



بسم الله الرحمن الرحيم

*Sudan University of Science & Technology*

**College of Graduate Studies**

**College of Computer Science and Technology**



**Development of a Framework for Smart  
Cities Network Management**

**(A Case Study of Khartoum City)**

**تطوير إطار عمل لإدارة شبكات المدن الذكية  
(دراسة حالة مدينة الخرطوم)**

*Presented by:*

**Malaz Daffalla Mohammed Almardi**

*Supervision:*

**Dr. Mohammed Elghazali Hamza Khalil**

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Master Information Technology

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## Declaration

I hereby declare that the work reported in this M.Sc. thesis titled as “Development Framework for Smart Cities Network Management (Case Study Khartoum City)” submitted at the Master of Science degree in Information Technology, is an authentic record of my work carried out under the supervision Dr. Mohammed Elghazali Hamza. I have not submitted this work elsewhere for any other degree.

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Malaz Daffalla Mohammed Almardi

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Dr Mohammed Al-Ghazali Hamza

Supervisor

## **Acknowledgement**

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I would like to thank my friends to awarded me the strength to face the hardships of life, the trustworthy and to encourage me always to progress and success. I would like to the meaning of love, the smile of life and the secret of my existence.

” **My parents**” whom were their litany the secret of my success. I am extremely grateful for your support throughout my entire life and your encourage to complet my study, your love and your standing with me always.

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## Abstract

Urbanization is one of the main challenges of the world we live in. More people than ever before live in cities, which leads to problems with future sustainability. The Smart City concept addresses this problem of urbanization. With the use of technology, a sustainable environment can be created. In this research, the focus is on Smart City networks that are in place to share knowledge and to bring together actors for smart cities define as uses digital technologies or information and communication technologies (ICT) to enhance the quality and performance of urban services, reduce costs and resource consumption, and engage more actively with its citizens. The problem of research have mulit-stages from Urbanization , population growth in urban area and dearth in resource with misusing it, that Has led to a weakness in the provision of services to citizens in various fields, we must can provide solution to growing urbanization and improve quality and of life and services for the smart city citizens. The aim of this study to development framework for smart cities network management to be guideline to improve the process of networks management. The research was carried out using mixed mode methods in order to collect data. Data were gathered in research based on inputs from literature review and questionnaire s. Data collected from experts in the networks field. And the results indicate: 88% of participants from questionnaire who had enough background about smart city. 89% of participants will interactive with smart city idea.84% of participants believe we needed the smart city to solve problem in traditional area. most of participants see Khartoum city will become smart city in the future. Finally, this study gives a better understanding of smart city networks management. The study recommends study smart city networks in- depth and present new technologies and solution to best services.

## المخلص

تُعرّف المدن الذكية بأنها استخدام التقنيات الرقمية أو تقنيات المعلومات والاتصالات لتحسين جودة واداء الخدمات الحضريه التي تقدم للمواطن مع تفاعله العالى معها وتقليل التكاليف و أستهلاك الموارد . مشكلة البحث هي أن التحضر الذى حصل في المناطق الحضرية وزيادة عدد السكان المفاجئ أدى إلى ضعف في تقديم الخدمات للمواطنين في مختلف المجالات مع شح فى الموارد والاستخدام السئ لها ، وظهور خدمات واحتياجات جديدة لم تكن موجودة من قبل ، لذا يجب أن نوفر حلاً للتوسع الحضري وحلول صديقه للبيئه لتحسين نوعية الحياة والخدمات التي تقدم لمواطنين. الهدف من هذه الدراسة هو تطوير إطار عمل لادارة شبكات المدن الذكية ليكون موجه لتحسين عملية إدارة الشبكات. تم جمع البيانات لهذه الدراسة باستخدام وسائل نوعيه لجمع البيانات كالمقابلات الشخصية والاستبيان . وتم جمع هذه البيانات من بعض المحترفين والخبراء فى مجالات الشبكات والحاسوب . كما تم ايضا جمع بعض البيانات من الدراسات السابقه فى مجال المدن الذكية . وتشير النتائج التي تم التوصل اليها من المشاركين فى هذه الدراسة إن: 88% من المشاركين من الاستبيان الذين لديهم خلفية كافية عن المدينة الذكية . 89% من المشاركين سوف تتفاعل مع فكرة المدينة الذكية . 84% من المشاركين يعتقدون أننا بحاجة إلى المدينة الذكية لحل المشكلة في المدن التقليدية. يرى معظم المشاركين أن مدينة الخرطوم ستصبح مدينة ذكية في المستقبل. أخيراً ، تعطي هذه الدراسة فهماً أفضل للمدن الذكيه وكيفية إدارة شبكتها. توصي الدراسة بدراسة عميقه لشبكات المدن الذكية وتقديم تقنيات جديدة وحلول لتقديم أفضل الخدمات.

## TABLE OF CONTENTS

Declaration .....	i
Acknowledgements.....	ii
Abstract .....	iii
Abstract (Arabic).....	iv
Table of contents.....	v
List of figures .....	vii
List of tables .....	viii
List of abbreviation.....	ix
<b>Chapter ONE INTRODUCTION.....</b>	<b>1</b>
1.1 Introduction.....	2
1.2 Background research.....	3
1.3 Problem Statement .....	4
1.4 Objective.....	4
1.5 Scope of Research.....	4
1.6 Proposed solution.....	5
1.7 Thesis layout.....	5
<b>Chapter TWO Literature Review.....</b>	<b>7</b>
2.1 INTRODUCTION.....	8
2.2 Digital Cities.....	8
2.3 Wireless Cities.....	9
2.4 Smart Cities.....	9
2.5 Internet Of Things.....	12
2.6 Smart Cities Framework.....	12
2.6.1 Key Outcomes and Benefits.....	13
2.6.2 integrative smart city framework.....	15
2.7 Network management.....	17
2.8 Related Work .....	19
Summary.....	22
<b>Chapter THREE Methodology.....</b>	<b>23</b>
3.1 Introduction.....	24
3.2. Data Collection Methods.....	25
3.3 Data Analysis Tools .....	27

3.4 Select city .....	28
3.5 Simulation.....	28
Summary.....	30
<b>Chapter FOUR Results and Discussions.....</b>	<b>31</b>
4.1 Introduction.....	32
4.2 Participants Backgrounds Analysis.....	32
4.2.1 Analysis of Gender.....	32
4.2.2 Participants specialization Analysis.....	33
4.2.3 Participants' Age Analysis.....	35
4.2.4 Years of Experiences Analysis.....	36
4.3 Data Analysis and Results .....	37
4.3.1 Questionnaire Item Analysis.....	37
4.3.2 Interview Question Analysis.....	52
4.4 Findings from Questionnaire and interview .....	53
4.4.1 Findings from Questionnaire .....	53
4.4.2 Findings from Interviews .....	54
4.5 The Simulation.....	55
4.5.1 Proposal Frameworks.....	56
4.5.2 Networks Configuration.....	57
Summary.....	59
<b>Chapter FIVE Conclusion and Recommendations.....</b>	<b>60</b>
5.1 Conclusion .....	61
5.2 Recommendations .....	61
References.....	62
Appendix A.....	66
Appendix B.....	79

## List of Figures

Figure 1.1: Smart City.....	3
Figure 1.2: the proposed solution flowchart.....	6
Figure 2.1: Smart City Factors.....	11
Figure 2.2: internet of thing.....	12
Figure 2.3: Smart City Frameworks.....	13
Figure 3.1: Research Processes.....	24
Figure 4.1: Analysis of Gender.....	33
Figure 4.2: Participants specialization Analysis.....	34
Figure 4.3: Participants' Age Analysis.....	35
Figure 4.4: Years of Experiences Analysis .....	36
Figure 4.5: Analysis of question 1.....	38
Figure 4.6: Analysis of question 2.....	39
Figure 4.7: Analysis of question 3.....	41
Figure 4.8: Analysis of question 4.....	42
Figure 4.9: Analysis of question 5.....	43
Figure 4.10: Analysis of question 6.....	44
Figure 4.11: Analysis of question 7.....	45
Figure 4.12: Analysis of question 8.....	47
Figure 4.13: Analysis of question 9.....	48
Figure 4.14: Analysis of question 10.....	49
Figure 4.15: Analysis of question 11.....	50
Figure 4.16: Analysis of question 12.....	52
Figure 4.17: Smart City network.....	55
Figure 4.18: Proposal Framework for Smart City networks.....	57



## List of Tables

Table 1: Analysis of Gender.....	33
Table 2: Participants specialization Analysis.....	34
Table 3: Participants' Age Analysis.....	35
Table 4: Years of Experiences Analysis.....	36
Table 5: Analysis of question 1.....	37
Table 6: Analysis of question 2.....	39
Table 7: Analysis of question 3.....	40
Table 8: Analysis of question 4.....	42
Table 9: Analysis of question 5.....	43
Table 10: Analysis of question 6.....	44
Table 11: Analysis of question 7.....	45
Table 12: Analysis of question 8.....	46
Table 13: Analysis of question 9.....	48
Table 14: Analysis of question 10.....	49
Table 15: Analysis of question 11.....	50
Table 16: Analysis of question 12.....	51

## **List of Abbreviations**

CCNA	Cisco Certified Network Associate
IBSG	Internet Business Solutions Group
ICT	Information and Communication Technology
IoT	Internet of Things
SCC	Smart Connected Communities
SCF	Smart city framework
SFC	San Fran Cisco
SPSS	Statistical Package for the Social Sciences
WSN	Wireless sensor network

**Chapter ONE**  
**INTRODUCTION**

# Chapter One

## Introduction

### 1.1 Introduction

Cities are changing rapidly growing in size and density, creating more waste, and using more resources. To solve the problems these pressures create, city governments need to think different. Enter smart cities. Smartness is one of the qualifiers for a city that has mainly emerged from the Information and Communication Technology (ICT) community. Smart city is the one that uses information and communications technologies to make the city services and monitoring more aware, interactive and efficient [1]. Smartness of a city is driven and enabled technologically by the emergent Internet of Things (IoT) [2].

As mentioned, a smart city utilizes information and communications technologies (ICT) in a way that addresses quality of life by tackling urban living challenges encompassed by more efficient utilization of limited resources (space, mobility, energy, etc.). World leading municipalities, in terms of services and quality of life, have provided efficient services to their citizens by the forward thinking and use of technology in monitoring various environmental parameters. Most of these systems consist of: sensor, data storage device, and computer at a base station where experts analyze the data [3].

The smart city framework (SCF) distils current good practices into a set of consistent and repeatable patterns that city leaders can use to help develop and deliver their own smart city strategies. Although many of the principles and methodologies recommended by the SCF are relevant within specific vertical sectors of cities, the focus is very much on the issues and challenges involved in joining all of these up into a whole-city approach. Central to the SCF is a strong emphasis on leadership and governance, culture, business model innovation, and the active role played by all stakeholders in the creation, delivery and use of city spaces and services [4].

Smart city primarily rely on capturing and gathering of data from the city that consider complex network that mean needed for sophisticated technology to network management. Developed a framework to provide a detailed view of how cities network management.

## 1.2 Background of Research

In the last two and a half decades, words like, smart city, smart growth, digital city, intelligent city and a successful city, have become more common in some countries and in engineering literature. To understand these concepts, it is very important to consider that cities are a key element for the future because cities have a huge impact on social, economic and environmental aspects [5].

According to this definition, A city that monitors and integrates conditions of all of its critical infrastructures, including roads, bridges, tunnels, rail/subways, airports, seaports, communications, water, power, even major buildings, can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens [6].

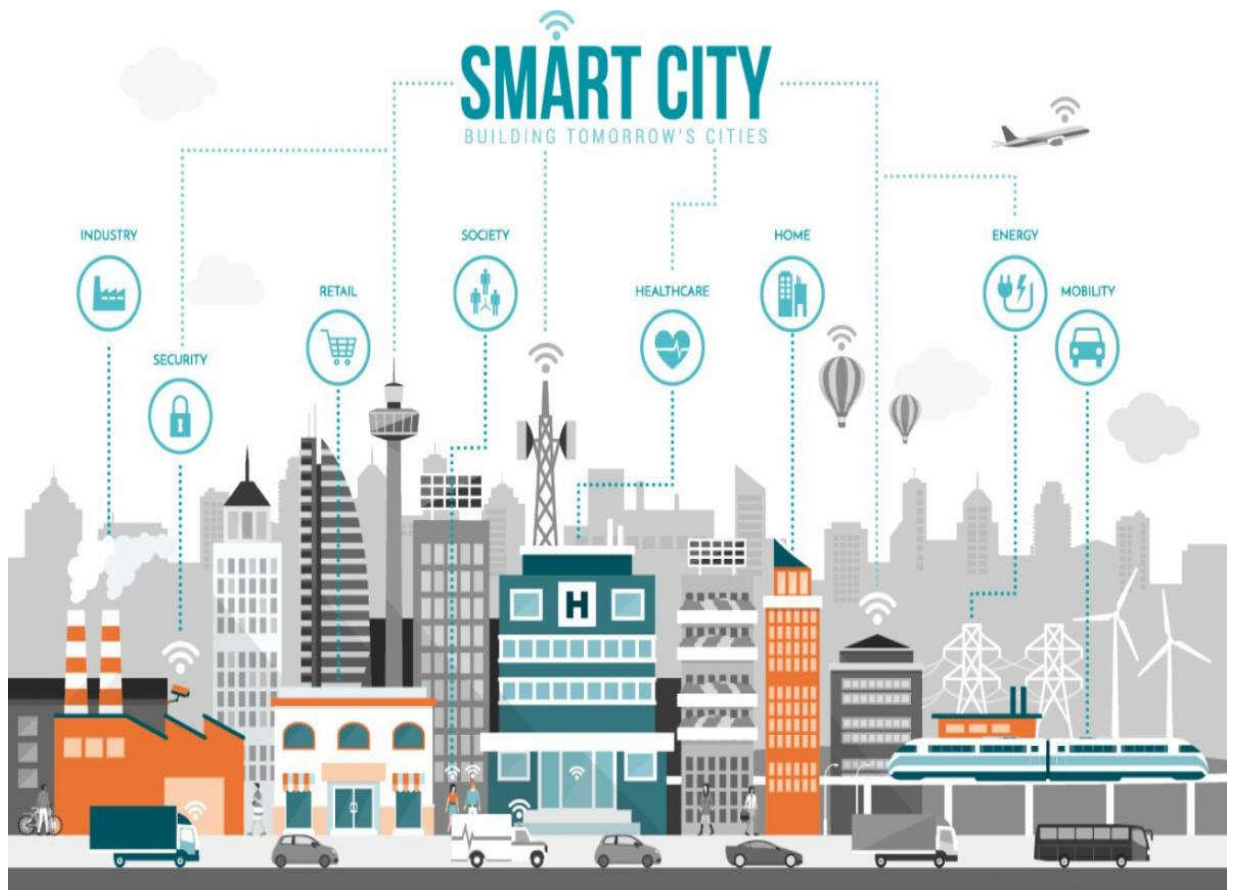


Figure 1.1 : Smart City [7]

