SFSC: ICT Strategic Framework for the Smart City

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Abstract
Several emerging issues are pushing cities to become smarter via introducing genuine approaches and innovative actions to solve emerging issues such as urbanization, demographic change and cities' carbon footprint. Cities that leverage on information and communications technology (ICT) - not only to mitigate the above issues, but to increase efficiencies, reduce costs, and enhance quality of life- are commonly referred to as Smart Cities. However, the definitions of "smart" cities remain vague, with lack of holistic strategic framework to assist decision makers to avoid any possible traps such as heavy investments in ICT infrastructure without maximizing its potential, or to focus on short-term solutions without considering the long term needs. This is seriously needed as city officials usually deal with challenges of rapid developments, sustainable development, and rational management of resources. The authors studied many Smart City initiatives and interviewed a number of top ICT managers with the aim to propose a holistic strategic ICT strategic framework for smart cities, which is expected to guide cities officials in any part of the world as they plan "smart" cities' initiatives and transformation projects.

Keywords:
Smart Cities; ICT Framework; Decision Support

1. Introduction

Recently, several researchers, policy's makers, public and private entities as well as standardization institutions have put tremendous efforts towards realizing a Smart city concept into play. All such works have been motivated with the huge rules the smart city concept playing and will play in the near future in the humanity life. Indeed, the a smart city aims to provide its users with extremely large number of services that touches every aspect of people life to name few health, transportation, homes, education. Moreover, several emerging issues are pushing cities become smarter via introducing genuine approaches and innovative actions to solve urbanization, demographic change and cities' carbon footprint. In 2014, the percentage of people who lives in urban areas is large and increasing continuously compared to the percentage of people who lives in rural areas. Specifically, the population percent in urban areas was 54% in 2014 while the same percentage was 30% in 1930. Furthermore, the same percentage is forecasted to be 66% form the total world's populations by 2050 [24].

The Smart City concept has a wide range of interpretation. Those interpretations vary according to the researcher point of view. Mainly this concept might be seen by an ICT sector researcher in terms of implementing technologies that facilitate the realization of the concept of smart city in reality. For example, in ICT, several buzz words are common in the implementation of Smart City such as Internet of things (IoT), Ubiquitous computing and many others. While for public office like commune administrations their focus is beyond the enabling technologies as they see all ICT systems as tool to perform a certain defined set of tasks; So, they might pay particular attention to the integration process of such system into their already existed system and how to manage the resulted combination altogether. Moreover, for management researcher they might concern more in effect of the process of building, running and maintaining the smart city. It is appropriate to mention that this paper focalizes on the fundamental role of ICT in linking and providing city-wide services.

In the perspective of modern technology, "smart" can indicate that following processes of computer programming or guidance, some level of intelligent self-rule or automation in action is present. Automation has been discussed as one of two dimensions in the application and impact of intelligent information technologies [5]. Considering that a smart city systems are taken over by such "smart machines", are prepared with enough intelligence from end to end while using sophisticated data sensors and computing algorithms, they are seen to achieve more accurately and reliably than what can be done by humans, if humans could accomplish such functions at all. For example, the Integrated Operations Center in Rio Janeiro, executed and implemented by IBM, is made to predict the amount of rainfall more accurately than ordinary and regular weather forecast systems and send out text messages to various city units for flood mitigation operations. Operations centers like this allow cities to leverage information across city divisions, anticipate problems and minimize the impact of disorders for rapid and effective response [6]. Additional sophisticated smart machines may employ algorithms or protocols (e.g. systems dynamics) that can model and provide strategic forecasts. Some researchers have commented that "Weak human + machine + better process was superior to a strong

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computer alone, and more remarkably, superior to a strong human + machine + inferior process" [7].

There is a growing belief in which a mixture of humans and smart machines is necessary. An important dimension about automated processes, smart machine should generate information about the creative and administrative processes, which support organizational operations [5]. It has been reported that the most productive firms, reinvented and reorganized decision rights, information flows, and other aspects of organization capital to get the most from the technology, and re-engineered its operational processes to use new ICT technologies [5]. Reference [8] further analyzes particular areas where humans give in the human-machine combination, such as the ability to think, having social and emotional intelligence, and having creativity, intuition, and improvisation. From these outlooks, smart machines handling city functions may achieve some basic levels of proficiencies; however, when combined with the human element in the processes, they may lead to exceptional benefits. Reference [9] declares that "The real key to being smart is to have an overall management system that allows leaders to coordinate across these smart systems" and that smart cities required good smart governance". Open Cities, a network for smart cities, points out in their definition that "the Smart City concept brings together all the characteristics associated with organizational change, technological, economic and social development of modern city" [10].

