 – Innovation and Business (Section 3.3)

As definitions (*italicized*) of ‘Smart Cities’ within each theme are examined and discussed, numbers are assigned against each. These themes and associated definitions are then cross matched with the following stakeholders in a Smart Cities Matrix (SCM) the results of which can be found in Section 3.4:

- Stakeholder 1 – People
- Stakeholder 2 – Governance
- Stakeholder 3 – Companies

3.0. Application of Methodology and Associated Results

3.1. Information Communication Technology (ICT)

The semantics of smart cities to ICT (smartphones etc), appears to be one resonating realisation of smartness. It appears to be an ideal which can act as the hope (or perhaps not) for the future. Whilst Smart cities embrace the element of unknown it is difficult to understand the eventual capabilities of ICT and how it will dominate our lives. The academic view is to see ICT in smart cities as a:

‘framework for a specific vision of modern urban development’, recognize the ‘importance of information’ and ‘general livability’ ‘ICT is considered an enabler of the ultimate objective’ [4], (1a).

In this definition Joss identifies ICT to be a parameter for the ‘*livability*’ feature of smart cities. However, the importance of its role therein remains uncertain in its definition. Others academics suggest it would be more sensible to frame smart cities as a grid of parameters:

‘the Smart Cities Group pursues sustainability, livability, and social equity through technological and design innovation’ [5], (1b).

In contrast Arup, a large multi-national company, suggests the following:

‘smart cities should combine new technology with smart new ways of thinking about technologies’ which as ‘a holistic system can result in positive behavioural change [6], (1c).

Although it is evident that ICT should be a tool for positive behavior the role of technology does not become clear in this. It could be individuals using smart metering or information from smart phone apps or even city management teams using mass data collection. Even more uncertain are the new ways of thinking about technologies that surely can change the meaning of technology itself. Observing the effects of digital technology today, we can see that our lives are now being bombarded with daily interactions with digitalization and technology. We then tend to speculate about the range of ICT that is or will be available and what effect this will make to people's lives; in terms of their wellbeing, health, security etc. Will or should ICT alone constitute a holistic lifestyle approach within the city? Not surprisingly, many commercial companies believe it should and it will. Arup believes that smart cities will find:

'ways that technology can create new urban user experiences', and in 'which the seams and structures of the various urban systems are made clear, simple, responsive and even malleable via contemporary technology and design'[6], **(1c)**.

In reality, this is a multiplication, to a ubiquitous extent, of the ways in which digital tools already dominate our lives. In essence perhaps focus should be reinterpreted as a system that comprises the smart city 'ideal' for a range of urban issues.

3.2. Sustainability / Resilience

The majority of definitions that recognize resilience and sustainability at the core of the smart cities definition belong to governance and policy stakeholders. In Smart Cities & Communities SCC smart cities are an integral part of sustainability and vice versa:

'The EU has developed a shared European vision of sustainable urban and territorial development. European cities should be places of advanced social progress and environmental regeneration, as well as places of attraction and engines of economic growth based on a holistic integrated approach in which all aspects of sustainability are taken into account' [7], **(2a)**.

In the same statement, it is noted that possible regulations could become a model to enhance and inform other locations and developments that would like to become smart. However, there is no regulatory body or framework thus far to deal with this and establish more rigorously any of these European-wide definitions. There are cities, mostly in the western world that claim *smartness*, so we can draw lessons from leading examples. For example, Barcelona claims many smart initiatives in the matter. The Mayor adds to the smart definition list by expressing that:

'A city can be considered as "smart" when its investment in human and social capital and in communications infrastructure actively promote sustainable economic development and a high quality of life, including the wise management of natural resources through participatory government' [8], **(2b)**.

The UK in particular, has attempted to provide greater clarity by providing a national (working) definition. Specifically, as part of the British Standards Institution [9] Standards Publication:

‘Smart cities’ is a term denoting the effective integration of physical, digital and human systems in the built environment to deliver a sustainable, prosperous and inclusive future for its citizens.’ [9], **(2c)**.