Vision of a smart cities [6] indicated that livability, workability and sustainability of cities could be achieved when the infrastructure is developed. For example, livability provides a better quality of life for people. Also, citizens should have more access to a green, clean, safe, comfortable, healthy lifestyle while workability means developing an economy with more good jobs and sustainability is using resources to meet the needs of the present without compromising the ability of future generations to meet their own needs. Therefore, the smart city factors can be broken down into six categories [8]; mobility (transportation), economy, environment, people, living and government. Many indicators have been chosen in smart city to measure those factors, for example, growth in population, crime rate, and people without insurance, gross domestic product, income levels, median house value, population density, education levels, poverty, green space and access to information Figure 1.

### **1.3 Problem Statement**

In recent times, the rapid population explosion in urban areas has been one of the most critical issues affecting the world. Urbanization in the 21st century is expected to further increase by 20 percent in the year 2050. This Urbanization Has led to a weakness in the provision of services to citizens in various fields, and the emergence of services and needs of a new did not exist before. The challenges facing cities have become how to improve the performance of services to citizens and increase the quality of life for them. Therefore, ways must be found to remove the service problems faced by the population by addressing urban life using intelligent policies.

### **1.4 Objectives**

- To develop framework for improving the process of smart cities networks management.
- To providing a guideline for Smart City stakeholders can move their ideas from vision to action.
- To clarify the comprehensive understanding of the smart cities networks complexities and technical factors of it.
- To enhance the ease with configuration or selection the network components.

## **1.5 Scope of Research**

The scope of this research focus on network management for smart cities will include detailed technical to improve the process of smart cities management and take Khartoum city as case study.

## **1.6 The proposed solution**

- Review the literature on smart city management concepts by using previous research.
- Collect data about city and design from expert engineering to determine best design by interview and questionnaire.
- Make simulation for smart city by packet tracer program.

## **1.7 Thesis layout**

This thesis is divided into five chapters: Chapter 1 include an introduction about smart city, research problems, research objectives, and scope of study. Chapter two literature review starts about the definition of Digital cities, wireless cities, smart cities, IOT, smart cities framework and networks management. Chapter three clarifies the research methodology. Data collection, research process, data analysis tools, Furthermore data analysis methods and simulate tool. Chapter four presents the research analysis and findings derived from the interviews, the questionnaire according to the methodology described previously and design the smart city network and smart city frameworks. Chapter five it contains conclusion of what has been achieved in this research and recommendations that help researchers in the field of data privacy and network expansion to know from where to begin or continue is the same field.

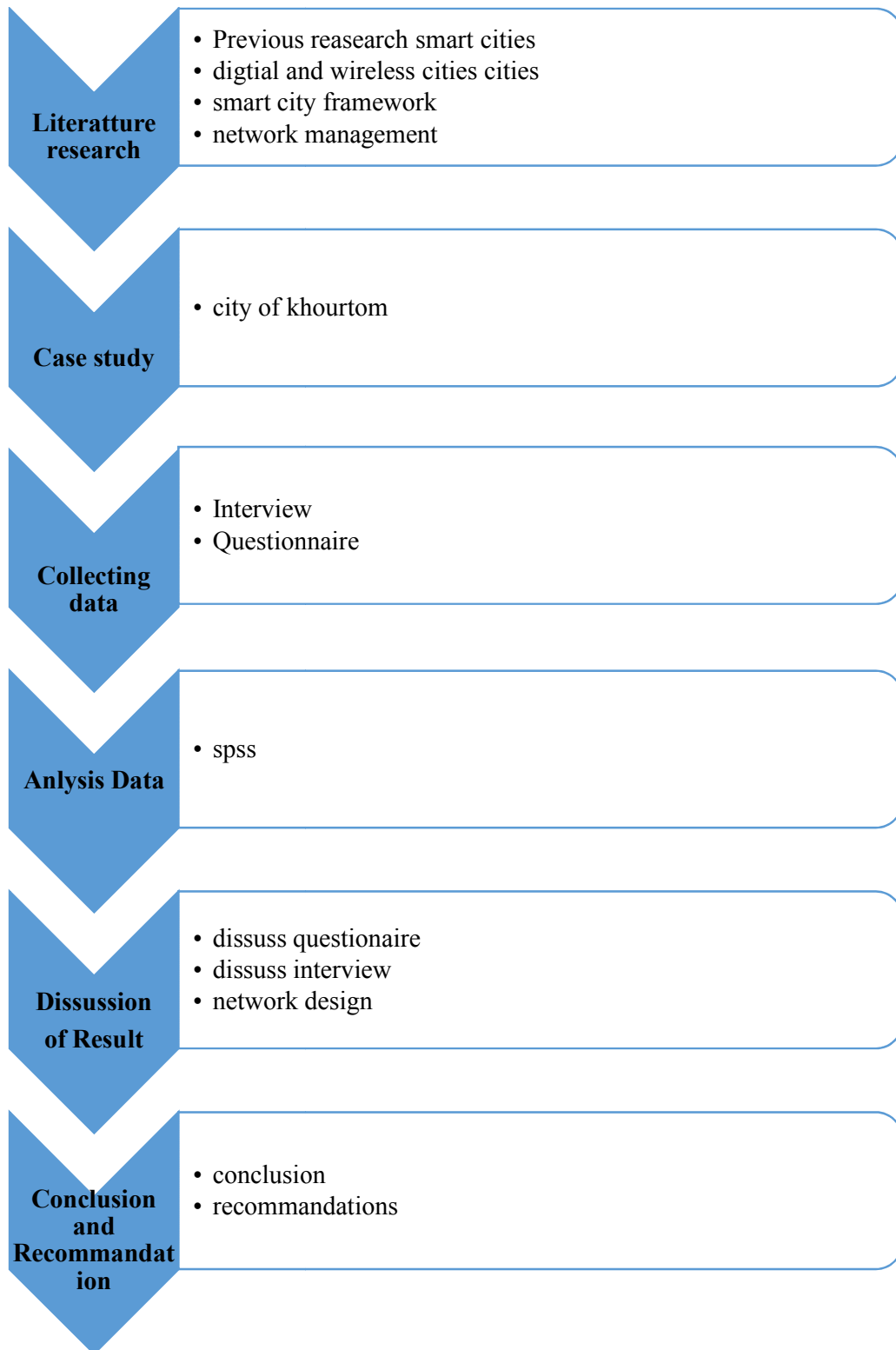


Figure 1.2: The research flow chart



# **Chapter Two**

## **Literature Review**

## **Chapter Two**

### **Literature Review**

#### **2.1 Introduction**

In this chapter, the focus on Literature Review gathering the body of knowledge necessary for this research the background on the topic of smart cities is described. This description includes the concept of smart cities, digital city, wireless city, framework for smart city and network management.

#### **2.2 Digital Cities**

Digital City embraces several meanings of “smart”, such as virtual city, cyber city, wired city, ubiquitous city and so on Moreover, Digital City is sometimes considered as a Smart City based on ICT infrastructures, because one of the most important technologies used to support Smart City strategies is ICT. Therefore, from this analysis, it appears that Digital City is the most recurrent terminology linked to the meaning of Smart City [9].

The definition of Digital City is a city connected to the net, equipped with technological platforms for information and communications management that can enable the Internet of Things. These platforms also make it possible to process huge amounts of data and information to offer new services to the inhabitants of urban areas and new functionality for the management of the urban environment.

there were several studies about Digital City definition: some researchers affirmed that a Digital City is a wired-city; while others affirmed that it is a virtual reconstruction of city; but the most famous Digital City definition is by Ishida in his study about Kyoto Digital City, in which he defines Digital City as “an arena in which people can interact and share knowledge, experiences, and mutual interests” [9].

Ishida’s studies have been very important for the development of Digital City topic, because they have paid attention to how a city could summarize different aspects (such as data and information, e-services, etc.) of urban everyday life on the Internet in order to facilitate people in their decisions-making process. Moreover, the Digital City idea is strictly linked with the use of ICT in public administrations and with the e-Government practices, regarding both central governments and also local

governments such as municipalities and city councils and administrations. Adopting an e-Government policy a city starts a transformation path towards a digital city [10].

### **2.3 Wireless cities**

Wireless cities are essentially cities completely covered by high-speed broadband and public Wi-Fi access, where the Internet can be openly accessed and used by their citizens. Wireless technologies are an important part of infrastructure development through which the efficiency and equity of governmental service can be improved [8]. Through its work with several pioneering cities around the world, the Cisco Internet Business Solutions Group (IBSG) has identified a strategic, four-stage process that helps cities link policy objectives to effective wireless programs, thereby ensuring the viability of city initiatives:

- Stage 1: Create a wireless city vision that identifies and clearly defines the city's long-term policy objectives for the wireless initiative.
- Stage 2: Conduct a feasibility study that defines the impact of the wireless network initiative in terms of the city's overall goals.
- Stage 3: Develop a business model that includes not only the government itself, but also private investors who can contribute to the overall sustainability of the Business model.
- Stage 4: Build a technology infrastructure and launch a wireless initiative that supports the policy objectives defined in the city's wireless vision with this structured, strategic approach, municipal governments can improve the efficiency and reduce costs of internal operations, improve the quality and safety of residents' lives, and enhance the climate for economic development and tourism [11].

### **2.4 Smart Cities**

In the last two and a half decades, words like, "smart city", "smart growth", "digital city", "intelligent city", and a "successful city", have become more common in some countries and in engineering literature. To understand these concepts, it is very important to consider that cities are a key element for the future because cities have

a huge impact on social, economic and environmental aspects [12]. Several approaches have been developed depending on technology, which helped to create what is now called “smart cities”. The concept of smart cities is not limited to one definition, one idea, or one application of the technologies of cities; the definitions of smart cities.

Differ and mean different things to various people. Definitions vary from city to city, town to town, and country to country as they relate to development. Washburn et al defined smart cities as “the use of smart technologies to make the critical infrastructure components and services of a city\_ which include city administration, education, public safety, healthcare, and utilities—more intelligent, interconnected and efficient”. Washburn et al. investigated the ability of those components to enhance the livability, workability and sustainability of cities [13].

Caragliu defines the concept of Smart City as "The city which invests in people and social capital, builds conventional transportation and modern information and communication technologies (ICT) infrastructures; provides sustainable economic growth and high standard of life-quality, and administrates its natural sources with participative governance.” To meet smart city criteria, Caragliu concluded the aspiring city needs six factors: Smart economy, smart mobility (transportation), smart environment, smart people (society), smart life and smart governance. “A city that monitors and integrates conditions of all of its critical infrastructures, including roads, bridges, tunnels, rail/subways, airports, seaports, communications, water, power, even major buildings, can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens” [14].



Figure 2.1: smart city factors [15]

Cisco describes smart cities along with additional term that is smart and connected communities (S+CC). All in all, Cisco believes that serious problems such as increased population, polarized economic growth, increased greenhouse-gas emissions, decreased budgets and others can be solved with scalable solutions that take advantage of Information and Communication Technologies (ICT) in order to reduce costs, increase efficiency, and enhance the quality of life. Moreover, from the Cisco point of view, the main barrier to implementing such kind of solutions is the complexity of how cities are financed, regulated, planned and operated. On the other side, smart cities present the great opportunity to integrate various physical infrastructures: transportation systems, utilities, real estate, city services, etc [16].

Although smart city definitions are numerous, it is possible to outline some common features attributed to smart cities by scholars and researchers. In general, smart city provides an intelligent way of managing its structures and systems such as energy, transport, healthcare, buildings, homes and also the environment. It means that “smart city” generally operates in the complex urban environment, causing the collaboration

between complex technological systems, city infrastructure, human behavior, economy, political and social structures [17].

## 2.5 The Internet of Things

The Internet of Things (IoT) is the network of physical devices, vehicles, home appliances, and other items embedded with electronics, software, sensors, actuators, and connectivity which enable these objects to connect and exchange data. Each thing is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure [18].

The (IoT) allows objects to be sensed or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention [18]. When (IoT) is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-physical systems, which also encompasses technologies such as smart grids, virtual power plants, smart homes, intelligent transportation and smart cities [19].