Many smart city pilot initiatives ignored the need for citizen involvement in the government role while designing their processes, which could lead to some undesirable consequences if the initiatives will be executed on a larger scale [21]. Reference [20] also detected that the lack of funds is a main barrier challenging smart cities, although there is a research recommending that the investment in the development of human capital contribute to successful adoption of smart cities. While, [14] criticized the authentic term of smart city, and referred to it as an urban classification phenomenon. He appealed that the definition is still vague, self-congratulatory which will lead to self- designation, and grips undeclared assumptions. Reference [20] debated that due to the necessity to increase automation and interconnectedness, a smart city could be vulnerable to large-scale failures as one single fault can crumple through and break down the entire city system. Future cyber-attacks are projected as a main intimidation to smart cities, many challenges related to security especially when a large volume of electronic devices and online systems are interconnected. Moreover, the researchers identified socio-political risks associated with smart cities. Also huge volume of artificial models within a city can have dehumanizing effects on its citizens, and the extraordinary level of monitoring and control can lead to a social disorder. Additionally, the business-led approach to smart city development can frustrate citizens if they are incapable to compete [13]. ICT is highly embedded within smart cities, more care needs to be dedicated to issues such as mistrust in ICT, and how the private lives of citizens' will be safeguarded. Smart cities are also criticized according to the indications that the benefits of this city digital revolution will not reach everyone within the city. Instead of reducing inequality between citizens, this digital divide might essentially extend social and cultural separations by increasing the gaps between expert workers motivated to move to the smart city, and the Information Technology illiterate and none or less educated citizens. In addition, the literature also is worried about the economic growth and environmental sustainability in the context of smart cities are achievable or no, and to what degree they might battle and disagree with each [14].

This work sought to provide a ICT Strategic Framework for the Smart City (SFSC) concept even though several other related works which are mostly focus on the evolution process of converting a city to be a smart city and sometimes to evolve a smart city to be much smarter city. More specifically, the paper aims at delivering a three tires framework for cooperative and reliable System of Systems able to handle dynamic and complex situations, by including technologies and methods to enable cooperation among all city related systems in order to realize a successful smart city. SFSC leverage on an innovative three view model namely Technology View, Systems View and Strategic View for promoting such integration and enabling the creation of new smart city able to support cooperation among the city stakeholders and to operate in different vertical domains integrating heterogeneous, mass market horizontal technologies, services as well as people.

The paper discusses the validity of the proposed SFSC framework for fostering the diffusion of successful smart city transformation in general. The framework is verified by three different methods namely, experts interviews, a hypothetical understanding of smart cities, desktop research conducted for sixty-two smart cities and finally case study of **Dubai Salik system** is selected and applied against SFSC concept. The researchers identified the gap between the concept of smart city by researchers and academicians, and how practitioners implemented cities initiatives (learning by doing) in order to build the proposed framework by aligning the lessons learned from practitioners related to smart city.

The paper is organized as the following: Section 1 introduces the importance of the SFSC conceptual framework for smart cities. Section 2 shed a light on is an absence of universally accepted structured model or framework to study ICT role in smart cities world. Section 3 identified a brief summary of similar research papers and projects and it classifies the summary into four different parts according the adapted smart city concept and required features. Section 4 presents insights structure of the adapted abstract theoretical framework and its main building blocks. Section 5 highlights the research strategy. Section 6 focuses on the research data collection and analysis. Section 7 discusses and presents the main work contribution. Finally,

Section 8 concludes the paper and presents the future plans to enhance the proposed framework.

2. Research Problem

2.1 General Problem

The topic of smart city is not new, but it is becoming a main tendency by many city leaders to transform cities to smart or smatter cities, due to technology advancement, availability of smart cities solutions and different governing factors such as environment, politics, governance etc. This tendency motivated the researchers to be interested to study smart cities research from ICT perspective to find a gap which needs further research. The researchers found that there is an absence of universally accepted structured model or framework to study ICT role in smart cities world.

2.2 Research Objective

This research focuses on ICT as a key tangible enabler for the smart cities' initiatives around the globe as per European Smart City Project. In addition, the research focuses on attempting to build a holistic strategic ICT framework or model to act as a planning tool for smart city decision makers, planners, practitioners and implementers for smart cities initiatives.

