MODEL FOR A SMART AND SAFE CITY

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Abstract: *The idea of smart cities is timely considering that urbanisation is inevitable. While smart city as a concept has gained popularity over the past few years, there is vagueness in the definition, as multiple aspects including governance, public transport and traffic, waste management, entertainment and safety among others, need to be considered.*

Europe is among the most urbanised regions on the globe. It is estimated that by 2020 around 80% of Europeans will be living in urban areas, in several countries the proportion will be 90% or more. As we continue to magnetise towards urban hubs we need smart cities – places where networks and services are made more efficient with the use of digital and telecommunication technologies for the benefit of inhabitants, businesses and the environment. The EU is trying to ensure that smart solutions for cities can be explored, implemented and replicated.

The present paper defines some of the aspects of the smart city as safety as well as specific models of smart and safe city will be discussed.

KEYWORDS: SMART CITY, INTERNET OF THINGS, CLOUD COMPUTING, CLOUD SERVICES, BIG DATA, MOBILE APPLICATIONS, URBANISATION

1. Introduction

Cities nowadays face complex challenges to meet objectives regarding socio-economic development and quality of life. Cities, not countries, will drive wealth creation in the future. According to Frost and Sullivan report, 60% of the world's population is expected to live in urban environments by 2025. As well, it is expected that around 26 global cities and a hundred sustainable cities will develop extensively, which leads to the vast consumption of the world's resources and the necessity of their smart utility.

The concept of smart cities is a response to these challenges. This paper explores smart cities as environments of open and user-driven innovation for experimenting and validating Future Internet-enabled services. Based on an analysis of the current landscape of smart city pilot programs, Future Internet experimentally-driven research and projects in the domain of Living Labs, common resources regarding research and innovation can be identified that can be shared in open innovation environments. Effectively sharing these common resources for the purpose of establishing urban and regional innovation ecosystems requires sustainable partnerships and cooperation strategies among the main stakeholders.

The increased growth of smart cities will drive the need to innovate and provide solutions to foster convergence within the city. The smart city market is growing, especially with the rapid rate of urbanization taking place, with the market expected to be a $1.5 trillion by 2020.The significant growth presents certain challenges for organisations and city authorities.

Given the urbanization trend the cities have to cope with the pressing challenges and continue to prosper. Indeed, civic leaders and policy makers must start to consider cities as complex ecosystems and adjust strategy, governance and operations accordingly. New solutions and insights are required to be able to manage these scarce resources efficiently and to be able to manage urbanization process for the benefit of all. The significant growth presents certain challenges for organisations and city authorities.

Rapid urbanization plays an integral role in economic and societal progress. However, it also strains a city's infrastructure. Key challenges, such as traffic congestion, energy usage, public safety and the building of sustainable communities are top of mind. Such challenges need to be addressed through the development and implementation of intelligent solutions. [1]

Smart city solution providers face the challenge yet a great opportunity of integrating key initiatives within a city's existing framework. Smart cities are measured by the integration of their infrastructure and the intelligent ways by which they tackle challenges. A smart city puts emphasis on creating a system of networks to allow for a systematic flow of information and effective management of resources. Enabling integration and convergence with organisations and local authorities to provide solutions for the development of a smart city is crucial.

The need to improve our understanding of cities however, is pressed not only by the social relevance of urban environments, but also by the availability of new strategies for city-scale interventions that are enabled by emerging technologies. Leveraging advances in data analysis, sensor technologies and urban experiments, we will provide new insights into creating a data-driven approach to urban design and planning.

Our future cities will desperately need such understanding. Cities evolutions is already happening. This evolution will provide cities with excellent ways to improve its living standards and economies. As a result, people would have access to comfortable, clean, engaged, healthy and safe lifestyle. Cities in turn would access further economic development with the foundations of prosperity – the fundamental infrastructure services that let compete in the world economy.

2. Smart City Models

In this section we will first make an overview of smart cities and the role of "safe" in smart cities (see Fig.1).