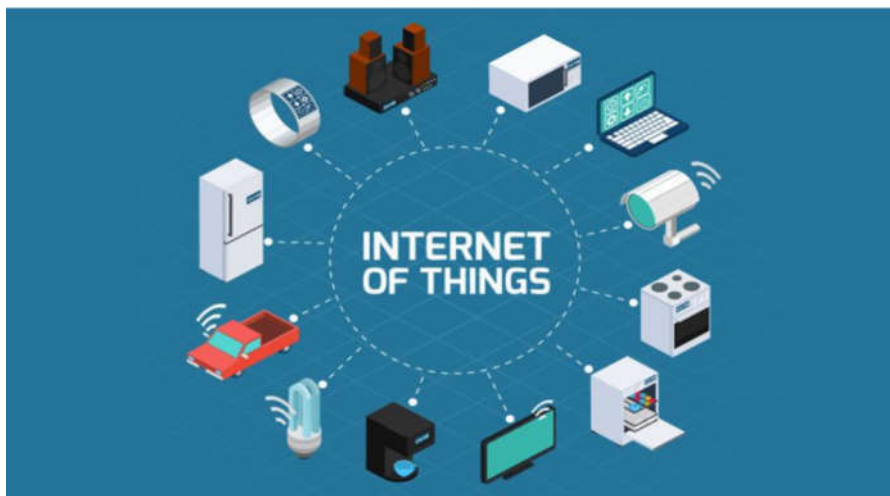


Figure 2.2: The Internet of Things [20]

## 2.6 Smart City Framework:

A Smart City Framework is a simple decision methodology that enables both the public and private sectors to plan and implement Smart City initiatives more

effectively. Most cities actually undergo this process in an intuitive way rather than in a clearly structured manner. A structured method not only will enable efficiencies in city infrastructures, but also transparencies into how cities work [13].

### 2.6.1 Key Outcomes and Benefits

A Smart City Framework not only provides a detailed view of how cities function, but also enables three major outcomes: Taxonomy/typology that enables cities to benchmark relevant content based on the hierarchy of physical city components. Stakeholder roles that define who does what. Unfortunately, this part is missing from many city discussions; its omission creates a lack of understanding in how to implement Smart City solutions. Catalog system of city content that is easily accessible [13]. These outcomes will enable cities to:

- Customize a Smart City blueprint.
- Identify where and how to implement ICT solutions in cities.
- Develop government policy guidelines for enabling private-sector participation in city projects.
- Conduct a city gap analysis that enables cities to benchmark themselves, consistently and accurately.
- Create a structured case study template for collating multiple business models for similar Smart City initiatives.

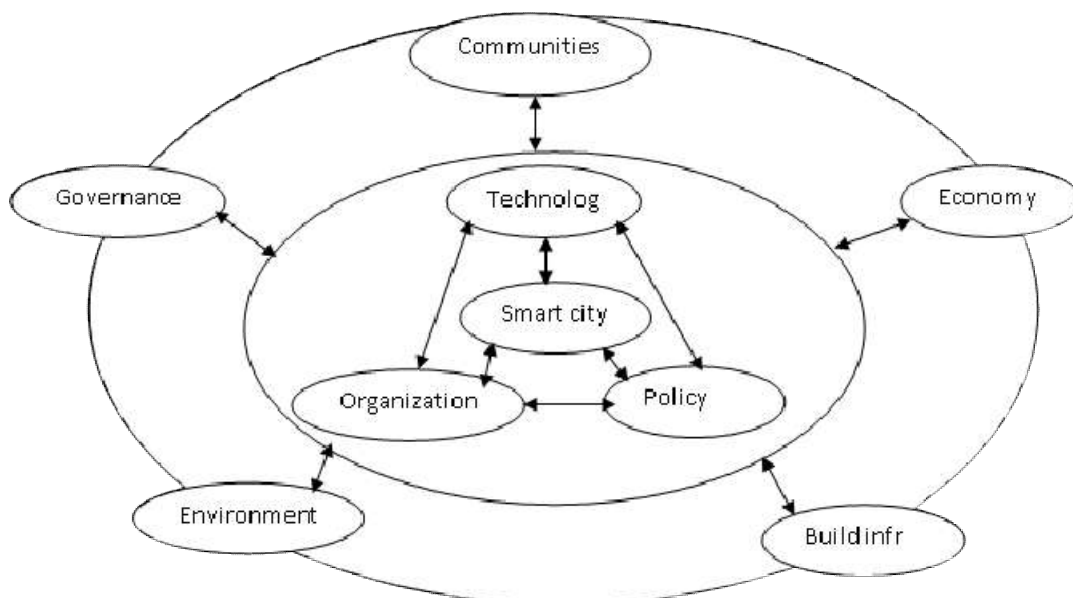


Figure 2.3: integrative smart city framework [21]

The framework presents a more detailed insight in relevant factors that influence the smart city initiative. Each factor can probably be seen alternating as a possible barrier or as a success factor. The framework could be used to tackle research issues and to address practical development of specific initiatives. An alternative framework with a comparable level of determination is presented by Hafedh Chourabi et.al. in their paper “Understanding Smart Cities: An Integrative Framework” [21] .

They identify eight critical factors of smart city initiatives: management and organization, technology, governance, policy context, people and communities, economy, built infrastructure, and natural environment. In this framework distinction is made between two levels of influence on the smart city initiative. The first level with the most direct influence is formed by the triangle: Technology, Organization and Policy. This has a high resemblance but is not fully identical to the three-circle model by Nam and Pardo [22].

The second level identifies five major factors of influence on the first level factors. All factors can by itself be influenced by the for a specific Smart City initiative determined objectives. The economy for example can be seen as a factor of influence in positive or negative way, but strengthening the economy by itself can also be an element of the chosen objectives. Of the presented frameworks this framework has the best integration of all relevant factors as we have seen in the previously described literature. The number of identified factors of influence, and the added hierarchy make this framework better suited for the objectives of this thesis. At a first glance there will be a better fit between the distinguished factors and the description of barriers and success factors found in the research literature. Because this framework will be used to design the basic form of the checklist to be used in analyzing the cases, the eight influencing factors will be described here by summarizing the explanation from the original paper. For readability reasons, and because most of the issues are already addressed in the literature review, only the main source reference is included [22].



## **2.6.2 integrative smart city framework**

### **2.6.2 .1 management and organization**

Only a few studies in the academic literature on smart city initiatives address issues related to managerial and organizational factors. Other sources are found in the area of e-Government research. For instance, Gil-Garcia and Pardo [23] suggested a list of success factors and challenges for e-government initiatives. Smart city initiatives might differ from more general e-government initiatives in the context and in some of the characteristics of specific projects, but there is much in common between those two types of initiatives because most smart city initiatives are also driven by governments and leveraged by the intensive use of ICTs to better serve citizens.

### **2.6.2.2 Technology**

ICTs are key drivers of smart city initiatives. The integration of ICT with development projects can change the urban landscape of a city and offer a number of potential opportunities; they can enhance the management and functioning of a city. Despite proclaimed advantages and benefits of ICTs use in cities, their impact is still unclear. Indeed, they can improve the quality of life for citizens, but they can also increase inequalities and promote a digital divide. Thus, city managers should consider certain factors when implementing ICT with regard to resource availability, capacity, institutional willingness and also with regards to inequality, digital divide and changing culture and habits[24].

### **2.6.2.3 Governance**

Governance, involves the implementation of processes with constituents who exchange information according to rules and standards in order to achieve goals and objectives. Stakeholders' relations are one of the critical factors to determine success or failure. "Stakeholder relations" refers to four main issues: the ability to cooperate among stakeholders, support of leadership, structure of alliances and working under different jurisdictions. Several cities have benefited from the emergence of ICTs that improve their governance. This ICT-based governance is known as smart governance. It widely represents a collection of technologies, people, policies, practices, resources, social norms and information that interact to support city governing activities[25].

#### **2.6.2.4 Policy**

Political components represent various political elements (city council, city government, and city major) and external pressures such as policy agendas and politics that may affect the outcomes of IT initiatives. Institutional readiness such as removing legal and regulatory barriers is important for smooth implementation of smart city initiatives [26].

#### **2.6.2.5 People and communities**

Projects of smart cities have an impact on the quality of life of citizens and aim to foster more informed, educated, and participatory citizens. Additionally, smart cities initiatives allow members of the city 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[25].

#### **2.6.2.6 Economy**

Giffinger suggest a smart city framework consisting of six main components (smart economy, smart people, smart governance, smart mobility, smart environment, and smart living). Their operational definition of a smart economy includes factors all around economic competitiveness [25].

#### **2.6.2.7 Built infrastructure**

ICT infrastructure includes wireless infrastructure (fiber optic channels, Wi-Fi networks, wireless hotspots, kiosks) service-oriented information systems. There is a little literature that focuses on ICT infrastructure barriers of smart cities initiatives. IT challenges can be grouped in three dimensions; IT infrastructure, security and privacy, and operational cost [27].

#### **2.6.2.8 The natural environment**

Core to the concept of a smart city is the use of technology to increase sustainability and to better manage natural resources. Of particular interest is the protection of natural resources and the related infrastructure such as waterways and sewers and green spaces such as park [25].

## **2.7 Network management**

Networks and distributed processing systems are of critical and growing importance in enterprises of all sorts. The trend is toward larger, more complex networks supporting more applications and more users. As these networks grow in scale, two facts become painfully evident:

- The network and its associated resources and distributed applications become indispensable to the organization.
- More things can go wrong, disabling the network or a portion of the network or degrading performance to an unacceptable level.

A large network cannot be put together and managed by human effort alone. The complexity of such a system dictates the use of automated network management tools. The urgency of the need for such tools is increased, and the difficulty of supplying such tools is also increased, if the network includes equipment from multiple vendors. Moreover, the increasing decentralization of network services as exemplified by the increasing importance of workstations and client/server computing makes coherent and coordinated network management increasingly difficult. In such complex information systems, many significant network assets are dispersed far from network management personnel [28].

### **2.7.1 Network management requirement**

#### **2.7.1.1 Fault Management**

To maintain proper operation of a complex network, care must be taken those systems as a whole, and each essential component individually, are in proper working order. When a fault occurs, it is important, as rapidly as possible, to:

- Determine exactly where the fault is.
- Isolate the rest of the network from the failure so that it can continue to function without interference.
- Reconfigure or modify the network in such a way as to minimize the impact of operation without the failed component or components.
- Repair or replace the failed components to restore the network to its initial state.

### **2.7.1.2 Accounting Management**

In many enterprise networks, individual divisions or cost centers, or even individual project accounts, are charged for the use of network services. These are internal accounting procedures rather than actual cash transfers, but they are important to the participating users nevertheless. Furthermore, even if no such internal charging is employed, the network manager needs to be able to track the use of network resources by user or user class for a number of reasons, including the following:

- A user or group of users may be abusing their access privileges and burdening the network at the expense of other users.
- Users may be making inefficient use of the network, and the network manager can assist in changing procedures to improve performance.
- The network manager is in a better position to plan for network growth if user activity is known in sufficient detail.

### **2.7.1.3 Performance Management**

Modern data communications networks are composed of many and varied components, which must intercommunicate and share data and resources. In some cases, it is critical to the effectiveness of an application that the communication over the network be within certain performance limits. Performance management of a computer network comprises two broad functional categories—monitoring and controlling. Monitoring is the function that tracks activities on the network. The controlling function enables performance management to make adjustments to improve network performance.

### **2.7.1.4 Security Management**

Security management is concerned with generating, distributing, and storing encryption keys. Passwords and other authorization or access control information must be maintained and distributed. Security management is also concerned with monitoring and controlling access to computer networks and access to all or part of the network management information obtained from the network nodes. Logs are an important security tool, and therefore security management is very much involved with the collection, storage, and examination of audit records and security logs, as well as with the enabling and disabling of these logging facilities

### **2.7.1.5 Configuration and Name Management**

Modern data communication networks are composed of individual components and logical subsystems (e.g., the device driver in an operating system) that can be configured to perform many different applications. The same device, for example, can be configured to act either as a router or as an end system node or both. Once it is decided how a device is to be used, the configuration manager can choose the appropriate software and set of attributes and values (e.g., a transport layer retransmission timer) for that device.

Configuration management is concerned with initializing a network and gracefully shutting down part or all of the network. It is also concerned with maintaining, adding, and updating the relationships among components and the status of components themselves during network operation [28].

## **2.8 Related works**

Literature review showed most papers and publications on this subject focus on governance, management, stakeholder side or on the technological, however only very few consider both process and project outcomes.

The concept of the 'smart city' has been quite fashionable in the policy arena in recent years. Its main focus seems to be on the role of ICT infrastructure, although much research has also been carried out on the role of human capital/education, social and relational capital and environmental interest as important drivers of urban growth.

In (2017) Wu et al . Studied the risks and ideas in developing the framework for a smart city by using Chinese characteristics to evaluate background data. Regarding their ideas, they pointed to some important targets that have been achieved in a smart city such as sustainable development, affordable housing, enhancing quality of civilian life, and economic growth. Risks can be determined based on limitations of budgets, scarce resources, traffic jams, air pollution, unexpected accidents, and others. They concluded from the study that the use of technology and ICT contributed widely to solving problems and avoiding risk in cities. Internet and mobile communications work together to collect data in the cloud and provide the ability to analyze them for getting the total picture for the problems. This study contributes sustainability to our

understanding of a smart city and inspires great goals for local government to help that segment understand the smart city [29].

Corry floor in (2015) present research, focus on Smart City networks that are in place to share knowledge and to bring together actors. The research was conducted with a mixed method approach. The networks that bring together actors in Smart City development are the main focus. These networks are set up in a highly dynamic environment of cities that deal with Smart City development in their own way [30].