3. Literature Review

The authors of the earlier article [2] introduce an important classification of the most common six application domains (along with each domain objectives) that attract the majority of investments in all smart cities initiatives. According to this research and many others, ICT systems are the enabling technologies in almost all the aforementioned six application domains. In addition to that, [2] concluded that this way of classification lack of a clear holistic vision on the ICT technology used in smart city; indeed, smart city is a system in which, different levels and layers should be clearly defined, integrated and interoperated. This is serious issue given that it is estimated in [3] "... investment in smart city technology infrastructure will total $108 billion during the years from 2010 to 2020". Notwithstanding, realizing holistic vision on the ICT technology in the context of smart city will provide valuable guidelines for policy's makers and wide city planners an important tool that facilitates the diffusion of smart cities in the world.

Generally, the strategic role of ICT systems has attracted the major global technology providers such as IBM, Cisco and Siemens. For example in [4], IBM defines smart city as "system of systems" where ICT systems is the city digital nervous systems that collect data from heterogeneous sources composing the city infrastructure. Furthermore. [4] stresses the role of ICT in enabling how city planners and leaders should determine how these systems operate, interrelate and share information, to enable better decision-making. Consequently, IBM has foreseen and tailored solutions for smart cities for wide range of city sectors and roles, including transportation, energy and utilities, retail, healthcare, airports, social services, communications, education, public safety and economic development. [4] concludes that smart city depends heavily on integrated technological solutions for sustainable urban infrastructure; such conclusion stresses the fact that a realizing tool to facilitate the job of cities leaders and planners in order determine how these ICT systems operate is demanded.

This section presents a summary of several academic contributions related to the Smart City concepts. The summary aims at categorizing related works into four parts based on the works high level definition, applications and features of Smart City. A comprehensive comparison with the proposed work elaborated at the end of each part.

Part 1: Smart city emphasizes the use of ICT for automation and intelligent role and actions, and is smart in the way its processes and data, organized and reorganized.

A number of research groups, such as [11], expanded the arrangement of Smart cities beyond the contribution of communities to superior networks of cities, whereby cities acquire from each other best practices in city governance and management, and renovating such wisdom to innovative application. The practice of learning and re-learning is the ability to measure performance, especially, through metrics or key performance indicators defined according to a city's objectives, initiatives and goals. A Smart Cities Wheel rubric and pillars were developed, which highlighted more than 100 indicators grouped into six comprehensive sets of Smart Economy, Smart Environment, Smart Governance, Smart Living, Smart Mobility and Smart People [12]. The intention is to have a framework to allow a common language to be developed amongst citizens, city staff, mayors, and the private sector and describes the interconnected processes of monitoring, managing and using gathered data for future simulations and design.

Part 2: Smart city thinks, learn and build lessons learned and adapts itself, over its intelligent networks, systems and sensors, with use of metrics, monitoring and feedback processes as a performance management and for learning and growth.

Another group of researchers [13] considered and viewed that smart cities are more than smart machines, correlating, fluctuating the application from city functions to governance. For instance, research in [14] assumes a critical view of self-proclaiming smart cities, emphasizing that the use of ICT is narrow in the transformative capacity of cities without incorporating human capital and shifts in the balance of power between government, institutions,

businesses and communities. Other researchers [15] caution against a top-down engineering-driven vision of smart cities where ICT and data-rich models, might be coupled by technocrats in places like China or Singapore to further tighten their grip on how cities function, smart cities involve more social and broad processes of mass innovation working with government and industry. They further caution against a machine city that can overwhelm the social focus of the people who live in its all-efficient embrace". A recent study [16] critiques that smart strategies should focus not on "the city as a single entity" but rather on the smartness of its citizens. Moreover, it views citizens as "generators of ideas, services and solutions, rather than recipients of them" and that cities should hence foster and facilitate their citizens' efforts, for example, through making data openly available. Thus stressing the need for cities to engage their communities. Furthermore, it expresses leadership and governance, innovation forums, and networks and community organizations as the soft infrastructure necessary element of a smart city [16].

Part 3: A smart city comprehends a joint process among governments units involving institutions, communities, businesses, research and educational institutions, citizens, etc. as buddies in a framework that drives and enable innovation and transformation.

Reference [17] magnified the definition of smart cities beyond an environmentally sustainable agenda involving infrastructure and livability, to take into account the economic sustainability built on "economic fundamentals". Analyzing the performance of 70 European cities lead to conclude the need for cities to concentrate on their stocks of capital, i.e. human, social and physical infrastructure [18]. Another study examined the business models of two Dutch smart cities and their application of technology in offering or improving city services [19]. As an outcome of that analysis, it is found that the design of the essential information architecture, by the cities' technological competences and assets, played a vital role in how the cities might promote and create innovation or enhance city business processes. One point observed is the performance of smart applications, with relevance to a city's technological competences and resources, as well as the observation on the return on investment (ROI) in these smart applications, these are key elements in shaping the form and level of these smart applications. It is also linked with the previous points on organization and governance (e.g. city's capacity, available resources, etc.), establishment of partnerships between governments, institutions, businesses and communities (e.g. business model of smart applications, finance and implementation models, etc.), and the use of metrics that assist to measure business performance.