The idea of smart cities is timely considering that urbanisation is inevitable. Europe is among the most urbanised regions on the globe. It is estimated that by 2020, around 80% of Europeans will be living in urban areas, in several countries the proportion will be 90% or more. As we continue to magnetise towards urban hubs, we need 'smart cities' – places where networks and services are made more efficient with the use of digital and telecommunication technologies, for the benefit of inhabitants, businesses and the

environment. The EU is trying to ensure that smart solutions for cities can be explored, implemented and replicated.

Smart means intelligence. Intelligence on the other hand is the key factor to keep a city safe. With the evolution of communication technology, the dissemination of information has become an extremely common task. When substantial investments are made in human and social capital, technology (communication infrastructure), and so on, that fuel sustainable economic development and increased quality of life, along with active participatory governance, the city can be defined as 'smart'. [2]

The below mentioned technologies and processes in Fig.1 are expected to be the core engine of a safer city in the future. Projects currently underway, are already implementing some of these technologies with the main goal of achieving greater integration in the near future. The emergence of smart technology from many devices, buildings, and critical infrastructure means that more information is widely available to gather and interpret. This analysis provides intelligence on how to act to critical situations. This is critical in making a city safe.

***Fig. 1** How smart drives safe – intelligence playing a major role in safer cities [2]*

The concept of 'smart' is expected to drive the further evolution of connectivity and communication to enhance safety. When mentioning smart technologies, we talk about smart buildings, smart transport, smart energy, smart grid, smart cars and smart devices. These new state-of-the-art technologies are the main drivers for city connectivity. The information flow from smart buildings will provide an overview of the status of current utility usage and any variation in the flow of information can trigger an alarm for first responders. Smart transport delivers information from the field and will inform traffic officials that an issue occurred; this may trigger an immediate
surveillance response and possible unit deployment.
Smart energy and smart grids are a crucial element in the surveillance of critical infrastructure and may reduce the risk of power failures. Smart cars give perfect information feed for graphical information systems (GIS) which could be used for the identification of potentially hazardous (traffic jams, accidents, etc.) areas in the city. Smart devices (Smart Phones, Tablets, etc.) allow the mapping of people through GPS and Wi-Fi internet. This also is a crucial aspect to having graphical information about the movement of people.

One common discussion on the market for safer city technology is how it relates to the creation of smart cities. A simple way of correlating these two concepts is by understanding their ultimate goals.

Smart city initiatives aim to deploy technology solutions across different infrastructures in a city with very specific goals. For example, smart transportation solutions are deployed to optimise traffic flow, increase transport connectivity, reduce time spent on mobility, etc. Smart energy technologies are used to increase efficiency, reduce pollution across urban areas, make use of renewable sources, amongst others. In essence, the "smart" concept is using cutting-edge technologies and solutions to make a city a better place to live. "Safe" is the enabler to "smart," simply because it must be present across all different factors—transportation, energy, etc. In other words, safer cites do not compete with smart cities.

Security and safety threat will be a factor influencing the implementation of safer city projects in the coming years. A part of the security factor is the internal/external terrorism threat a city faces.

The higher the internal/external threat of terrorist attacks the more probability there is of a city implementing a safer city project. Other elements that are included in the security and safety threat factor are natural disasters, crime, and so on. The element that is the most important in this segment is crime. The main purpose of safer cities is to decrease the crime rate and increase the feeling of safety amongst the citizens.

Key Trends for safer cities are [2]:
Move towards wireless transmission
Growth of cloud computing, data mining and analytics
Integration of smart technology

Wireless transmission is already present and fairly saturated today through mobile phone, tablet PCs, two way radios etc. The trend for 2012 will allow for large amounts of data to be transmitted wirelessly and real time at greater speeds. This includes development in Long Term Evolution Solutions (LTE), City Clouds, Machine to Machine communication (M2M), internet protocol (IP) technology etc. The development of the above technologies will allow for government agencies and departments to share information with one another seamlessly, thereby reducing the processing time for any activity. In terms of law enforcement, we are already seeing law enforcement agencies in India, China and Singapore using hand held smart devices to retrieve information from numerous vast databases. Mobile devices would also allow law officials to view city footage of key areas in a city remotely without having to be at a stationary location. Remote viewing would allow individuals to attend to a situation before the situation becomes more intensified. IP technology in video surveillance has allowed for cameras to be installed at locations where previously, because of the lack of infrastructure, wiring was not available for the cameras. Today, through IP technology, cameras can be installed immediately and effectively while also providing footage to multiple users across numerous remote locations.

