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ScienceDirect

Procedia Computer Science 93 (2016) 902 – 909

Procedia Computer Science

6th International Conference on Advances on Computing & Communications, ICACC 2016, 6-8 September 2016, Cochin, India

Developing Smart Cities: An Integrated Framework

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Abstract

With the advent of "smartphones", technology has helped mankind to solve some of its difficulties. On a similar note, "smart city" is a futuristic approach to alleviate obstacles triggered by ever-increasing population and fast urbanization which is going to benefit the governments as well as the masses. Modern day cities are deprived of vital elements like quality of life and socio-economic development which can be delivered by the smart cities. Smart cities are an endeavour to make cities more efficient, sustainable and liveable. In other words, a smart city is a city that can monitor and integrate functionality of all the critical infrastructure like roads, tunnels, airways, waterways, railways, communication power supply, etc., control maintenance activities and can help in optimizing the resources while keeping an eye on the security issues as well.
This research paper explores various aspects and dimensions of a smart city. To bridge the gap in literature regarding the concept of smart cities and its implementation, a framework has been developed to get better insights about the idea of smart city. On the basis of extensive and deep research of literature from diverse domains, we have identified six significant pillars for developing the framework as: **S**ocial, **M**anagement, **E**conomic, **L**egal, **T**echnology and **S**ustainability (SMELTS). The paper throws light upon how these factors can make the smart city initiative a successful project. The proposed framework has been used to figure out various agendas for research and traces its practical implications.

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Peer-review under responsibility of the Organizing Committee of ICACC 2016

Keywords: Smart City; **S**ustainability; Smart-Governance; Internet of Things; Conceptual framework.

1. Introduction

More than 50% of global population is now urbanized (United Nations Report 2012) [1]. Complexity of social ecosystem in cities and urban areas has increased making sustainability an important factor. The ecosystem as a whole is experiencing an economic turmoil, high rate of urbanization, climatic variations and vast population growth (Cisco Report 2013) [2]. These factors hampers the growth and cities become disordered and unorganized (Johnson,

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Peer-review under responsibility of the Organizing Committee of ICACC 2016
doi:10.1016/j.procs.2016.07.258

2008) [3].Problems related to health, traffic, pollution, scarcity of resources, waste management and poor infrastructure arise and hence development of city falls apart. (Borja 2007; Marceau 2008; Toppeta 2010; Washburn, Sindhu, Balaouras, Dines, Hayes, & Nelson 2010). [4, 5, 6, 7] These problems trap the growth of city and dismantle it completely (Dawes, Cresswell & Pardo 2009; Rittel & Webber 1973; Weber & Khademian 2008) [8, 9, 10].

This has triggered the usage of technology as a solution of all these issues and to address them in a smarter way. Hence the concept of Smart Cities is coming up. Smart Cities ensure sustainable environment with the help of Big Data and Internet of Things. By "smart", we mean that the city is more sustainable, livable and efficient. The smart city market is estimated to reach an annual spending of about $16 billion by the year 2020 (Pike Research 2011) [11].

Smart Cities, with a proper roadmap, will serve people at large and will surely help in reducing man power for the long term. Though, the concept of smart city is still foggy in the minds of people, few studies have attempted to address the questions regarding the development of smart cities. After performing an extensive research in diverse domains like public governance, information technology, e-governance, we have identified six critical factors that form pillar for the development of a smart city. This research paper explores various aspects and dimensions and helps in bridging this gap by proposing a framework to give a clear insight about the establishment of smart cities. The framework proposed also helps in identifying recent trends and requirements for a city to evolve into a "smart" city.

2. Literature Review

Ensuring sustainable development and quality of life in complex social ecosystems of cities and urban areas are important concerns. Cities are increasingly aware of the concept of "smart city" and are actively developing strategies towards the goal of becoming "smart" and manage city resources more efficiently while addressing development and inclusion challenges.