Part 4: A smart city is conscious of its human, social and physical stocks of capital, and it invests in smart technologies and functions, which have the potential to gain better economic, social and environmental benefits.

It has been claimed that in order to achieve the needs, wants of the smart city, a culture of innovation, learning, and partnership between the components of a city is vital [20]. Moreover, an extensively varied population is desirable to energize association and raise knowledge sharing among citizens. Complications when aiming to encourage and retain this type of citizens are often challenging since outdated governmental policies and organizational structures needs to be restructured.

4. The Theoretical Model

Theoretical framework serves as a research lens for researchers and helps in interpretation of data collected throughout the literature review and the empirical study. Reference [22] put a simple model or guide on perspectives on researching smart city solution. The researchers found this guide a good starting point in building the researchers framework.

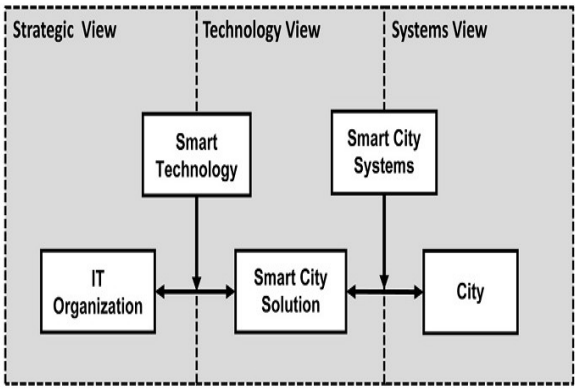

Figure.1: Perspectives On Researching A Smart Et Al (2013) City Solution By [22]

5. Research Strategy

Case Study selected as the research strategy, the reasons for selecting this strategy is that this an empirical study (Qualitative) and more data needs to gathered by people who are serving in the field of smart city in order to build the proposed researchers framework. Case study research is the most common qualitative method used in information systems [23].

6. Research Data Collection and Analysis

Data collected primarily by exploratory interviews and secondarily from a hypothetical understanding of smart cities and desktop research conducted for sixty-two smart cities. The researchers identified the gap between the concept of smart city by researchers and academicians, and how practitioners implemented cities initiatives (learning by doing) in order to build the proposed framework by aligning the lessons learned from practitioners related to smart city.

1.1 Desktop Research

A number of key smart cities initiatives have been used in order to evaluate the city planners of these cities conceptualization and implementation of smart cities including and considering the application of ICT and the engagement with technology providers. In addition, the researchers study relied on secondary data sources including news articles, governments' websites, blog articles, city reports, papers and presentations. It is prominent that many of these data sources are non-academic by nature, and thus might deliver different perspectives and levels of analysis on the cities' efforts.

A.1 Desktop Research of Sixty Two Smart Cities

Over a desktop research of "smart cities" reports from technology providers and cities' news, a research of these cities is gathered. The list is non-comprehensive and expected to expand as more cities state the application of ICT and new technologies as an integral part of their city utilities. First, it appears to be a wide and varied belief of "smart cities" across the globe. All of them share the common theme of adopting ICT and new technologies, the fields of application range broadly. A second observation is that the "smart cities" seem to be in diverse stages of development. A few cities (e.g. Rio de Janeiro, Amsterdam, Santander, Oulu, Stockholm, Singapore, etc.) had already implemented solutions, which are currently in use, while a large bulk seems to be in a conceptual or development phase. Third, almost one third of these cities reported to be cooperating with major global technology providers such as IBM, Cisco or Siemens. On the other hand, few cities had been teamed up locally or regionally with technology providers and research institutions as their strategic partners, the technology providers for many other cities are still unknown and further exploration will be needed to determine how these cities are transforming toward smartness.

The key findings from the sixty-two smart cities initiatives are:

1. Three main smart cities technology providers exist, which they are Cisco, IBM and Siemens.
2. There are many solutions provided by the technology providers, which serve different city domains such as Transport, Business, etc.in the context of smart cities.
3. There are many Technological components exist in smart cities initiatives such as Near Field Communication NFC, Smart Government, Data and Analytics, Smart Cards, Internet of Things, Radio Frequency Identification RFID, Wireless Sensor Networks, Integration between many domains using integration technologies, Online Governments Portals and Cloud Computing.