This way of defining smart cities as an integrated part of the sustainability agenda is aimed at offering the potential for citizens to improve their lives in the urban context and sustaining it for the future. Whilst a regulated definition of smart cities is desirable to adopted have in a national and international spectrum, it would prove difficult to relate it in the same way to most of the cities. If we are talking about individual cities, we see that their local context and aspirations make a big difference on how they become smarter. Whilst the importance of context seems logical, it appears sometimes to have been ignored when it comes to smartness. We merely need to seek the ingenuity of the city’s context first to draw the conclusions. This requires us to understand what has made them smart so far and what could make them smarter. In addition a universal UK or EU framework might foster competition between them for the better or worse? In a study of medium size smart cities in Europe, cities are already being compared based on sets of characteristics and scores - the one with the highest score becomes the smartest. Policy then seeks to improve this standing. For example:

‘A Smart City is a city well-performing in a forward-looking way in these six characteristics (smart economy, smart people, smart governance, smart mobility, smart environment, smart living), built on the ‘smart’ combination of endowments and activities of self-decisive, independent and aware citizens’ [10], **(2d)**.

Possibly some of these characteristics are not crucial for every city or even do not create and sustain smartness for others. What is important though would be to see a grid of parameters that emerge that could be adjusted to idiomorphic situation of every city location. This difficult approach to overcome a static definition has also noted in the Department for Business Innovation & Skills background paper for smart cities as a

‘no absolute definition of a smart city, no end point, but rather a process, or series of steps, by which cities become more “liveable” and resilient and, hence, able to respond quicker to new challenges’[11], **(2e)**.

Additionally, in the Smart Cities Framework (SCF) is noted that:

‘The SCF has been developed to bring together good practices in responding to these challenges in an integrated way the focus is on the enabling processes by which innovative use of technology and data, coupled with organizational change, can help deliver the diverse visions for future UK cities in more efficient, effective and sustainable ways’ [12], **(2f)**.

However, these ideas seem to change later on in the document, when it comes to smart cities having an effect on national or international standards. The international transportation consultants

Steer Davies Gleave, in collaboration with Research At, published a research report where they state that the hierarchical prioritizing within a smart cities agenda is as follows:

‘the top of the list is a pleasant place to live, work and socialise, followed by, a healthy, vibrant economy’ and ‘what people really want is a pleasant all-round experience [13], (2g).

What is required here is for commercial companies, if they want to be part of the smart initiatives, to consider the real values of smart cities and focus in on things that have more human value than profit alone. However, there should also be ways that smart cities are protected by regulations and frameworks that emphasize the human existence as a priority for resilience in smart cities. In achieving this aim the FG-SSC (Focus Group on Smart Sustainable cities) published their ideas of defining ‘smart and sustainable cities’ at its fifth meeting in June 2014:

“A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects”[14], (2h).

Quite clearly, the smart cities agenda is embracing the sustainability agenda, as a way to maintain them for the future, turning away from focusing on the ICT and technology as the main point of concentration. Again, because the term is not crystallized, and what exactly ‘smart’ means in the future, we do not know and whether this is allied or opposing to sustainability is not yet clear and yet in a proposed framework at a Systems Science Conference it has been said that

‘a smart city is as an icon of a sustainable and livable city’[15], (2j).

However there is inherent danger here that the term smart city will be confused with sustainable development, sustainability or green or a range of other city models that already exist. In smart cities

‘we cannot intellectually sustain a singular conception of ‘sustainable development’ collectively smart cities ‘must act as though such a conception exists as the ideal for which we strive’[16]. (2k)

In actuality the important point here is that a smart city has a clear vision, and an ideology that considers people’s wellbeing and makes cities eminently more livable. Moreover this vision must be sustained in the future, something that is remiss from short term governmental regulations and/or policies.

3.3. Business model / Innovation

In the current decade, many businesses worldwide have closed down due to the economic crisis that followed rapid economic cyclical expansion and contraction that had previously been seen but not to such an extent in the 70's and 80's, 90's. In this economic context many of our lifestyles proved to be unsustainable. As Doherty argues smart cities could be the resolution of many economic challenges and as such stable growth requires that:

‘new and existing cities to respond with powerful new programs, solutions and relationships between people, places and things’ [17]. He is a believer of the idea of *‘not just smart technologies and systems but smart thinking’*[17]. **(3a)**

Innovation is a key thread here, where Smart cities and empower the need for them to be economically sustainable and resource secure for generations to come. The Smart cities concept is after all viewed by some as a:

‘multi-trillion dollar global market’ that has huge capita potential [18], **(3b).**

Therefore, it is not surprising that the smart cities framework has been heavily criticized for reinterpreting the smart city ideal into a calculated process for economic gain and enhanced revenue streams:

‘many smart cities also emerge through the materially and politically contingent spaces and practices of urban design, policy, and development’ [18], **(3c)**

Much speculation has gone into how these ‘business’ focused visions for Smart Cities can help build the finances of private companies and governments. Laneri in a Forbes article has said that

‘smartest cities not only look at infrastructure and livability, but also economic fundamentals’ [19], **(3d).**

Soon enough it is believed that the smart cities will be the new planning model for cities because:

‘The old model for planning cities, which developed during the Industrial Revolution of the 1800s, is now not fit for 21st century needs’ [20], **(3e).**

Assuming that the city requirements for today are urging for new economic responses smart cities might well be an urban model that can solve old urban issues. Arup’s idea on smart city optimization is to:

‘transform its basic infrastructure and optimise energy and resource use’ [6], **(3f).**

The same ideology can be seen in government organisations, illustrated most recently by the UK's Future Cities Catapult. They state that smart cities require:

'city systems which use data and technology to achieve integrated management and interoperability' [21], **(3g)**.

Furthermore, the British Standards Institute generates ideas for the economic feasibility of smart cities. It aims for

'Economic recovery in cities– nationally and globally' ... 'providing cost effective and innovative delivery channels' [9], **(3h)**.

The document follows a top-down approach, aimed at UK city leaders' however the working definition of smart cities from PAS refers to:

'effective integration of physical, digital and human systems in the built environment to deliver a sustainable, prosperous and inclusive future for its citizens' [9], **(3h)**.

Hence the links with sustainability (previously discussed in Section 3.2) are still readily apparent. In early 2012, they also published on-line a document of standards for the standards of data interoperability for smart cities, open for public consultation. Whilst available to everyone, the document was really looking into facilitating the big data needs of organisations and companies:

'This PAS aims to look beyond the current use of data to facilitate city services, and encourage decision-makers to explore the reuse of data as a resource to innovate the future direction of systems and services' [22], **(3i)**.

Copenhagen is often considered to be the most successful smart city in Europe and in part this is due to innovation and new business models. There are a host of examples of green technologies adopted here (not just ICT as discussed in Section 3.1) which have brought multiple benefits to the city. Moreover:

'it is an open source community, where the ideas of one actor can be borrowed, improved and ultimately returned to the community by another' [23], **(3j)**.

As a smart city, Copenhagen, has realized a business minded urban plan. Its innovation lies in the fact that:

'making a city smart is a new approach to urban development' [24] **(3k)**.

Similarly, the European Innovation Partnership on Smart Cities and Communities Strategic Implementation Plan from 2013 proposed the following idea of a business minded framework for Smart Cities where:

‘Smart cities should be regarded as systems of people interacting with and using flows of energy, materials, services and financing to catalyse sustainable economic development, resilience, and high quality of life; these flows and interactions become smart through making strategic use of information and communication infrastructure and services in a process of transparent urban planning and management that is responsive to the social and economic needs of society’ [25] (3l).

Although in terms of business they tend to see smartness as follows:

‘The objective of Smart Cities is to accelerate investment and the rate of innovation in cities in Europe with the aim of achieving social, economic and environmental objectives’ [26], (3m).

The difference with companies is that regulations could benefit citizens and communities at the first instance to become collaborators with new initiatives. Therefore, it is not surprising that we can see big corporations like Cisco is suggesting interpreting their own ideas on the framework when suggesting to:

‘Smart Cities should reduce carbon emissions by introducing fundamental improvements in the efficiency of urban infrastructures through ICT’ [27], (3n).

3.4. Smart Cities Matrix (SCM)

From the analysis undertaken within this study (Figure 1) it can be seen that Smart Cities Governance highly considers two key themes ‘Resilience and Sustainability’ and ‘Innovation and Business’ (highlighted green) and yet appears to ignore the role of ICT (highlighted red). When considering the Public and Commercial worlds there is relatively equal consideration between all three themes.