The growth of cloud computing will allow companies and government agencies to have their data stored in a virtual cloud thereby, allowing for access from numerous locations and more importantly, save on cost and space, which would otherwise be used by physical servers. The implementation of cloud technology will allow for faster data retrieval as well as an increase in the size of data that can be retrieved. Cloud computing also allows for data to be retrieved instantly across a large number of devices. Data mining and analytics will allow for government officials to have key data to help them to interpret situations that are taking place currently and accordingly allow them to take preventive steps.

Smart technology is already present through the aid of smart phones, contactless payments, near field communication (NFC), integration of smart cards with biometrics etc. The next stage for smart cities will involve the integration of smart technologies with video surveillance, biometrics, access cards etc. Through this integration, law enforcement agencies will be able to identify criminals/offenders in a city and accordingly take steps towards apprehension. We are already witnessing the benefits of smart technology in the form of smart national ID cards in countries such as Malaysia, Singapore, Indonesia etc wherein the users details are present on the card itself thereby proving to be a key identification card for the user.

The key part of safer cities is technology. With the safer city concept becoming more popular on a worldwide basis, there will be a higher demand for new security solutions. Convergence is happening across industries and markets at a great pace and the security sector is no different from other infrastructure related markets such as energy and transportation. Technologies such as video surveillance, biometrics, and so on, are gradually changing the way intelligence is being gathered and processed. Without being noticed, CCTVs on the streets increase public safety through better surveillance.

Safer city solutions incorporate a wide array of technology. Integration and interoperability of various technologies is fundamental in obtaining better intelligence from various sources.

From CCTVs to crisis management centres, technology will act as a key enabler for law enforcement, emergency services and local decision makers to optimise their response to the expected and unexpected. With older technology reaching maturity new security solutions are implemented to strengthen city safety.

A new set of tools and technologies now exist to help city governments manage public safety and city services, improve management of city resources towards security and safety, share information effectively, manage data deluge, improve decision making and collaboration, develop smart innovation, deliver safer and more secure communities.

Given the complexity of a smart city, it can be represented using various models and modeling techniques and formalisms. Each of these models will represent a particular view of a smart city. A comprehensive modeling of a smart city needs to include different views. [3]

In what follows we present four relevant models for smart cities.

• **Domain Knowledge Model**

As the emergence of the requirement of building smart cities across many countries, the Domain Knowledge Model of smart city becomes necessary for two reasons. First, the aggregation of multi-source and heterogeneous data and service needs a set of unified concepts and terminologies. Second, the development of applications needs the support of common knowledge of smart cities.

The Domain Knowledge Model of smart city has abundant contents and involves many domains and cities. In order to support cross-domain and cross-city interoperation of knowledge, we should concise the common concepts and their relationship from domains and cities and construct a core concept model. Furthermore, the domain knowledge in smart city is abundant and complex. No single individual or organization can build it comprehensively and thoroughly. The model should use swarm intelligence to build it and the participants should work collaboratively. To support better cooperation, we should construct a standard and core concept model that can specify terms from different stakeholders, support semantic understanding and give standard knowledge expression [3].

This model aims to:

a) Support interoperation of cross-domain knowledge model:

The model provides a sharing model of common knowledge in Smart City's domains and supports interoperation among cross-domain knowledge model.

b) Support extension and customization for specific domains and cities:

The model only defines the cross-domain and cross-city core concepts and their relationships. It supports extension and customization for specific domains and cities to reflect their differences.

This model will apply to following circumstances:

— Support cities to build their own smart city Knowledge Model which processes specific city features.

— Support smart city related domains to build their own smart city Knowledge Model which has specific domain characteristics.

- **Data and Services Model**

Using the OSI2 (Open Solver Interface 2) as a template, a data services model would reflect the data, communications, service and application layers that are used by citizens, businesses, and city authorities. Such a model would provide an adequate technical view of and for a more general smart city model.