Whereas the application of technology in city planning and management could not be new, a few possible reasons for the emergent "smart cities" fashion could be due to the rise in the classifying of cities' efforts as "smart", the increased application of more widely available ICT, as well as technology providers' efforts to partner these cities under a "smart theme". This search is compiled by the researchers using 2014 Key data sources, which are:

1. Cities websites and news reports
2. Smart and Connected Communities Institute, 2012, Smart Cities Expose: 10 Cities in Transition.
3. ABI Research, 2011, Smart Cities: Municipal Networking, Communications, Traffic/Transportation and Energy. Research Report 110 pages.
4. Pike Research, 2011, Smart Cities: Intelligent Information and Communications Technology Infrastructure in the Government, Buildings, Transport, and Utility Domains. Research Report 88 pages.
5. Wikipedia, 2014, Smart City. en.wikipedia.org/wiki/Smart city, retrieved 20 February 2014.

A.2 Desktop Research on Five Smart Cities.

Out of the sixty-two smart cities (the entire population) the researcher selected five cites as random samples to obtain more information about the reported initiatives. Additionally, the random samples selected based on a number of key selection criteria formed by the researcher and derived from diverse perspectives and contexts considering some facts that the selected cities would differ in terms of their scales and sizes, their backgrounds of governance, modes of city planning, management and operations, geographical location, etc. The selection criteria applied are as follows:

1. **Relevancy of possible application in ICT solutions in city planning and services offered to citizens:** While the broad nature of planning encompasses fields as wide-ranging as transportation and infrastructure planning,

community engagement, citizen, participation, etc. The selection criteria will be used to assess how the use of ICT or new technologies may be relevance, or may be extended in application to city planning.

2. **Real initiatives: Reported range of "smart" initiatives:** The second criterion in this research is to select cities that already implemented smart city initiatives. Like cities which have initiatives that have been evidently identified in partnership with technology providers. This will allow better understanding of challenges or issues faced by the city planners, as well as functional or organizational issues that have arisen during implementation in order to build the strategic ICT framework.
3. **Scope of application and initiatives:** Cities that have a range of initiatives in various fields will be preferred, as a varied assortment of application imitates the actual concept of being "smart".
4. **Diversity of political socio-economic contexts:** Selected cities are from a range of political socio-economic contexts, as this may reflect how city planners' perceptions or conceptualizations of "smart cities" might vary or be related across different contexts.
1. **Diverse technology providers:** Finally, selecting cities that collaborated with diverse technology providers will actually provide a wider insight of city planners' perceptions or conceptualizations of "smart cities". Hence, selecting cities partnered with many technology providers will be healthier than the cities relayed on one technology provider. The selected five smart cities are: Dubai, UAE; San Francisco, USA; Stockholm, Sweden; Singapore; Amsterdam, Netherlands.

Out of the five cities, the researchers selected to present the case of Dubai with more concentration and focus.

Table 3: Key Findings of Smart Cities Initiatives

Technologies Used	Smart City Fields
Dubai:	
RFID	Transportation
Mobile Applications	Smart Government
Portals and Online Services	Smart Government
Cloud Services and Grid Computing	Education
San Francisco:	
Mash-Ups	Environment: Energy and Waste Management
Portals	Economy
Stockholm:	
Dashboards	Public Entities and Citizens
Portals	Citizens
Single ICT city infrastructure technology for multiple services	1.1.1.1.1 Transports, Logistics, e-Health and Telecommunication
Singapore:	
Web Portals and Data Analytics	Government and Citizens' Services
Wireless Networks	Telecommunication
NFC	E-Payment ICT City Infrastructure
Grid Computing	Economy
Mobile Apps	Transportation
Amsterdam:	
Web Portals and Data Analytics	Government and Citizens' Services

B) Example City Imitative - Dubai

On March 05, 2014, a strategy was launched to transform Dubai into a 'Smart City', by Dubai Government. The strategy is based on six key pillars and 100 initiatives on transport, communications, infrastructure, electricity, economic services, and urban planning. Under the strategy, 1000 government services will go smart in the next three years. (Dubai Media Office, March 2014). Our goal is to bring about happiness to all"., the researchers observed that Dubai concept of smartness is to provide all the service through smart devices. As an example of "Smart" Initiatives is the Transportation Initiative: Salik Toll Gate System. Salik is an initiative by the Roads and Transport Authority in Dubai, the solution is based on the RFID technology; where RFID tags are used to identify vehicles crossing through paid roads.

Sheikh Mohammed, Ruler of Dubai and Prime Minster, UAE declared "Our ambition is that this project touches the life of everyone in our country, or every mother in her house, or every employee in his work, or every investor in his project, or every child in his school, and doctor in his clinic. Our goal is to bring about happiness to all. May Allah help us in achieving this end". From the statement, the researcher observed that Dubai concept of smartness is to provide all the service through smart devices. As an example of "Smart" Initiatives, let's consider the Transportation Initiative: Salik Toll Gate System. Salik is an initiative by the Roads and Transport Authority in Dubai, the solution is based on the RFID technology; where RFID tags are used to identify vehicles crossing through paid roads. Also, we considered and analyzed other initiatives for Dubai, which will appear in the summary table of all studied initiatives worldwide.