Wang (2015) investigated intelligent transportation technology as a part of the smart city, and focused on traffic congestion forecasting abnormal conditions like events and bad weather. He copes with this problem by using a GPS to collect data from taxis to monitor unexpected conditions. Wang recommended internet, technology, mobile internet, phone apps, and cloud technology to locate large traffic congestion. This enables a driver to avoid those areas. This work has had a great impact on industry by regulating the traffic [12].

In late 2014, the Sunshine Coast Council partnered with Cisco and Telstra to develop a Smart City Framework for the Maroochydore City Centre Priority Development Area (PDA), and the wider Sunshine Coast region.

The Smart City Framework was developed through consultation with key stakeholders and is designed to help make the Sunshine Coast even more livable, workable and sustainable [31].

Liu and Li (2013) investigated three domains for the smart city. The first domain is development of the smart city; the second focuses on the process of urban construction, and the third concentrates on land uses patterns. They discussed three core components of smart cities: technology, organization, and policies; Liu and Li further contend that these factors have high impact on government, people, environment, communities, economy, and infrastructure. They also discussed the problems facing cities worldwide, such as air pollution, unclean water, erosion, and climate change [32].

Finally, they concluded that the smart city has a beneficial impact on environment and14 provides smart preventative solutions. The economy would also profit with proper land use for smart city development.

Michal peter(2017) mention A Smart City is an urban area that has become more efficient and/or more environmentally friendly and/or more socially inclusive through the use of digital technologies. The goal of a Smart City is to improve its attractiveness to citizens and/or businesses by enhancing or adding city services[35].

Andrea Caragliu<sup>1</sup>, Chiara Del Bo<sup>2</sup>, Peter Nijkamp<sup>3</sup> present paper aims to shed light on the often elusive definition of the concept of the ‘smart city’. They provide a focused and operational definition of this construct and present consistent evidence on the geography of smart cities in the EU27. Their statistical and graphical analyses exploit in depth, for the first time to our knowledge, the most recent version of the Urban Audit data set in order to analyses the factors determining the performance of smart cities. they find that the presence of a creative class, the quality of and dedicated attention to the urban environment, the level of education, multimodal accessibility, and the use of ICTs for public administration are all positively correlated with urban wealth. This result prompts the formulation of a new strategic agenda for smart cities in Europe, in order to achieve sustainable urban development and a better urban landscape [14].

In (2013) Jiong Jina, Member, IEEE, Jayavardhana Gubbib, Member, IEEE, Slaven Marusicb, Marimuthu Palaniswamib, Fellow, IEEE. Presents paper about a framework for the realization of smart cities through the Internet of Things (IoT). The framework encompasses the complete urban information system, from the sensory level and networking support structure through to data management and Cloud based integration of respective systems and services, and forms a transformational part of the existing cyber-physical system. This IoT vision for a smart city is applied to a noise mapping case study to illustrate a new method for existing operations that can be adapted for the enhancement and delivery of important city services [3].

Vlasios Tsiatsis, Pramod Anantharam in (2013) noted that Smart City Framework, The report presents the architecture in different views, functional, interface and information, security and privacy view and thus explains respectively what the framework does, how components interact with each other, the generation and flow of information, and the necessary mechanisms to address security and privacy concerns about city and citizen relevant data [33].

Hafedh Chourabi , Taewoo Nam , Shawn Walker in (2012) presents its proposes a framework to understand the concept of smart cities. Based on the exploration of a wide and extensive array of literature from various disciplinary areas they identify eight critical factors of smart city initiatives: management and organization, technology, governance, policy context, people and communities, economy, built infrastructure, and natural environment [21].

Nam and Pardo (2011) discussed the difference between the concept of the smart city and other related terms, such as digital, intelligent or ubiquitous city, along with the three categories of technology, people, and community. From the technology perspective, a smart city is a city with a great presence of ICT applied to critical infrastructure components and services [16].

Harrison et al. (2010), in an IBM corporate document, stated that the term “smart city” denotes an “instrumented, interconnected and intelligent city.” “Instrumented” refers to the capability of capturing and integrating live real world data through the use of sensors, meters, appliances, personal devices, and other similar sensors. “Interconnected” means the integration of these data into a computing platform that allows the communication of such information among the various city services. “Intelligent” refers to the inclusion of complex analytics, modeling, optimization, and visualization services to make better operational decisions [34].

Michel peter, Raphael , Blaise , Michael Wade they have presented a concise and practical definition of the term Smart City and explored the main motivations for city leaders engaging in Smart City projects, including efficiency benefits, environmental objectives, augmenting a city’s social inclusiveness and increasing a city’s attractiveness. Additionally, we have introduced the Smart City Piano, which can be used to assess the transformation needs of a city to implement Smart City projects [35].

## **Summary**

In this chapter present firstly theoretical information about described the introduction of smart city concepts. Secondly, in next section describe the work related to smart city framework .it also present introduction for network management published by various researchers by highlighting their contributions.



# **Chapter Three**

## **Methodology**

## Chapter Three

### Methodology

#### 3.1 Introduction

This chapter provides the research method steps. In addition, listing concrete tools and methods for chapter includes the methodology implemented to fulfill the goals of this research. The detailed information about data collection methods, data collection process and samples for expert interviews and questionnaires will be provided in the current chapter.

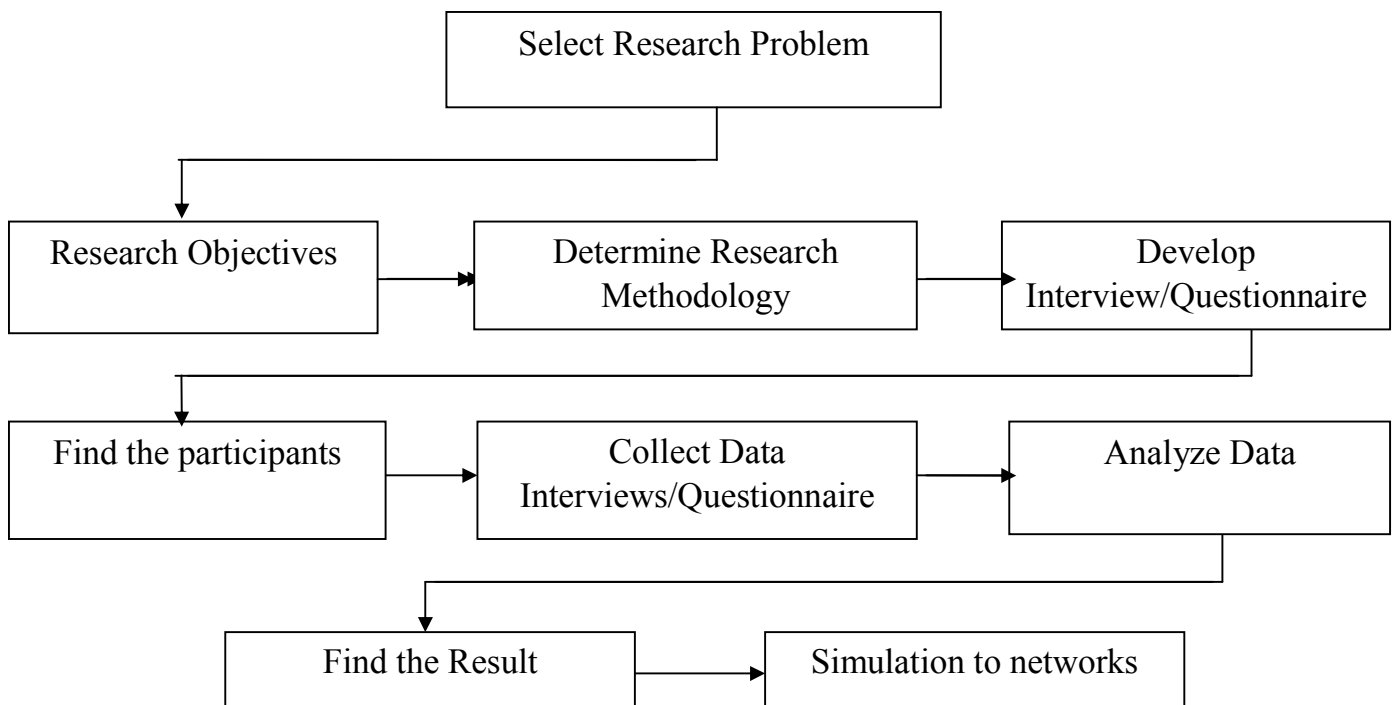


Figure 3.1: Research Processes

### 3.2 Data collection methods

Nowadays, there are various types of researches that differ in topics and aspects. However, these researches are common in the fact that they all need some data to be collected and derive results, recommendations or conclusions based on information gathered.

The data sources for this research include expert interviews, questionnaire and scientific papers. The interview is a process of exchanging views between two or more individuals on a topic of mutual interest, the interview can be identified as the systematic way of talking with and listening to people or as a way of collecting data from people through conversations.

There are several reasons to use interviews as the data collection method and the research instrument:

- A need to attain highly personalized data.
- Importance of good return rate.
- Opportunities are required for probing.
- Respondents are not fluent in the native language of the country, or where they have difficulties with written language.

Four major types of interviews are widely spread nowadays differing from each other by types of questions, aims and the general format of interview. These types are:

- The structured interview (the standardized interview where the same questions with the same wording and in the same sequence are asked from respondents ,
- The unstructured interview (the non-directed interview; the flexible method in which interviews are different and do not require certain guidelines).
- The semi-structured interview (the non-standardized interview not only with guidelines, but also with the possibility to ask additional questions).
- The non-directive interview (the interview with no preset topics to pursue and no pre-planned questions during which the interviewee leads the conversation).

To accomplish this research the semi-structured form of interviews with experts in the field of smart cities and network was chosen. This type of interview suits current research the most because it gives more freedom in comparison with a structured interview in which the interviewer has to adhere to a detailed interview guide .Another advantage of semi-structured interviews is the fact that the researcher has the opportunity to prompt and go deeper into the given question.

They are 11 questions developed for this research in which four factors are assessed concerning the scope of knowledge about smart cities, how to manage the network of it and what services we can present it in smart city. The full set of the interview can be found in Appendix “B”.

After the interview with experts will be validated with a data collection tool such as a questionnaire oriented on the large sample. The questionnaire is a data collection instrument that represents the systematically prepared form or document with a number of questions intentionally designed to detect responses from respondents or research informants with the purpose of collecting necessary data or information. The questionnaire can be identified as a paper with a series of questions with the aim of extracting some necessary information to be used later for the research (or other) objectives.

There are two main types of questionnaires: unstructured (open ended forms) and structured (closed forms) different in the forms of questions that constitute the questionnaire.

The unstructured questionnaire also often named as the unrestricted type of questionnaire or the open-ended one calls for free responses in the own words of the respondent. Such forms of open-ended questions give the respondent the opportunity to express his or her point of view through a set of options. This type of questionnaires requires more time and may not be suitable for some researches since some of respondents may refuse to participate in the questionnaire (that will immediately decrease a number of answers).

The current research assumes to make the questionnaire for quite a wide sample of respondents in order to gain more valid results. Due to this reason the second type of questionnaires, the structured one was chosen to fulfill current research. Structured questionnaires give more control or guidance for the answer of the respondent. This type can be described as a closed form because the

questions require the respondent to give answers like 'yes' or 'no' or simply check an item out of a list of given responses. Those questions that require 'yes' or 'no' answers are also named as dichotomous questions. There also can be multiple-choice questions for which the respondent selects the answer that is very close to his or her opinion. It means that the choice of the respondent is limited to the set of options provided, however, such kind of questionnaires saves the respondent's time and do not require extended answers. To conclude, the structured questionnaire of the closed form was chosen as a research tool with the objective to check the model built previously based on expert interviews.

Expert interviews and questionnaires that were chosen as data collection methods for current research allow guiding to select best design for smart city management, interviews and questionnaires give the opportunity to extract data that is not available in open sources.

### **3.3 Data Analysis Tools**

in order to analysis qualitative data that collected from the questionnaire's participants the tool used is SPSS. SPSS Statistics is a software package used for interactive, batched, statistical analysis. Long produced by SPSS Inc., it was acquired by IBM in 2009. The software name originally stood for Statistical Package for the Social Sciences (SPSS), reflecting the original market, although the software is now popular in other fields as well, including the health sciences and marketing.

SPSS is a widely used program for statistical analysis in social science.

It is also used by market researchers, health researchers, survey companies, government, education researchers, marketing organizations, data miners, and others. The original SPSS manual (Nie, Bent & Hull, 1970) has been described as one of "sociology's most influential books" for allowing ordinary researchers to do their own statistical analysis. In addition to statistical analysis, data management (case selection, file reshaping, creating derived data) and data documentation (a metadata dictionary is stored in the data file) are features of the base software [36].

### **3.4 Select city**

Khartoum is the capital of Sudan and located in the middle part of the country. Population of Khartoum amounts to 8 million people; it is the largest city by population in Sudan, Moreover, the City of Khartoum also takes roles of the cultural, economic and political center of Sudan And one of the most successful cities all over the country where the infrastructure, innovations and the quality of life are highly concerned. That is why we selected as case studies for this research .

### **3.5 Simulation**

Simulation for smart city by packer tracer program, simulate all device and how to connect. Packet Tracer supplements physical equipment in the classroom by allowing students to create a network with an almost unlimited number of devices, encouraging practice, discovery, and troubleshooting. The simulation-based learning environment helps students develop 21st century skills such as decision making, creative and critical thinking, and problem solving.