		THEMES		
		ICT	Resilience & Sustainability	Innovation & Business
STAKEHOLDERS	People (Academics, public)	1a, 1b	1b, 2j, 2k	1b, 3a, 3b 3c
	Governance (Policy)		2a, 2b, 2c, 2d, 2e, 2f, 2h, 2i	3h, 3i, 3j, 3k, 3l, 3m, 3n
	Companies (Commercial)	1c	2g	3d, 3e, 3f

Figure 1. A Smart Cities Matrix (SCM).

5. Concluding Discussion

Cities are made and grown by people. However, is difficult to predict city living and city expansion that proves to be not harmful, but courteous to humans. Therefore, rapid urbanization and fast developing technology have created problems in the past. Even more nowadays, cities face problems such pollution, illness, crime and others that demand human response. Smart cities could be part of the response for the betterment of life in cities. Smart cities are synonymous with intelligent cities, information cities, virtual cities, amongst many other nomenclatures (Batty, 2013). The term is vaguely technological, although in the Oxford dictionary, smart (noun-smartness) refers to 'a quick-witted intelligence...of some independent action' (Oxford, 2014), whereas the word independent is not specifically referring to ICT, humans, or other systems. Usage of the term pertains rather narrowly to data and theory that brings much more immediacy to our urban understanding (Batty, 2013). Therefore we could assume that smart cities would respond in a smart and independent way to provide solutions to a range of city problems. Moreover if this is true and people are their cities then we need to be aware of the inner workings of the systems and the relationships that exist within and how people are involved.

There has been much debate on to what exactly it means to be a smart city. The SCM provides a methodological approach whereby the ways in which smart is being defined can be better understood. As more definitions occur the SCM can be refined perhaps with more themes and more stakeholders in order that similarities and differences of those defining smart cities is made clear, leading ultimately toward a shared understanding of how smart is being defined and embraced by those spear heading the smart cities agenda.

Harsh critics of the smart cities movement believe that Cities are already smart, and their intelligence resides in the people' (Greenfield, 2013). Undoubtedly citizens will be affected most and will be the harshest of the critics of all. IBM expresses that urban citizens have come to expect more from their cities and therefore they are the ones who are redefining what it means to be a smarter city (IBM, 2012). In order to define the smart city meaning, we need therefore to be aware of the criticisms and understand what it means not to be a smart. Based on the range of definitions for smart cities we may be led to the hypothesis that the main aim of smart cities is after all human existence. The majority of definitions belong to the spherical ideology that, either as a resilience framework or a business strategy, smart refers to the services, security and growth of citizens within an urban environment. After all, the hope of 'the smart city' is a specific rhetorical move within a much larger space of potential (Greenfield 2013). Whilst one would expect big companies to become service providers for government regulations, their current positions have received wide criticism. The concept of optimizing resources within smart cities, aim to manipulate and privatize big data, that can only benefit the service providers themselves. In this situation, the citizens won't be able to have a say in their own data, apart from their own input and usage of their private lives. As he says, the manipulation of smart cities is: *'stewardship of such place is a simple matter of keeping key performance indicators balanced between nominal thresholds'* [28]. Commercial companies will always be keen to draw their earnings as a service provider and there will always be a degree of oiling the economic wheels which must turn, it is the rate at which they turn that needs careful monitoring. In reality city dwellers and people in general will have to think more deeply about what they want smart cities to be. We are all active members of our society, who need to think, act and decide whether we truly want to make our

cities smarter. As Greenfield says, smart cities are ‘*rhetoric*’ that needs to be more accurately defined, pinned down as it were. Moreover as technology has become an enabler of progress, we need to establish the real benefits for human resilience both now and the future. Cities may be good for us and when they act smartly (for example with a range of sensors that embed share information) it can help regulate the metropolis [29]. However, it is essential to understand who is the end receiver, who is the main actor and who are those most affected the most by the vast amount of data, ICT, optimisation and innovation that will / should be an integral part of smart cities.

We should never forget that Smart cities can only get data from their citizens (an easy example would be cookies on the internet), and in a smart context this needs to be used to promote innovation and open source in a safe environment for us to work and live. People are the city and according to a humanistic view should be the main focus of ‘smart’ cities. If we can talk about a smart cities framework, then citizens and human value should be in the central part of the diagram. Reason being, is that this will protect citizens from any corporate model that excludes core human value(s).

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Conflict of Interest

The authors declare no conflict of interest.

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