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As a system of systems, a smart city can be modelled using formalism described in Joined JTC 1/SC7 standards such as ISO/IEC 42010 Software and Systems Engineering –Architecture description or ISO/IEC 19505 Information Technology – Object Management Group Unified Modeling Language (OMG UML). [3]

The view on Fig. 3 put the emphasis on the concepts that characterize the smart cities.

The physical city is collapsed in the bottom layer and three characteristics of a smart city are expanded: citizen centric, digital and openness & collaboration. This view is well tailored to explain the characteristics of a smart city to city administrators and governors.

Citizen-centric refers principally to the accessibility of pertinent services to citizens and business in the city. The digital city is essentially the IT enabled connectivity and integration of the different elements and services of the city. Finally, the openness & collaboration characteristic, also IT enabled, put an emphasis on the elements that drive innovation, and thus competitiveness and economic growth in a city.

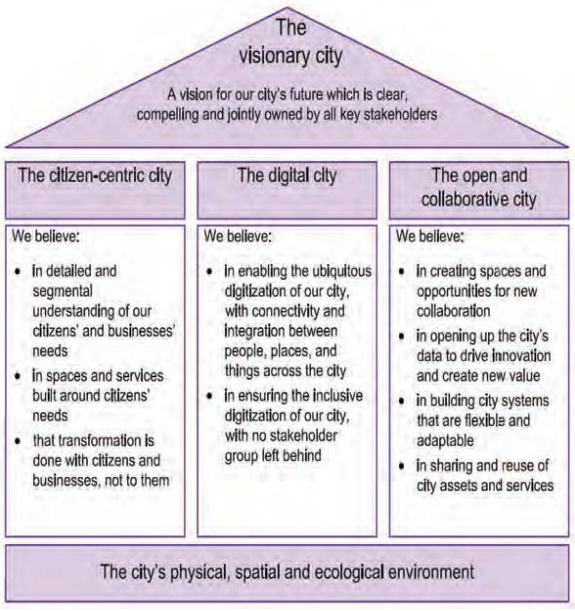

Fig. 3 *Smart city concepts and outcomes [3]*

We can also put the emphasis in a simple model on the system integration and synergistic characteristic of a smart city (see Fig. 4). Such a view not only illustrate succinctly the 'glue', or the system integration property that ICT provides in smart cities, but it also makes the contributions of JTC 1 very visible.

In this view, a smart city is presented as a combination of four Internets or networks: Internet of Data, Internet of Things, Internet of People and Internet of Services. [3]

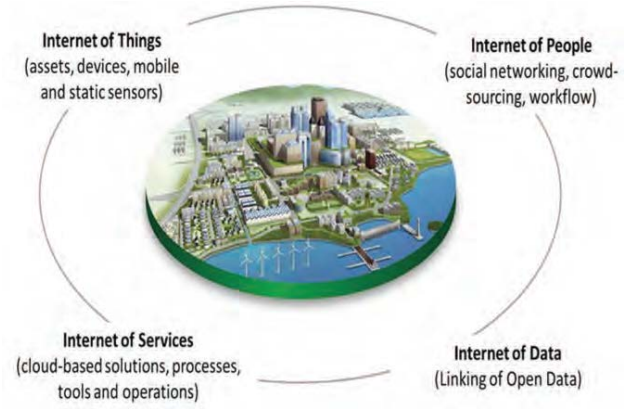

Fig. 4 *The smart city as a set of 'Internets' [3]*

- **Urban Information Model**

Could be viewed as a means to structure and classify the many different types of information contained or flowing in these networks. From an information technology point of view, it is helpful to think of the Urban Information Model as a very large number of layers representing a common two-dimensional space, the territory of the urban environment, whether that is a single city or a metropolis. Such a model is often instantiated in a Geographic Information System (GIS), however increasingly social networking tools are taking this model in new directions [4].

The groups of layers are:

1. The Natural Environment group including topography, flora and fauna, natural resources, geology, and so forth.

2. The Infrastructure group including the Built Environment (roads, bridges, tunnels, buildings, pipelines, electrical and communication lines, and so forth) as well as Things That Move (trains, boats, buses, and so forth) that is constructed on the Natural Environment.