Packet Tracer complements the Networking Academy curricula, allowing instructors to easily teach and demonstrate complex technical concepts and networking systems design. Instructors can customize individual or multiuser activities, providing hands-on lessons for students that offer value and relevance in their classrooms. Students can build, configure, and troubleshoot networks using virtual equipment and simulated connections, alone or in collaboration with other students. Packet Tracer offers an effective, interactive environment for learning networking concepts and protocols. Most importantly, Packet Tracer helps students and instructors create their own virtual “network worlds” for exploration, experimentation, and explanation of networking concepts and technologies [37].

Cisco Packet Tracer is a powerful network simulation program that allows students to experiment with network behavior and ask “what if” questions. As an integral part of the Networking Academy comprehensive learning experience, Packet Tracer provides simulation, visualization, authoring, assessment, and collaboration capabilities to facilitate the teaching and learning of complex technology concepts [37].

Cisco Packet Tracer provides multiple opportunities for instructors to demonstrate networking concepts. Although Packet Tracer is not a substitute for real equipment, it allows students to practice using a command-line interface. This “e-doing” capability is a fundamental component of learning how to configure routers and switches. Packet Tracer’s simulation mode enables instructors to demonstrate processes that were formerly hidden to students. These simulation capabilities can help simplify the learning process by providing tables, diagrams, and other visual representations of internal functions such as dynamic data transfers and packet content expansion. The simulation mode also decreases instructor presentation time by replacing whiteboards and static slides with real-time visuals. Packet Tracer helps instructors teach complex networking concepts in the following ways:

- Provides a visual demonstration of complex technologies and configurations.
- Allows instructors to author customized, guided activities that provide immediate feedback using the Activity Wizard.
- Facilitates numerous learning activities such as lectures, individual and group lab activities, homework, assessments, games, network design, troubleshooting, modeling tasks, case studies, and competitions.
- Enables visualization, animation, and detailed modeling for exploration, experimentation, and explanation.
- Supports self-paced learning outside the classroom.
- Supports social learning processes by enabling collaboration and competition.
- Supports the majority of protocols and technologies taught in the following Networking Academy curricula: Cisco CCNA Discovery, CCNA Exploration, and CCNA Security, and can be used to teach concepts from IT Essentials and Cisco CCNP courses [37].

## **Summary**

This chapter provides a description of the research methodology steps using a block diagram. Also, demonstration current chapter covers the description of methods applied for data collection and creation of the smart city management. Key tools used for data collection are qualitative including expert interviews, questionnaires and science papers. In order to analysis qualitative date that collected from questionnaire's participants the tool used is SPSS.



# **Chapter Four**

## **Results and Discussions**

## **Chapter Four**

### **Results and Discussions**

#### **4.1 Introduction**

This chapter explains the data collected and analyzed. This chapter starts with an explanation of the participants starting from the analysis of gender and education level and the participants' occupation after that come to the analysis of the questionnaire items and interview questions. And the results of the data analyzed come in the final of this chapter.

#### **4.2 Participants Backgrounds Analysis**

This section analyses the participants whom take part in this questionnaire in different aspects first the name of participant that is optional second the name of institution, third the gender taken part in this study, fourth the specialization of the participants because it a significant things to know their work background, fifthly they age of participants in questionnaire divided into three levels up 35 years second 35-45 third more than 50 ,sixthly the year of experience of each participant also is important to know how long they are in their work and also divided into three levels up 5 years second between 5-10 and third level more than 10.

##### **4.2.1 Analysis of Gender**

This chart shows the distribution of genders among the participants in the questionnaire. We can see the number of male whom participate in the questionnaire are more than female who participants. 34 male from different specialization and experience who take part in questionnaire and 25 from female.

Table 1: distribution of Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	34	57.6	57.6	57.6
	2	25	42.4	42.4	100.0
	T	59	100.0	100.0	

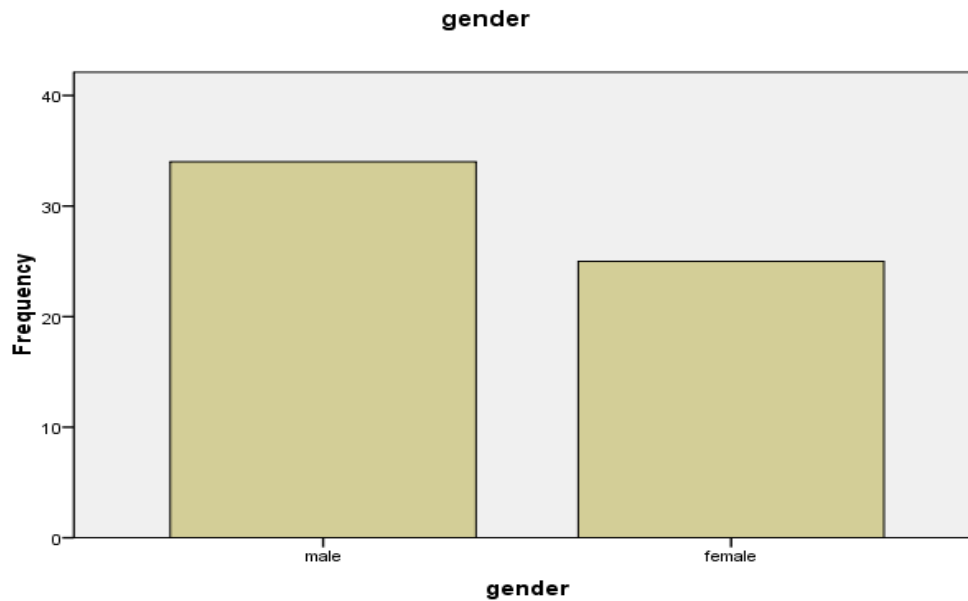


Figure 4.1: distribution of Gender

#### 4.2.2 Participants specialization Analysis

This chart shows the specialization of the questionnaire participants, the majority of participants are communication engineers and network engineers after that comes the specialization of information technology, after that computer engineers a appearance in study, the last computer science coming by minor appearance in this study.

Table 2: Participants specialization Analysis

	Frequency	Percent	Valid Percent	Cumulative Percent
Vali network engineering	16	27.1	27.1	27.1
communication engineering	20	33.9	33.9	61.0
IT	14	23.7	23.7	84.7
computer engineering	6	10.2	10.2	94.9
computer sciences	3	5.1	5.1	100.0
Total	59	100.0	100.0	

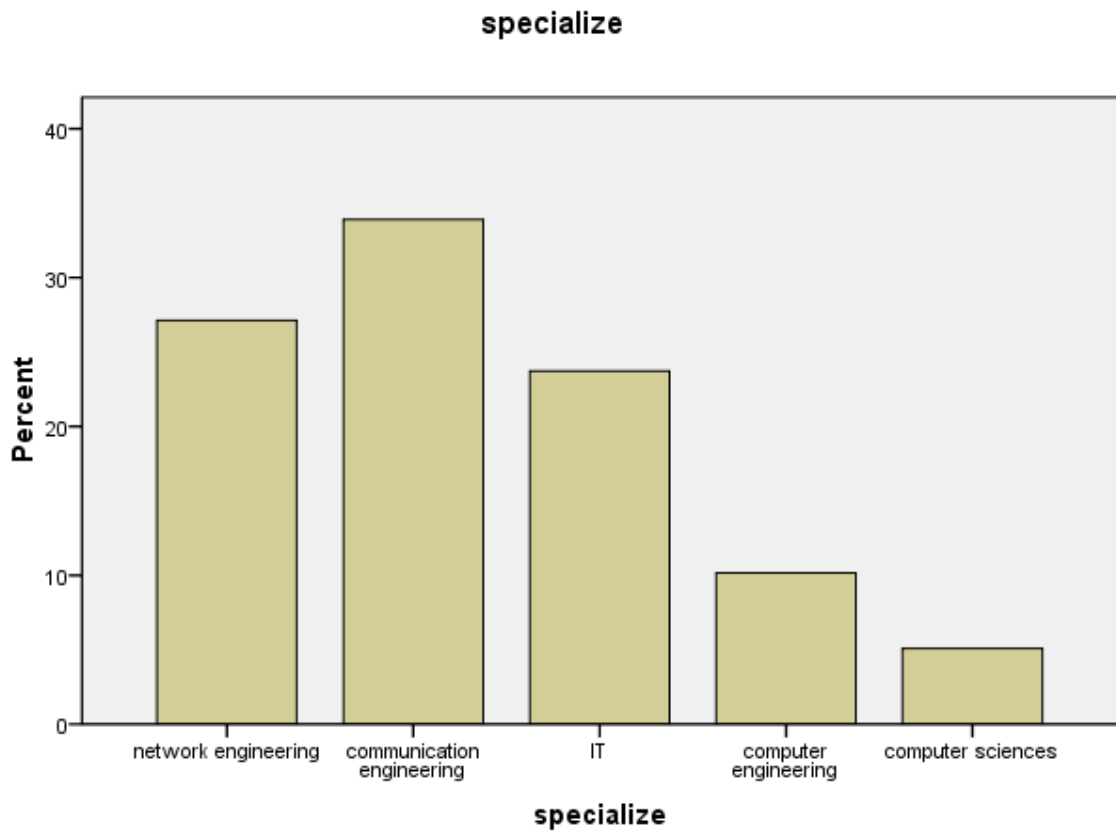


Figure 4.2: participants specialize

### 4.2.3 Participants' Age Analysis:

The Age of the participants had classified into three categories: first up 35 years second 35-45 third more than 50. This chart shows the Age of participants in this study obviously the majority of the less than 35 years old, come after that age between 35-45 and only one participant has more than 45.

**Table 3: Participants' Age Analysis**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid less than	35	59.3	59.3	59.3
35-45	23	39.0	39.0	98.3
more than	1	1.7	1.7	100.0
Total	59	100.0	100.0	

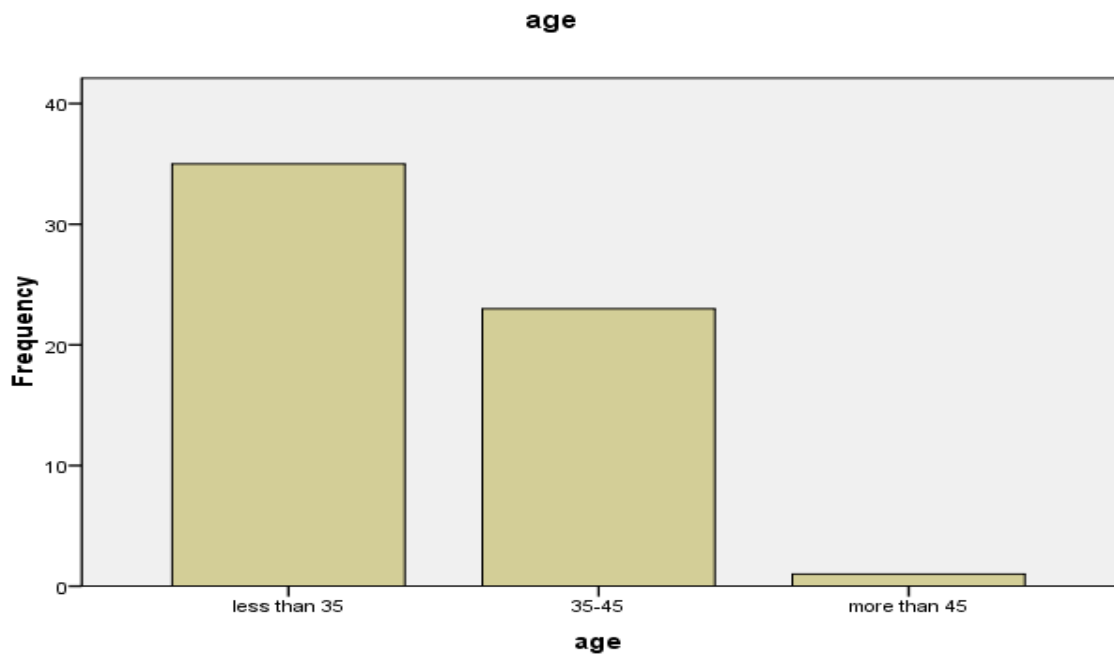


Figure 4.3: participants AGE

#### 4.2.4 Years of Experiences Analysis

The year of experiences of the participants in this study classified into three level first from (up 5) second from (5-10) third from (more than 10) .in this study the participants from (up 5) year has more appearance, after that the professionals from (5-10) have a good appearance also the experts from (more than 10) years had taken part in this study.