To understand the concept of smart city, we begin with understanding the conceptual relatives of the model. Although limited in scope, they set the theoretical framework for the holistic notion of the smart city currently understood by the urban planning sphere. The genesis of the concept lie in Dutton's wired city, which promised to use emerging telecommunications technology to provide unprecedented amounts of data and information to households and businesses through "information highways" that, would create a communications-centric society. Another precursor to the smart city is the digital city, a technologically-defined city that uses widespread broadband infrastructure to support e-Governance and "a global environment for public transactions" (Mitchell, 2000) [12].The notion of smart city is established from the combination of the knowledge society and digital city. It is defined as a "multi-layer territorial system of innovation" made up of digital networks, individual intellectual capital, and the social capital of the city, which together constitute collective intelligence (Komninos, 2008) [13]. Economic competitiveness and innovation achieved through the knowledge-based economy marks a city as intelligent, allowing it to generate a "spatial competitive advantage" through industrial districts, regions, and learning clusters that produce sophisticated R&D and are supported by digital networks and artificial intelligence (Komninos 2008). Based on the exploration of a wide and extensive array of literature from various disciplinary areas, the identified factors– Social, Management, Economy, Legal, Technology, Sustainability, (SMELTS) forms the basis of an integrative framework. This comprehensiveness is the distinguishing factor of the smart city, which integrates a number of physical, institutional, and digital components to create a holistic definition of what smart planning would look like.

3. Pillars of Smart City Initiative

In this research paper, we have proposed critical factors that are crucial for understanding and developing smart cities. These factors have been used to design a framework that gives a more holistic view of the smart city initiative. The six pillars or factors are: (1) Social, (2) Management, (3) Economy, (4) Legal, (5) Technology and (6) Sustainability.

3.1. Social

The ability for all citizens to communicate with one another and agencies and groups that represent them provides a new sense of possibility to the idea that smart cities are based on smart communities whose citizens can play an active part in their design. Presently there are many initiatives where citizens can first access information about what is happening in their communities and cities but also explore ways in which many different groups can become actively involved in the design and planning process, both in face-to-face and remote situations using data, scenarios and models all informed by the contemporary ICT (IFF. 2020 Forecast)[14]. Current forms of participation are responding to new ICT but still remain inert and passive. New media and the web are increasing the liquidity of this type of interaction as both data and plans are being shared (R. K. Brail (Editor) [15].

Cities that are smart only with respect to their economy are not smart at all if they disregard the social conditions of their citizenry. Smart cities initiatives should be sensitive in balancing the need of various communities. Projects of smart cities have an impact on the quality of life of citizens and aim to foster more aware, educated and informed citizens. Also, smart cities initiatives allow the citizens to participate in the governance and management of the city and become active users. If they are key players they may have the opportunity to engage with the initiative to the extent that they can influence the effort to be a success or a failure.

The smart city is invisible to many citizens, which makes it difficult to get them engaged. But the smart city is about all citizens, not just a group of enthusiasts. It is about daily chores and everyday life. Social Media also plays an important role in smart city initiatives. As the smart city is about altering attitude, communication is a critical factor in engaging people by showing them the enormous value of data. In addition to the traditional role of a watchdog on behalf of the people – the media now needs to work on being the –Disseminator of information ; Educator – on a variety of aspects of modern urban living and Simplifier of policy and how it impacts individual lives. Reaching a large audience is hard in a time where the media landscape is changing rapidly. Today, we can immediately find out about what's happening anywhere in the world by the use of Internet.

3.2. Management:

Governance is a major execution challenge for smart cites. Limited transparency, fragmented accountability, unequal city divisions and leakage of resources are some of integral characteristics of regular governance. A move from this type of governance to digital or e-governance is essential for an effective and efficient administration of the smart cities. Smart Governance includes political and active participation, citizen services and the smart use of e - Government. (Gil-Garcia & Pardo 2005)[16] suggested a list of success factors and challenges for e-government initiatives which can be extended to the smart city governance as most smart city initiatives are also driven by governments and leveraged by the exhaustive use of technology to better serve citizens. E-government can be explained as an initiative to improve the decision making process, improve public policy-making and improve public governance – all with ICT at its foundation. E-governance helps the citizens to involve comprehensively in all these aspects. Internet is the most widely used channel of communication for many people and thus cities can incorporate it to identify the needs and wishes of the different target groups and address them in the most effective manner. ICT can enhance democratic processes and increase opportunities for individuals and communities to interact with the government. Internet enables greater participation, as it incapacitates the restrictions imposed by geography, disabilities or other factors. It also enables access to information by individuals and groups that had not been included previously. Smart governance is an important characteristic of a smart city that is based on citizen participation (Giffinger, Fertner, Kramar, Kalasek, Pichler-Milanovic & Meijers, 2007) [17] and private/public partnerships. Smart governance relies on the implementation of smart governance infrastructure that facilitates service integration, collaboration, communication and data exchange (Odendaal, 2003) [18].