C) Interviews Data Collection and Analysis

A common theme was found between most of the interviewee, majority of them projected that in the next few

years there will be significant sifts and trends in Society, Technology, Environment and Politics when any city decides to transform to a smart city. The interviewer informed all the interviewee about his academic research, and requested them if they are welling to aid in proposing a strategic ICT framework for smart cities. Most of them showed an interest in putting their touches in order to come with a holistic strategic ICT framework or model. Each Interviewer responded to the researcher conversation from his/her perception about smart cities. All the interviews were conducted in a conversational tone. There are some foundation questions formulated in the researcher mind, those questions served as a starting point for the discussion about the research goals and objectives. Below Are the Questions Formulated by the researchers:

1. What is smart city and what are the perception of your mind about smart city?
2. Do smart cities initiatives need a strategic ICT model to be followed?
3. What are the emerging ICT technologies in the context of smart cities?
4. What is the needed ICT infrastructure for smart cities?
5. How to sustain the smart cities and optimize its ICT resources?
6. What are the needed securities, governance to protect the smart city ecosystem?

There are many data in the context of smart city, how can these data used and presented for the continuous improvement and radical openness?

The researchers formulated some foundation questions to serve as a starting point for the discussion about the research goals and objectives.

C.1 Interviewees' profiles

This section presents brief information about the profile of the persons who has been interviewed in the below table.

Table 4: Interviewees' Profiles

Interviewee	Position	Organization Type
Interviewee 1	*IT Strategy Director*	*Government*
Interviewee 2	*Excellence Advisor*	*Government*
Interviewee 3	*IT Manager*	*Government*
Interviewee 4	*Public Advisor*	*Multinational*

The interviews data were transcribed, documented and analyzed.

a. Observations based on literature review, the desktop research, and the empirical study

At this stage of the research, we were able to identify a list of items that can serve as core inputs for building the framework.

Table 5: list of identified items

Web Portals.	Data and Analytics.	Trusted service manager for security and privacy in smart city.
Mash-Ups.	Mobile Apps.	Investment in ICT for smart city.
NFC.	Grid and Cloud Computing.	Internet of Things (IoT).
RFID.	Augmented Reality.	Social Networks for Awareness.
Sensor Networks and Wi-Fi.	Dashboards.	Governance.
Unified ICT Infrastructure.	Application Programming Interface API interoperability	Systems Integration.

b. Analyzed data using the Frequency Analysis Technique

The researchers used the frequency analysis in order to rate the list of items found during the data collection and literature review. On scale of Low, Moderate and High the researchers will rate the occurrence of items found in the desktop research, interviews and literature review in order to construct the proposed model.

7. Discussion and Findings

From the literature review, desktop research, and interviews the researchers found that there are many ICT components exists such as technologies and ICT Governance practices, which need to be all grouped into a strategic framework or model for smart cities.

Table 6: Items Occurrence Rate Table

No	Items	Literature Review	Desktop Research	Interview 1	Interview 2	Interview 3	Interview 4	Ocurrence Rate
1	Web Portals	*	*		*	*		H
2	Mash-Ups		*	*		*		M
3	NFC	*	*	*		*		H
4	RFID	*	*	*		*		H
5	Sensor and Wi-Fi	*	*	*		*		H
6	Smart City Unified ICT	*	*	*		*		H
7	Data and Analytics	*	*		*	*		H
8	Mobile Apps		*	*	*	*		H
9	Grid and Cloud	*	*	*	*	*	*	H
10	Dashboards	*	*	*		*	*	H
11	Augmented Reality		*	*				L
12	API interoperabi			*		*	*	M
13	Trusted service	*	*		*	*		H
14	Investment in ICT for	*	*	*		*	*	H
15	Internet of Things	*	*	*		*		H
16	Social Networks			*	*		*	M
17	Governance		*	2.	*	*		M

a. Proposed ICT Strategic Framework

The proposed framework is premeditated as a multi tiers or layers. On each layer, there are certain ICT technologies; components or mechanisms need to be in place in order to orchestrate all the components for successful smart city.