**Table 4: Years of Experiences Analysis**

	Frequency	Percent	Valid Percent	Cumulative Percent
Val less than	27	45.8	45.8	45.8
5-10	27	45.8	45.8	91.5
more 10	5	8.5	8.5	100.0
Total	59	100.0	100.0	

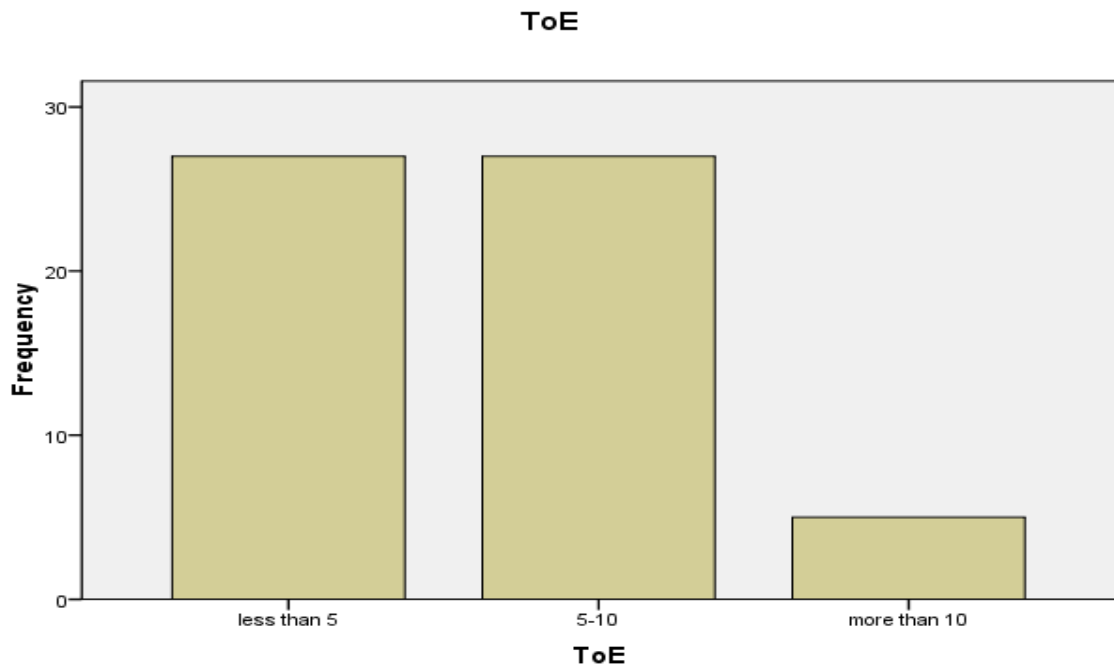


Figure 4.4: participants TOE

## 4.3 Data Analysis and Results

### 4.3.1 Questionnaire Items Analysis

This section shows the analysis of data that collected from questionnaire participants and in order to fit questionnaire items with the research main objectives, there are seventeen items analyzed in this section. As mentioned in chapter three the tool used to analyze these data is SPSS.

#### 1. Analysis of question 1

This question is the first one of the questionnaire item. The aim of this question is explore knowledge of people about smart city. We find there enough people have a good knowledge about smart city. There are 23.7% of participants have very high knowledge about that, and 22% of participants have high background about the smart city and 42.4% of the participants have little knowledge .11.9% of the participants do not know about the term.

**Table 5: Is the idea of a smart city understandable to you?**

	Frequency	Percent	Valid Percent	Cumulative Percent
Val very high	14	23.7	23.7	23.7
High	13	22.0	22.0	45.8
between	25	42.4	42.4	88.1
Low	7	11.9	11.9	100.0
Total	59	100.0	100.0	

### Is the idea of a smart city understandable to you?

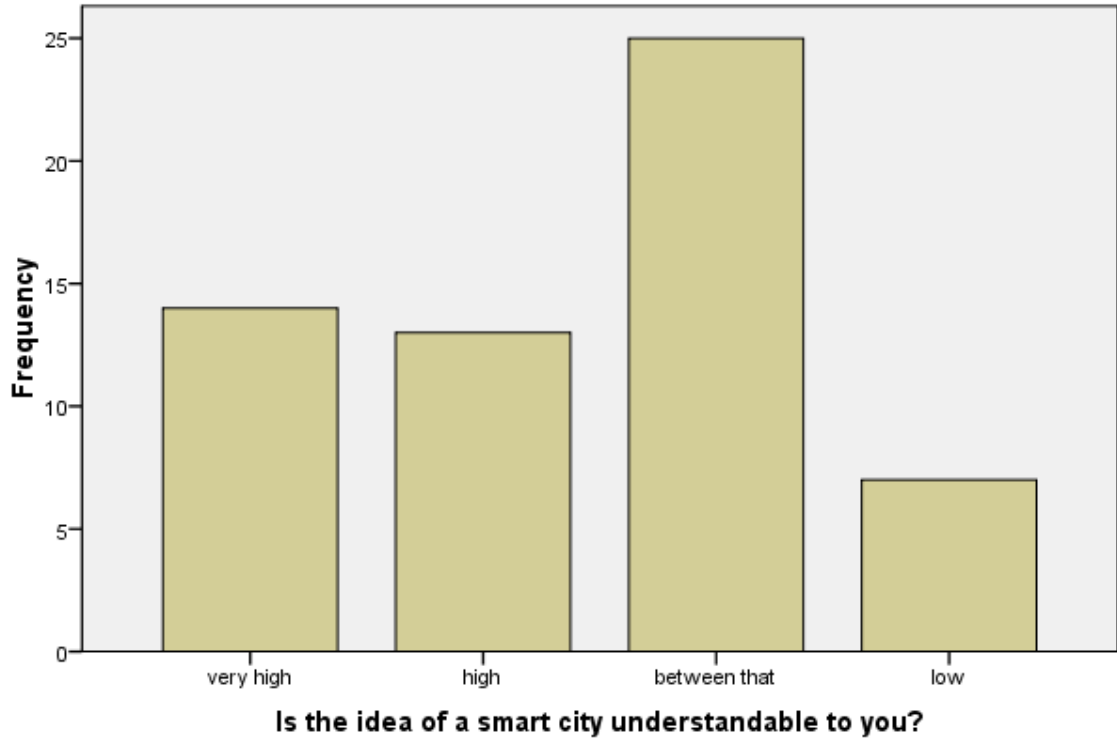


Figure 4.5: Analysis of question1

## 2. Analysis of question 2

This item is very important it explain the rang of participants except to smart city. 39% of participants have very high interacting about that 28.8 % of participants have high interacting about the smart city 22% from participants about 13 participant have between that interacting 5.1% of the participants have little interacting .3.4% of the participants do not interacting about the smart city.



**Table 6: Will you interacting with the idea of a smart city?**

	Frequency	Percent	Valid Percent	Cumulative Percent
Val very high	23	39.0	39.0	39.0
High	17	28.8	28.8	67.8
between	13	22.0	22.0	89.8
Low	3	5.1	5.1	96.6
very low	2	3.4	3.4	100.0
Total	59	100.0	100.0	

**Will you interacting with the idea of a smart city?**

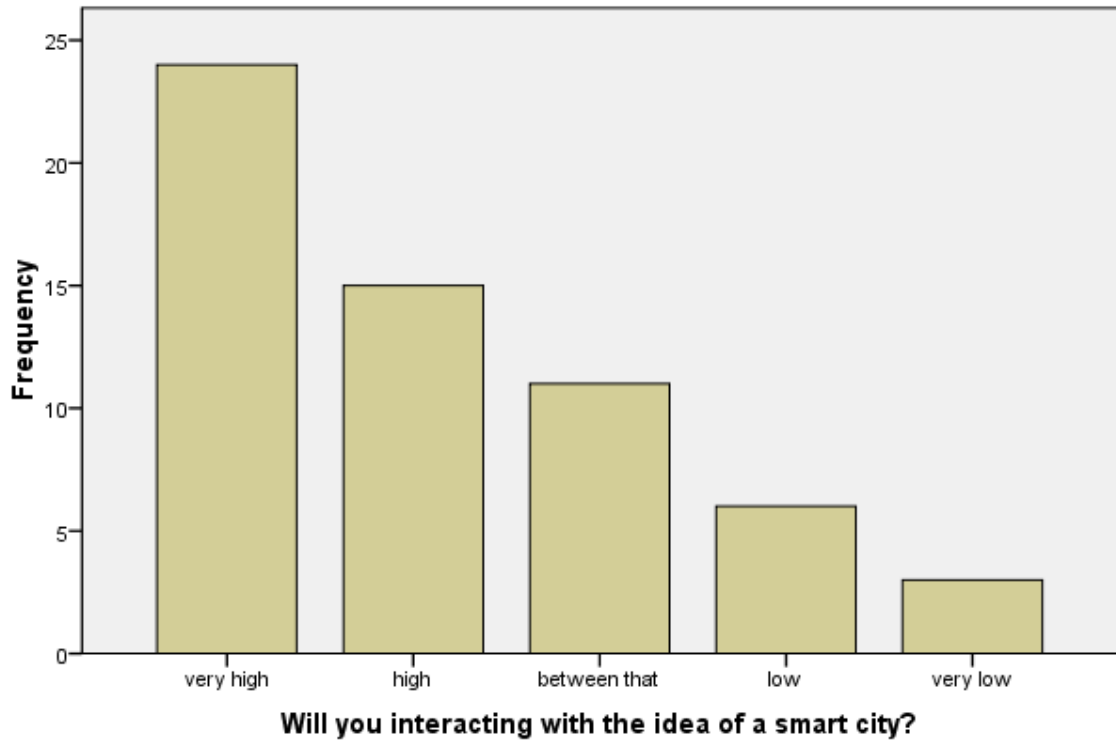


Figure 4.6: Analysis of question2

### 3. Analysis of question 3

Participants believe about if we need for this smart city also it take into consideration because it will show the participants accept for idea. There are 26 from participants about 44.1% of participants have very high agree by idea 23.7% have high agree 18.6% have between that seeing 6.8 %of participants low and 3.4% of the participants disagree.

**Table 7: Do you believe we need to this idea “smart city framework” in Sudan?**

	Frequency	Percent	Valid Percent	Cumulative Percent
Val very high	26	44.1	44.1	44.1
High	14	23.7	23.7	69.5
between	11	18.6	18.6	88.1
Low	4	6.8	6.8	94.9
very low	2	3.4	3.4	98.3
Total	59	100.0	100.0	

**Do you believe we need to this idea “smart city framework” in Sudan?**

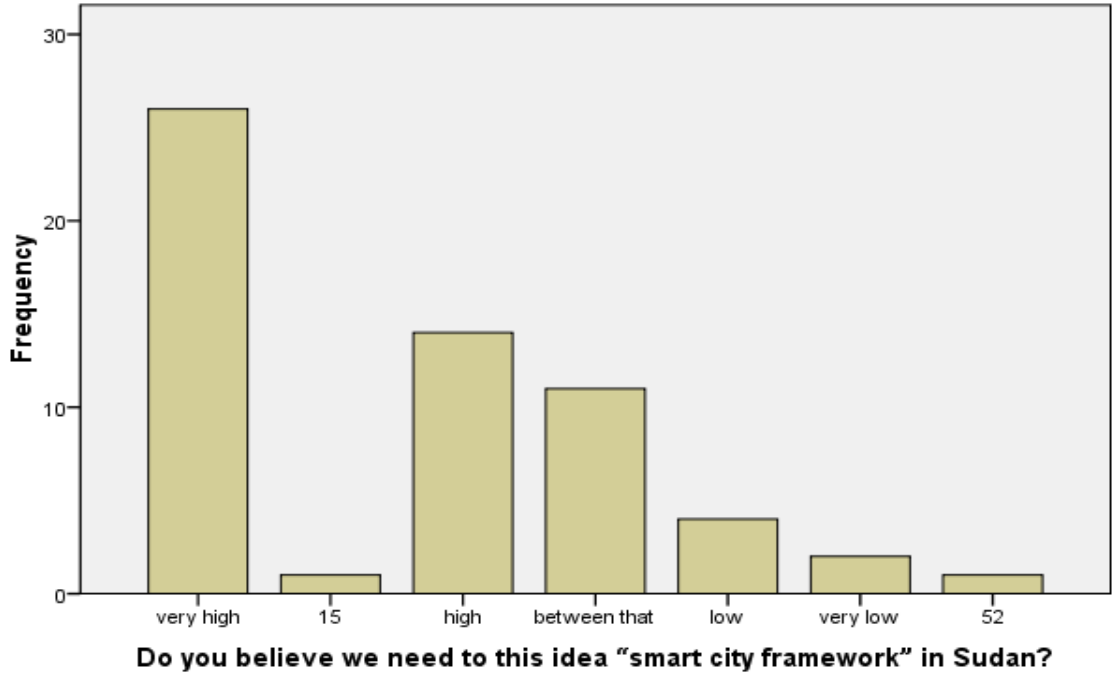


Figure 4.7: Analysis of question3

**4. Analysis of question 4**

The aim of this question to knowing people accept by change to smart city. Because cannot work on some something people do not desire or not have willing and ability to go with new thing. There are 24 participants about 40.7 have very high expect people can interact by change 25.4 have high expect 18.6% have between that 10.2% of participants have low expect and 5.1% of the participants do not seeing people can interact by smart city.

**Table 8: Will you expect the People interact with the idea of a smart city?**

		Frequency	Percent	Valid Percent	Cumulative Percent
Val	very high	24	40.7	40.7	40.7
	High	15	25.4	25.4	66.1
	between	11	18.6	18.6	84.7
	Low	6	10.2	10.2	94.9
	very low	3	5.1	5.1	100.0
	Total	59	100.0	100.0	

**Will you expect the People interact with the idea of a smart city?**

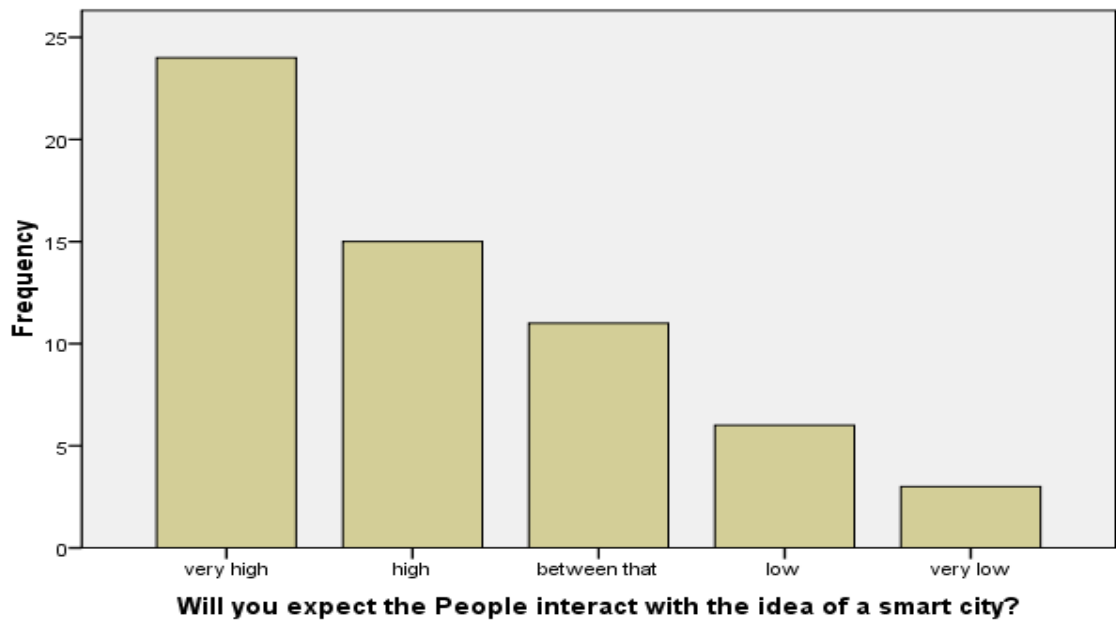


Figure 4.8: Analysis of question4

## 5. Analysis of question 5

This question it is explore expect of participants about Khartoum city is possible becomes smart city in the future. There are participants have very high and high expect about 19%. There are 8% of participants between that, 2% of participants have low expect and 11 %of the participants have very low expect.