. Table 1. Factors of smart governance found from the literature

Factors	Reference
Collaboration	Lam W. 2005[19]; Luna-Reyes L. F., Gil-García, J. R. & Cruz C. B. 2007[20]
Data exchange	Luna-Reyes L. F., Gil-García J. R. & Cruz C. B. 2007[20]; Nfuka E. N. & Rusu L. 2010 [21]
Service and application integration	Nfuka E. N. & Rusu L. 2010[21]; Odendaal N. 2003.[18]
Communication	Odendaal N. 2003 [18].
Accountability	Mooij J. 2003.[22]
Transparency	Mooij J. 2003[22]; Nfuka E. N. & Rusu L. 2010[21]
Participation and partnership	Odendaal N. 2003[18]; Luna-Reyes L. F., Gil-García, J. R. & Cruz C. B. 2007 [20]
Leadership	Lam W. 2005[19].

3.3. Economy

Economy is one of the major drivers of smart city initiatives. A key indicator to measure growing city competition is the ability of the city as an economic engine (Giffinger, Kramar, & Haindl, 2008) [23]. Operational definition of a smart economy includes factors all around economic competitiveness as entrepreneurship, trademarks, innovation, productivity and flexibility of the labor market and the integration in the national and global market. What truly makes a city intelligent is its capability to innovate and capitalize economically. The smart city, like all models used for economic development, supports the maximization of profits. Economic growth in smart city must be constant because of the short life cycle of ICTs. As an economic development platform, the smart city facilitates the flow of capital. The precedent of government sponsorship, oversight, and intervention in smart city projects is crucial to checking the power of corporate players.

A series of studies (Dirks & Keeling, 2009; Dirks, Keeling, & Dencik, 2009)[24] released by the IBM Institute for Business Value identify business as one of core systems of smarter cities, which comprise citizens system, business and transport system, services system communication system, water and energy system. The smart city initiatives are designed to develop information technology capacities and establish an agenda for change by industry actions and business development (Cairney, & Speak, 2000) [25]. Creating an environment for industrial development is pivotal to a smart city (Bronstein, 2009) [26]. The economic outcomes of the smart city initiatives are business creation, job creation, workforce development, and improvement in the productivity.

3.4. Legal

Evolution of smart cities cannot be successful without legitimate legal compliances. Also councils, governments and other political bodies influence the operation of these initiatives. So both political and legal components are crucial for smart city development (Mauher & Smokvina, 2006) [27]. Governments and the organizing entities must write down policies that support the development of smart cities (Eger & Maggipinto, 2010) [28]. Legal and regulatory issues should be tackled accordingly by the government for frictionless development of a city. City governments must boost pro-active steps for implementing and managing smart city drive by framing laws and policies that become the fulcrum for growth and development. Technological innovations are necessary but innovations in policy making are even more essential and are obscure (Hartley, 2005) [29]. The policies must conform to both technical as well as non-technical requirements that are imperative for urban growth (Yigitcanlar & Velibeyoglu, 2008) [30].

Smart cities face various challenges with respect to legal compliances, environmental and regulatory issues that dominate the policy context (Gil-García & Pardo, 2005) [16]. Before taking any kind of decisions, rules and regulations must be kept in mind (Mahler & Regan, 2002) [31]. Knowledge of policies, law and restrictions is

critical in understanding and using Information and Communication Technology in a proper manner. Smart cities must be governed on the grounds of well-laid principles and guidelines. Therefore, principles and policies are important for efficient and smooth working between administration and local public bodies.