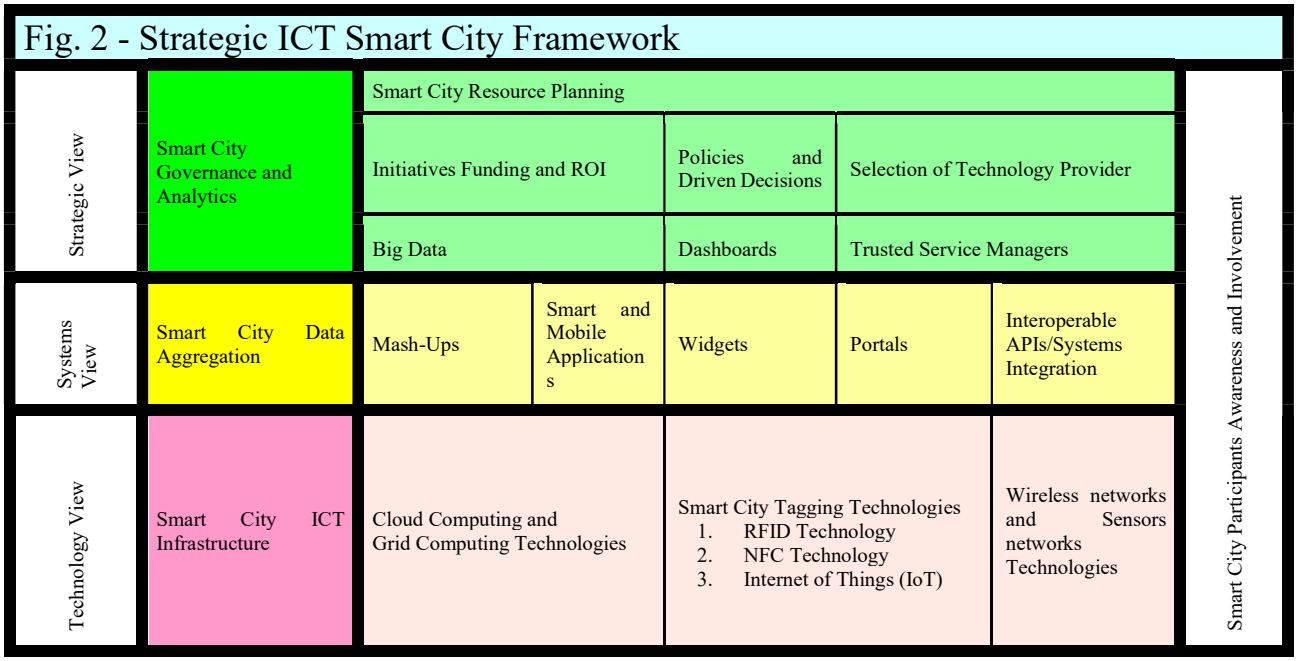

Figure.2: Strategic ICT Smart City Framework

Smart City ICT Infrastructure (Technology View): This is the layer were all the needed infrastructures need to be deployed and embedded in the existing city infrastructure. This layer acts as the entry point for any smart city utility or service, this layer maintains and emphasizes on the connectivity model or connectivity solution for smart city. The components of this layer are Cloud Computing, RFID Technology, NFC Technology, Internet of Things (IoT) and the wireless and sensors network technologies.

Smart City Data Aggregation (Systems View): is the middle layer of the proposed model. The purpose of this layer is to capture real-world data from different sources using different techniques such as Mash-Ups, Widgets, and Portals and additionally providing smart apps to the smart city participant to access the captured data in this layer the integration between smart city systems takes place by providing interoperable APIs. All the element of this tier are a kind of software embedded or deployed in objects to capture real- world data from different sources.

Smart City Governance and Analytics (Strategic View): This is the upper tier of the framework (High Level Tier) where all the data collected will be processed and presented for public and policy makers. This tier is the governance and data analytics tier: Trusted Service Manager deals with the security, privacy, identity and authentication of all participants. Another important role at this tier is the strategic role where the policy makers will be able to make decisions on changing existing policies and make decisions based on the existing situations. Additionally at this tier, the selection of smart city technology providers will be made and return on investment studies will be calculated. Finally, the whole model is capped with the top layer called smart city resources planning; the purpose of this component is to optimize all the resources used on the whole framework. A key-supporting element that comes as vertical on the framework is the awareness and involvement of the entire concerned smart city participant.

b. Framework Expected Outcomes Categorized based on the Framework Layers

The researchers highlight some expected outcomes as a result of implementing the model. The below table illustrates the outcomes on different views of the proposed model.