**Table 9: Is possible Khartoum becomes smart city in the future?**

	Frequency	Percent	Valid Percent	Cumulative Percent
Val very high	19	32.2	32.2	32.2
High	19	32.2	32.2	64.4
between	8	13.6	13.6	78.0
Low	2	3.4	3.4	81.4
very low	11	18.6	18.6	100.0
Total	59	100.0	100.0	

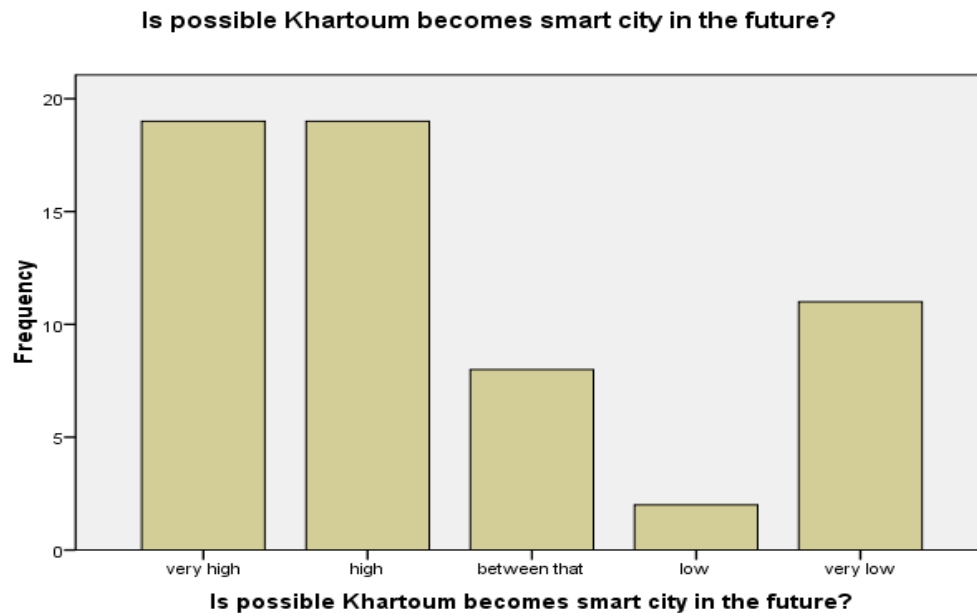


Figure 4.9: Analysis of question5

## 6. Analysis of question 6

The aim of this question is to know how participants rely on technology in their daily transactions. This study shows that more participants rely on technology, with about 30% of participants very high, 21% high, 6% between, and 2% low. 2% of the participants do not rely on technology in their daily transactions.

**Table 10: Do you rely on technology in your daily transactions?**

	Frequency	Percent	Valid Percent	Cumulative Percent
Val very high	30	50.8	50.8	50.8
High	21	35.6	35.6	86.4
between	6	10.2	10.2	96.6
Low	2	3.4	3.4	100.0
Total	59	100.0	100.0	

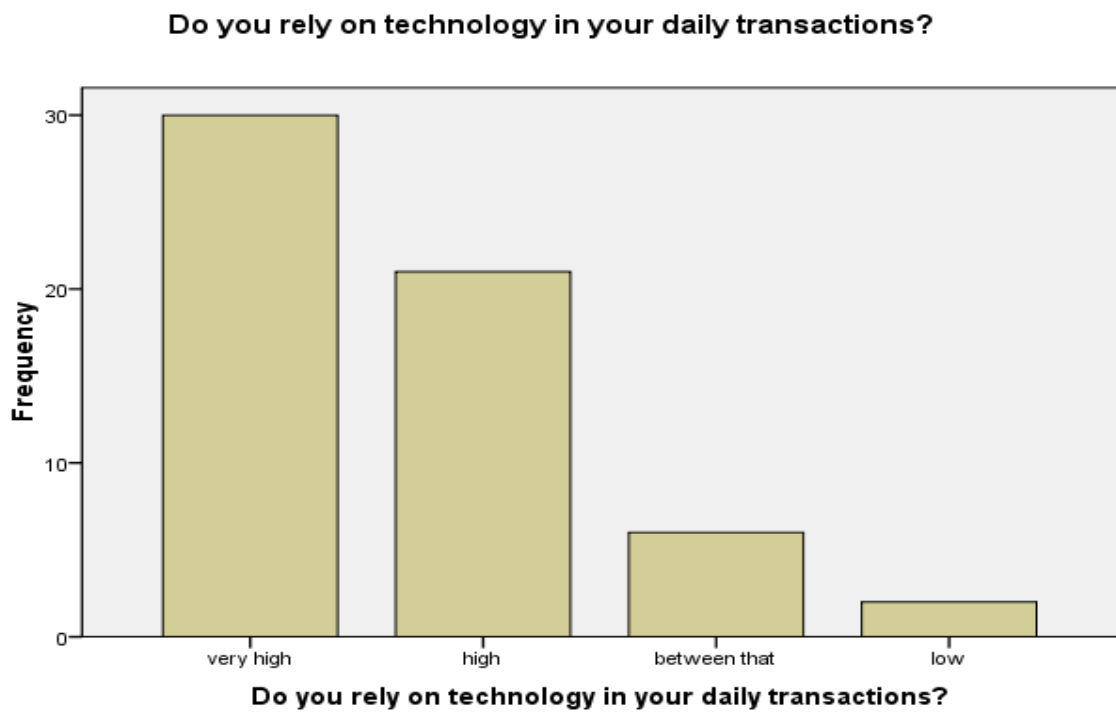


Figure 4.10: Analysis of question 6

## 7. Analysis of question 7

The aim of this question to knowing range of participants accepting by change that imposed to their .this study show participants have very high accept about 28% .23% of participants have high accept 2% of the participants have little accept .2% of the participants do not accept on by transformations.

**Table 11: Do you accept by transformations that imposed the technology today?**

	Frequency	Percent	Valid Percent	Cumulative Percent
Val	1	1.7	1.7	1.7
very high	28	47.5	47.5	49.2
High	23	39.0	39.0	88.1
between	2	3.4	3.4	91.5
very low	2	3.4	3.4	94.9
very low	3	5.1	5.1	100.0
Total	59	100.0	100.0	

**Do you accept by transformations that imposed the technology today?**

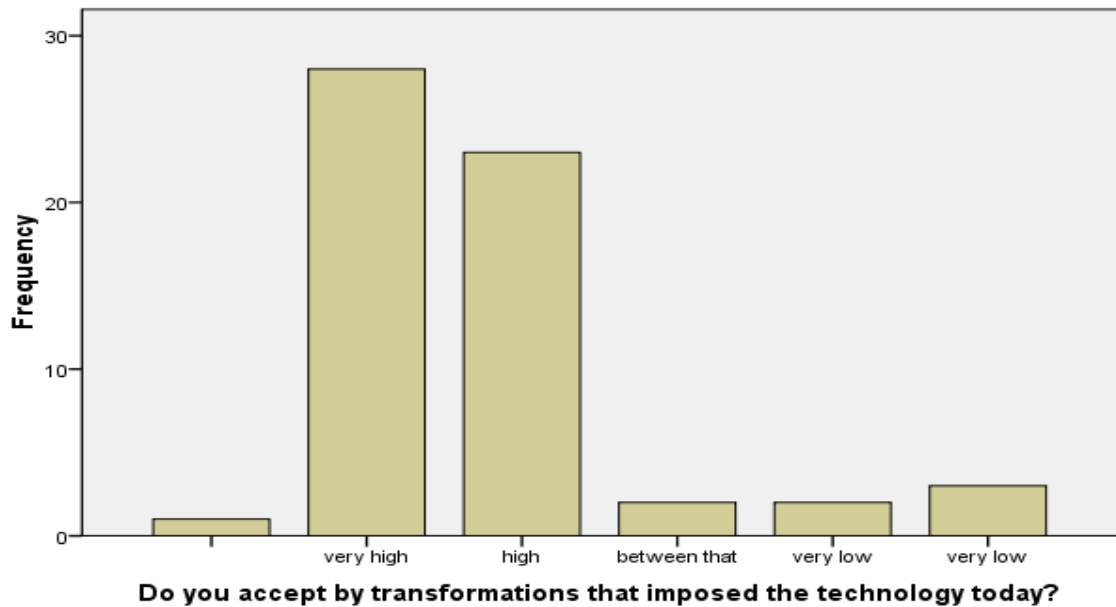


Figure 4.11: Analysis of question 7

### 8. Analysis of question 8

Analysis of The question show role of government to build smart city .this study show 33% from participants have very high seeing 16% of participants have high 2% of the participants have low .1% of the participants do not seeing any role on government.

**Table 12: Are you seeing the government have role in transfer to digital life?**

	Frequency	Percent	Valid Percent	Cumulative Percent
Val	1	1.7	1.7	1.7
very high	33	55.9	55.9	57.6
High	16	27.1	27.1	84.7
between	6	10.2	10.2	94.9
Low	2	3.4	3.4	98.3
very low	1	1.7	1.7	100.0
Total	59	100.0	100.0	



### Are you seeing the government have role in transfer to digital life?

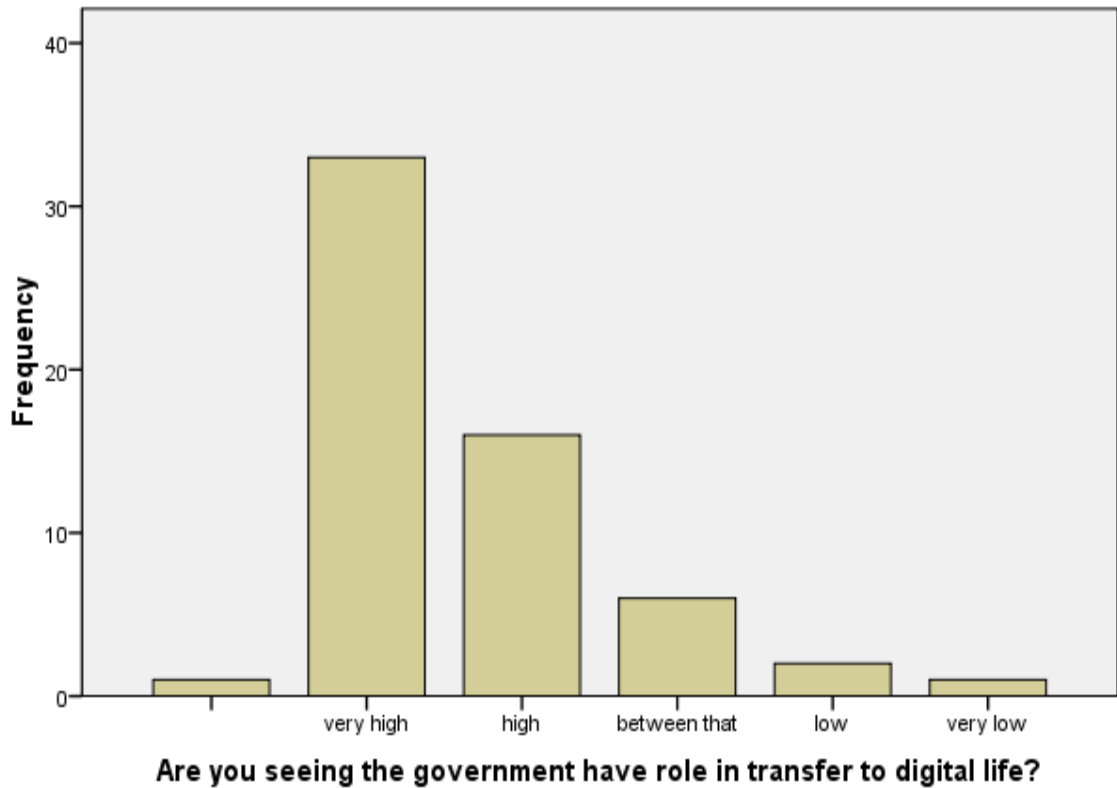


Figure 4.12: Analysis of question8

### 9. Analysis of question 9

This question is very important it explain participants believe about benefits of E-life .31 from participants rely have very high believe about 52.5%. 30.5% of participants have high believe about 18 participants from all 13.6% between that believe 1.7% from participants have low believe about on participants .1.7% of the participants do not believing.