3.5. Technology

For an ordinary city to transform into a "smart" city, technology (notably ICT technologies) plays major role. Modern cities are getting smarter because of rapid evolution of technology. Problems can be avoided, anticipated and mitigated by analyzing huge data available. This is where Big Data comes into picture. Various devices and components must be connected with each other to facilitate real-time decision making. Smart cities must exploit information and communication technology to increase sustainability and improve quality of life for the citizens (Bakici, Almirall & Wareham, 2013) [32].

Information and Communication Technology is one of the most essential drivers of the smart city initiative (Hollands, 2008) [33]. The amalgamation of these drivers along with others such as sustainability and quality of living can completely transform the prospect of urban life and can boost the proper functioning and management of the cities (Odendaal, 2003; Vasseur, 2010)[18,34].

Despite taking center-stage in the development of a smart city, technology has some hurdles. Use of ICT can certainly raise the standards of living but it also faces fierce challenges (Odendaal, 2003) [18]. Technologically sound human resource with practical skills is limited. Moreover, educating and training these employees with IT skills can be a major challenge. Politics, cultural differences and lack of inter-departmental cooperation are some of the organizational barriers that lie ahead of smart city development (Ebrahim & Irani, 2005) [35].

3.6. Sustainability:

Sustainability can be defined as the way of economic and social development without disrupting the environment. If we consider the Brundtland commission report (The United Nations Report 1987) [36], it defines sustainable development with two concepts: development focusing on the world's poor and although development is limitless from the technology purview, it still has many limitations considering the environment's ability to satisfy our present as well as future needs. The sustainable development can be broadly classified into Social, Economic, and Environmental sustainability. These would encompass the major requirements of city environments comprising of sustaining water, energy, and food supplies, managing water and reducing greenhouse gas emission. 70% of the world's population is expected to reside in the cities in less than 40 years (Charbel Aoun 2013) [37]. Cities are the foundation for providing economic stability to its citizens by attracting business and capital. The global financial crisis has exhumed flaws in the financial models and strategies of public authorities in their infrastructure investments. The economic sustainability now rests on enhanced and better integrated infrastructure apart from a new financial model. Cities need to become more efficient, more livable and provide better quality of life, business opportunities and security to achieve social inclusiveness and social sustainability. Cities consume 75% of our energy resources, and emit 80% of the carbon that is harming our environment (Charbel Aoun 2013) [37]. To diminish the impact of cities on the environment resource it is vital to encourage the effective and intelligent deployment of technology and to integrate infrastructures. At the same time, it is also imperative to increase the resilience of cities to environmental shocks. A smart city leads its community to become more competitive for capacity, opportunity and investment by providing an enhanced quality of life as well as decreases the environmental consequences of urban life by decreasing its carbon footprint.

4. Conceptual Framework:

At its core, a smart city framework leverages from the existing legal, economic and technical environment and impacts the social and management aspects in a sustainable manner. Setting a smart city vision and effectively moving towards it with a systems-based approach is imperative to ensure optimum resource efficiency and security, along with preserving socially inclusive growth. Drawing on the literature and the factors considered above, we

have conceptualized an integrative framework that explains the relationships between these factors in a more coherent fashion. We have named it as SMELTS framework (Social, Management, Economy, legal, technology and Sustainability. Each of these factors enables both the public and private sectors to plan and implement Smart City initiatives more commendably. These elements provide a basis for matching how different cities are envisaging their smart initiatives, employing shared services, and the related challenges. This framework also analyses the actual impact of different factors on the success of smart city initiatives.

The framework indicates that each factor is both affecting and getting affected by each other factor. It also indicates that some factors may be more influential than the others depending on the context. The framework can be bifurcated in two levels. The inner level consists of the factors which have greater impact on the smart city initiatives. This also consists of technology which is the foundation of smart cities. The outer level factors are the ones which might get influenced by the inner level before impacting the smart city initiatives. This includes governance and the socio balance of the community apart from sustainability which should be the basis of any development.