Table 7: Expected Outcomes of the proposed ICT Strategic Framework

Strategic ICT Smart City Framework Outcomes		
Model Layers		Outcomes
Strategic View	Smart City Governance and Analytics	1. Overall integrated strategic plan. 2. ICT is optimized and in use in all city domains. 3. Built Sustainability competence in all the smart city domains. 4. Improved decision-making. 5. Development and continues improvement. 6. Security and Governance plan for Smart City.
Systems View	Smart City Data Aggregation	1. Overall integrated smart city systems, which give real time data and reporting. 2. Accessibility of data by the entire smart city participant in a controlled and secure manner and based on the authorized level of access. 3. High level and effective solutions. (Fit for Purpose).
Technology View	Smart City ICT Infrastructure	1. Diverse interaction points using different technologies. 2. Well established channels for two-way communication between the entire smart city participants. 3. Many data capturing technologies through a unified ICT infrastructure that serves different smart city domains.

a. Conceptual Validation of the Framework

The researcher will validate the model by using one of the reported initiatives in this research. The researcher selected an initiative called Salik (Toll Gate System). The below table summarizes the initiative details

The following table demonstrates an application of the proposed framework by mapping all Dubai initiative's items into the proposed framework along with measured outcomes from implementing the model. The demonstration is a kind of conceptual validation; however, the model still needs to be tested in other smart city initiatives and other smart city domains.

Table 8: Salik Initiative Details

Initiative Details	
Initiative Name	Salik Toll Gate System
City	Dubai
Country	United Arab Emirates
Smart City Domain	Transportation
Initiative Description	This is a toll gate system based on RFID technology for vehicle recognition (RFID Tag), cloud for data storage and data processing, portals and mobile apps for data access and other purposes such as topping up the balance of the user account and dashboards for reporting the gathered and processed data to smart city participant involved (in this case it's the Road and Transports Authority RTA, which part of Dubai Government).

Table 9: Implementation Scenario Of The Proposed Framework

Strategic ICT Smart City Framework for Salik		
Model Layers		Outcomes
Smart City Governance and Analytics (Strategic View)	1. Dashboards for the top management. 2. Security Standards in the Used RFID technology and security on the portals using secure https Protocol. 3. Selected technology providers for the full solution. 4. Justifies ROI.	1. Secure Solution Provided. 2. Plan Roads Capacity for future improvement and maintenance projects. 3. Know the peek time and roads congestion rate. 4. Improved decision-making.
Smart City Data Aggregation (Systems View)	1. Portals for users (track the trips, recharge users account, list of all vehicles registered under the user account, etc. 2. Payment Gate way for Recharging the Account (Integration) 3. Mobile Apps for Android and IOS 4. Integration with Dubai Police for Salik fine Payments. 5. Integration with Government Resource Planning system of Dubai Government.	1. Overall integrated systems, which give real time data and reporting. 2. Accessibility of data by the entire smart city participant in a controlled and secure manner and based on the authorized level of access.
Smart City ICT Infrastructure (Technology View)	1. RFID Tags 2. Wireless Network 3. Cloud Based Data Storage	1. RFID for Traffic Management. 2. One Unified ICT infrastructure that is used by different government entities.

8. Conclusion and Recommendation

Smart City is still a broad concept, and as long as the city planners agree on certain framework to follow. Additionally, the proposed framework by the researchers needs to be validated and improved by industry practitioners. Moreover, ICT is the crucial nervous system of smart cities and citizens and business demand access to services from anywhere at any time. Finally, Smart cities initiatives stages are research, pilots' trials, innovation and improvements. The empirical study in this research was limited to four participants in UAE to create the researchers' model. The nature of the research required the research to follow a qualitative approach. The research model needs to be validated using more initiatives from different domains in smart city. Still there is more future work needed to improve the model. Many researches are still needed to understand the concept of smart cities and make smart cities initiatives

successful, Areas or topics that need to be investigated can be, but not limited to:

1. Internet of things / Internet of Everything: this is a new concept about having presence of any object in the Internet. This topic still needs to be more investigated in terms of technology, issues etc.
2. Data analytics and analytical technologies: this is the concept on which how the smart city will capture the data, cross check the collected data, correlated with other data, and produce a meaningful information for decision-making.
3. Smart City Cloud solution: How the smart cities cloud will be built and integrated among different technologies used for different context in smart city.
4. Security and Governance (Both Technical and Non-Technical): how the relation between entities will be governed in the context of smart city information system, radical openness and interconnected world.
5. Privacy concern: how citizens will build trust with the government while providing private information and what will be the possible trust model that would be implemented.
6. Video surveillance /Image processing / gesture recognition: how all the equipment related to streaming and sensing will be developed, tested, installed and maintained to adopt the smart city.
7. Develop new economic models: how the organization will be restructured and business process will be designed or reengineered in order to adopt the transformation towards smart city model.
8. Smart City Ecosystem sustainability: how the city will sustain its resources and maintain it for long-term services.

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