3. The Resources group representing materials that originate in and eventually return to the Natural Environment after passing through various processes of refining and consumption in the Services group as well as capacities that are temporarily consumed.

4. The Services group representing many kinds of services, including transportation, energy, commerce, healthcare, and so forth. Many of these services consume or transform resources from the Resource group.

5. The Social Systems group, including the locations and Actions of people, such as commerce and culture, laws, regulations, governance, and so forth that exploit the Services and Resources from these respective groups. This group contains the topmost and most interesting layer in which we find the People Systems.

So the representation of an Urban Systems model takes place on these five groups of layers. The ordering of the layers is not important. The grouping of layers is also somewhat arbitrary, for example, some or all of the layers in the Resources group could well be included in the Natural Environment group.

Another basic concept is the Service. This is a very general concept and again may be simple or highly complex. Services are Things That People Interact With in the city, including other people or even oneself. Services often consume or transform Resources and always require some form of payment or exchange. The act of invoking a Service is called an Action, which is initiated by a person or another Service and is always either bi-lateral or multi-lateral.

In the topmost layer of the Urban Information Model are the People Systems. People Systems represent Processes For Things That People Do, whether in their work or in their private lives. A People System is a composition of Actions upon high-level Services to achieve some goal. [4]

- **Security- as- a-service and managed services**

Security-as-a-service (SaaS) is a fast emerging outsourcing model for security management and the technology is expected to play a significant role in the development of safer cities in the coming years. It may refer to security management provided in-house by an external organization.

Numerous security vendors are planning to leverage cloud based models to deliver security solutions. With growing interest from various security solutions providers, Frost & Sullivan expects this technology to fast catch up and witness significant growth in the coming years. [2]

Various types of SaaS are listed in Fig.5 below:

Fig. 5 *Safer cities market: security as a service [2]*

Following are some of the major drivers of the global SaaS market:

- Replacement of human resources
- Convergence of physical security
- Switch from CAPEX to OPEX
- Complexity reduction

Following are some of the major restraints of the SaaS market:

- Privacy and data concern
- Reduced control of security systems

3. Concluding discussion

Market value of smart city solutions is forecasted to reach $1.5 trillion by 2020. These tremendous figures create huge opportunities, both for smart city providers and local city authorities to deploy.

At a more general level, the growing effort to standardise concepts, such as smart cities, sustainable communities and eco-cities on the part of national agencies, professional bodies as well as voluntary organisations reconfirms the trend towards more ubiquitous approaches to urban design and planning. This is quite understandable, given both the challenges and opportunities of unprecedented urbanisation globally, and the related economic and technological potential. At the same time, one needs to be mindful of the limits of the technocratic language and use of standards, given the social, cultural and political plurality and diversity of cities and city life.

It is clear from the presented models that the 'smart' in the context of a smart city is ICT based and also that JTC 1 standards play a key role in the implementation of a smart city. It is also clear that building and operating a smart city is like building and operating an IT enabled organisation. As well, it is very visible that close cooperation with ISO TCs would be required given that the domain expertise lies there. Since it is difficult to communicate effectively without a common vocabulary, and even more difficult to develop IT system in such a situation, it is very apparent that a priority should be put on smart city vocabulary/ terminology and ontologies.

In a future research, to truly develop a market for the IT applications that will make a city 'smart', the ideal approach would be to develop a Reference Business Architecture.

References

[1] Höjer, M., Wangel, J. 2014. Smart Sustainable Cities: Definition and Challenges. In: Hilty, L.M., Aebischer, B. (eds.) ICT Innovations for Sustainability. Advances in Intelligent Vol. 310, pp. 333-349. Springer International Publishing. http://link.springer.com/bookseries/11156

[2] Frost & Sullivan report. Safer Cities: A Plethora of opportunities for technology providers. March 2012.

[3] ISO/ IEC JTC1, Smart Cities Preliminary Report 2014. www.iso.org

[4] Harrison Colin and Ian Abbott Donnelly. A theory of smart cities, IBM UK Limited, 55th Annual Meeting of the International Society for the Systems Sciences 2011 01/2011.