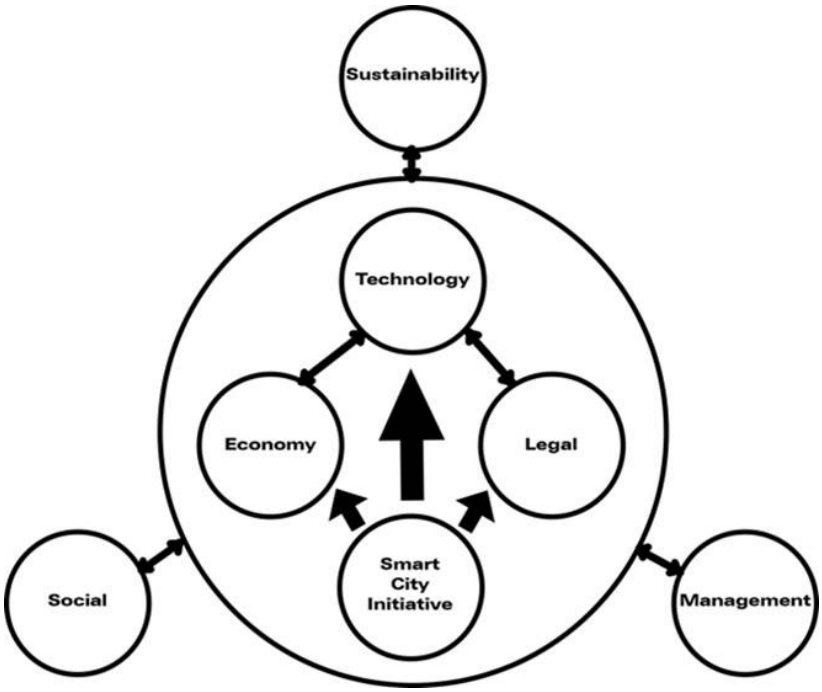


Figure 1: SMELTS Framework for smart city initiative

5. Managerial Implications:

Only a few studies on smart cities address the issues related to the management of smart cities and highlight the managerial implications. As a smart city requires smart governance, the issues and the strategies pertaining to these are different from those for usual governance and management. The smart cities and e-governance initiatives have a

list of success factors and initiatives (Gil Garcia and Prado 2005). There are a number of challenges pertaining to the management of a smart city that any manager may come across regarding the above mentioned factors.

The project size is one major issue from management perspective. The strategy behind the size of the team should be the team skills. Another challenge can be faced in multiple or conflicting goals. This can be overcome by having clear agendas and measurable deliverables.

Resistance to change and conflicts are the key social challenges that can arise. These can be handled using good communication and developing trust with the people. It is essential to employ people with both technical and social skills and respect them to avoid any attitude or behavioral issues.

One may come across technological challenges such as lack of understanding, ambiguous architecture, issues in interconnection of subsystems, etc. The strategy is to ensure a highly skilled work force with domain expertise and to map human resource according to their field of knowledge and experience.

There are various legal, compliance and political challenges that any manager may come across. These should be dealt with utmost sensitivity in accordance with the legal departments. It's important to not to take legal issue in hand without understanding the consequences.

The economic challenges of budget slack and resource crunch, etc. can be avoided by analyzing the project thoroughly well before its initiation and forecast the budget and resource requirements and get the required approvals before starting with the project

Culture, environment and climate distortions and economic slump are a few sustainability challenges that one can come across. To ensure a sustainable development, a manager must ensure to not deplete the resources beyond a set critical level. He/she must control over budgeting and spending to stay financially healthy.

6. Conclusion:

With the ever increasing population levels and sudden population explosion in the cities, the urban challenges faced by the cities have increased to unprecedented measure. This is expected to continue with additional increments in the pollution level, scarcity of resources, traffic and many more. Cities today are facing new economic, political and technological responsibilities which they must satisfy to deliver sustainable prosperity to their citizens. It's time to leverage from technology and establish smarter systems that can optimize the use of limited resources. Many cities have already started. It's essential to act fast as the need to provide a sustainable development and satiating the needs of the increasing population without disturbing the environment will become critical soon. SMELTS can be considered as the important factors affecting a smart city initiative and a detailed study of these would help better understand smart city initiatives as well as provide a managerial purview to the same.

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