**Table 13: Do you believing that transfer to E-life come with benefits for your life?**

	Frequency	Percent	Valid Percent	Cumulative Percent
Val very	31	52.5	52.5	52.5
High	18	30.5	30.5	83.1
betwee t	8	13.6	13.6	96.6
Low	1	1.7	1.7	98.3
very	1	1.7	1.7	100.0
Total	59	100.0	100.0	

**Do you believing that transfer to E-life come with benefits for your life?**

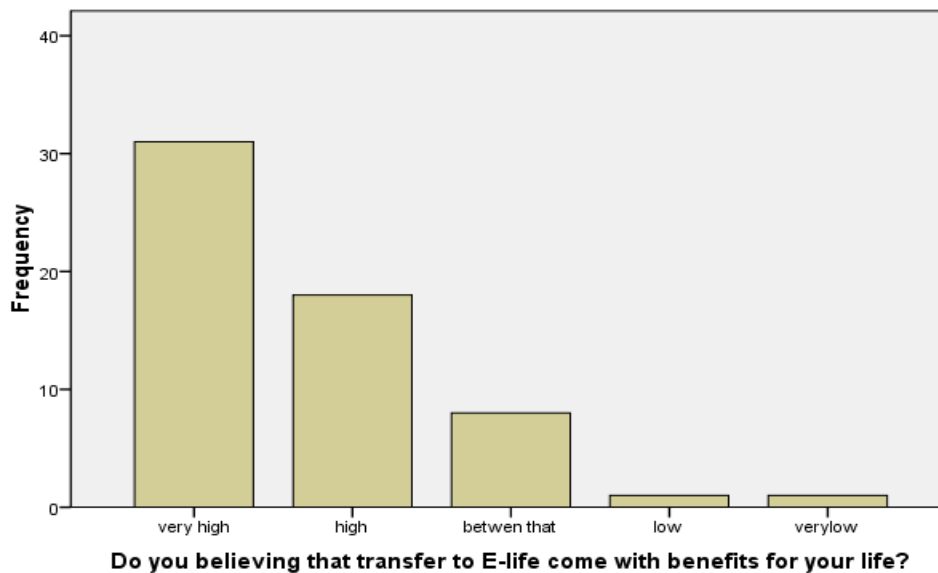


Figure 4.13: Analysis of question9

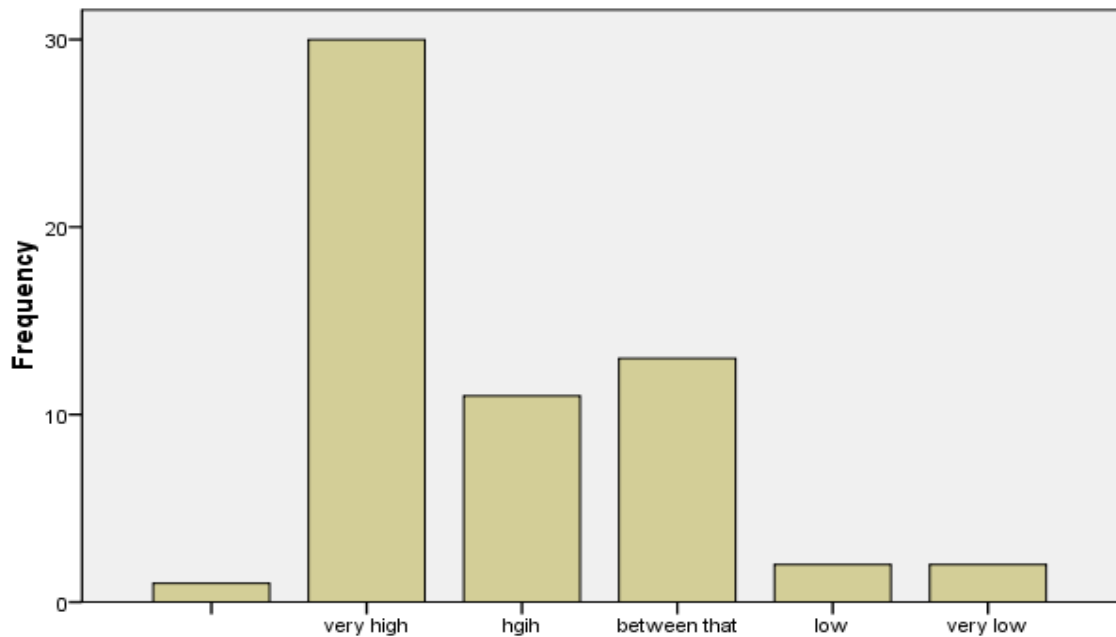
## 10. Analysis of question 10

The result from this question it is show range influence to joblessness. There are 50.8% of participants have very high agree about 30 from all 18.6% have high agree 22% have between that seeing 3.4 of participants low and 3.4% of the participants do not have any seeing about tow participant.

**Table 14: Are you seeing the transfer to digital influence for joblessness?**

	Frequency	Percent	Valid Percent	Cumulative Percent
Val	1	1.7	1.7	1.7
very high	30	50.8	50.8	52.5
High	11	18.6	18.6	71.2
between	13	22.0	22.0	93.2
Low	2	3.4	3.4	96.6
very low	2	3.4	3.4	100.0
Total	59	100.0	100.0	

**Are you seeing the transfer to digital influence for joblessness?**



**Are you seeing the transfer to digital influence for joblessness?**

Figure 4.14: Analysis of question10

## 11. Analysis of question 11

The aim of this question to knowing people if they like to transfer to live E-life because that shows they accept the idea of smart city. 31 from participants about 52.5 have very high like 33.9% have high like about 20 participants 6.8% have between that like 5.1 of participants low and 1.7% of participants dislike any change.

**Table 15: Would you like to transfer to electronic life?**

	Frequency	Percent	Valid Percent	Cumulative Percent
Val very high	31	52.5	52.5	52.5
High	20	33.9	33.9	86.4
between	4	6.8	6.8	93.2
Low	3	5.1	5.1	98.3
very low	1	1.7	1.7	100.0
Total	59	100.0	100.0	

**Would you like to transfer to electronic life?**

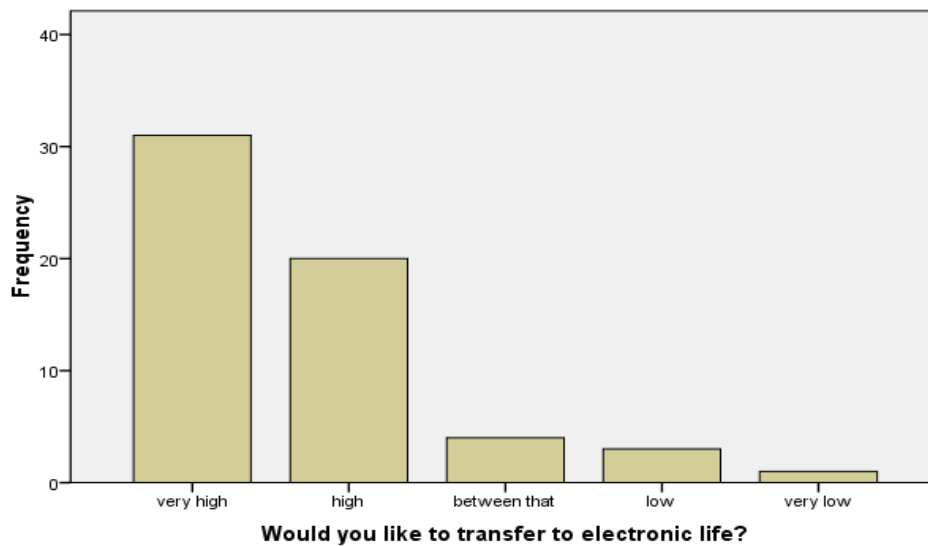


Figure 4.15: Analysis of question11

## 12. Analysis of question 12

This question it is the last in questionnaire. The aim of this question to knowing people aware to dealing with technology. 14 from participants about 23.7% of participants have very high seeing by people aware. 22% have high seeing about 13 participants 22% have between that seeing 3.4 of participants low and 28.8% of the participants do not seeing aware for people.

**Table 16: Are you see the people have enough aware to dealing with technology?**

	Frequency	Percent	Valid Percent	Cumulative Percent
Val very high	14	23.7	23.7	23.7
High	13	22.0	22.0	45.8
between	13	22.0	22.0	67.8
Low	2	3.4	3.4	71.2
very low	17	28.8	28.8	100.0
Total	59	100.0	100.0	

**Are you see the people have enough aware to dealing with technology?**

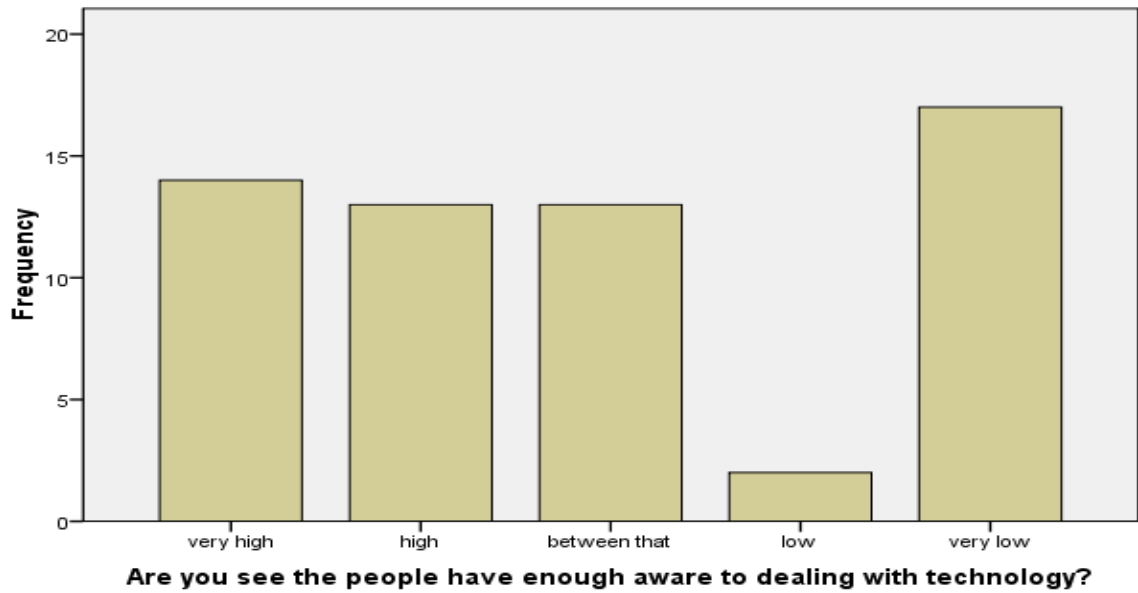


Figure 4.16: Analysis of question12

### 4.3.2 Interviews Questions Analysis

Q1: How would you define a 'smart city'?

The aim of this question to understand the interviewee's general knowledge about Smart city. The first interviewee" define smart city it relies on modern technologies in its daily dealing to enhancing the quality of life whereat as live city and becomes collects and distributes information. It rely basic on internet for present the services". The last interviewee sees "the smart city it is city that deals with its transactions and its services and provides electronically by high speed to transfer information where its share the information in real time of and provide the network of it by security and protection system".

## Q2 what services we can present it in smart city?

This question aims to knowledge about services that we should be in smart city. Where all it is by networks and every data depend on each other. Interviewee number one says” all services the citizens they need it in life but condition that must be electronically such as E-health, E-learning and E-government”. And the other interviewee says” in smart city we must present all smart service doesn’t available in traditional city from smart traffic circle, baby control, service of smart fridge and monitors the food”.

## Q3: How can manage smart city network?

The aim of this question to knowing how to manage the smart city network to including interviewee idea in network design. Interviewee number one says “The network is managed by active directory, related to the work of protocols and servers by where all the security policies and authorities that enable by administration of the network”. And the other interviewee says” the network management it’s very important that in smart city or in traditional city. There are many tools and programs its progress this process, the administrator of network uses them to awarding security authorities”.

## **4.4 Finding from questionnaire and interview**

This section presents the results regarding the qualitative data collected from the questionnaire and interviews. It is divided into two areas: the results from the questionnaire, which adds a lot to the interview findings.

### **4.4.1 Findings form Questionnaire**

This section proves the actual result that obtained from the questionnaire and participant point of view and quantitative data analysis results by using a statistical tool.

1. In the first questionnaire question participants who had enough background about smart city are about 88.1% of all people in the study and 11.9% hasn’t any background.

2. About 89.8% of participants will interactive with idea of smart city and the other will not that.
3. The needed to this idea “smart city framework” in Sudan 86.4% believe that, but other see we don’t needed for live in smart city.
4. more than 94% of participants seeing the government have role in transfer to digital life that meaning we must participate to support us in any same schema, .
5. Transferring to E-life come with benefits for your life, this question also we ask to participants in this study 96.6% they believe it come with benefits for their life, but other see another.
6. When we present any technology services for people we must sure all people have enough aware to dealing with technology, in this study more participants seeing the people haven’t aware with technology.

#### **4.4.2 Findings form interview**

This part of the findings it shows the general results and opinions that collected from professional in network engineers.

1. The professional interview had background about smart city they have knowledge about smart cities and have agreed to use modern techniques to improve human life.
2. Smart city Services, it all that is needed by the citizen of the services of smart provided that they are automatically implemented.
13. About how can SC network management, they mentioned the necessity of managing the network for the magnitude of the data passing through the network of smart debt, agreed to use the network management software and granted the powers within the network by the administration.



## 4.5 The simulation

In this section we address simulate to smart city network and scenario of configuring the network and devices within the network and how to connect them with each other and how to exchange data across them.

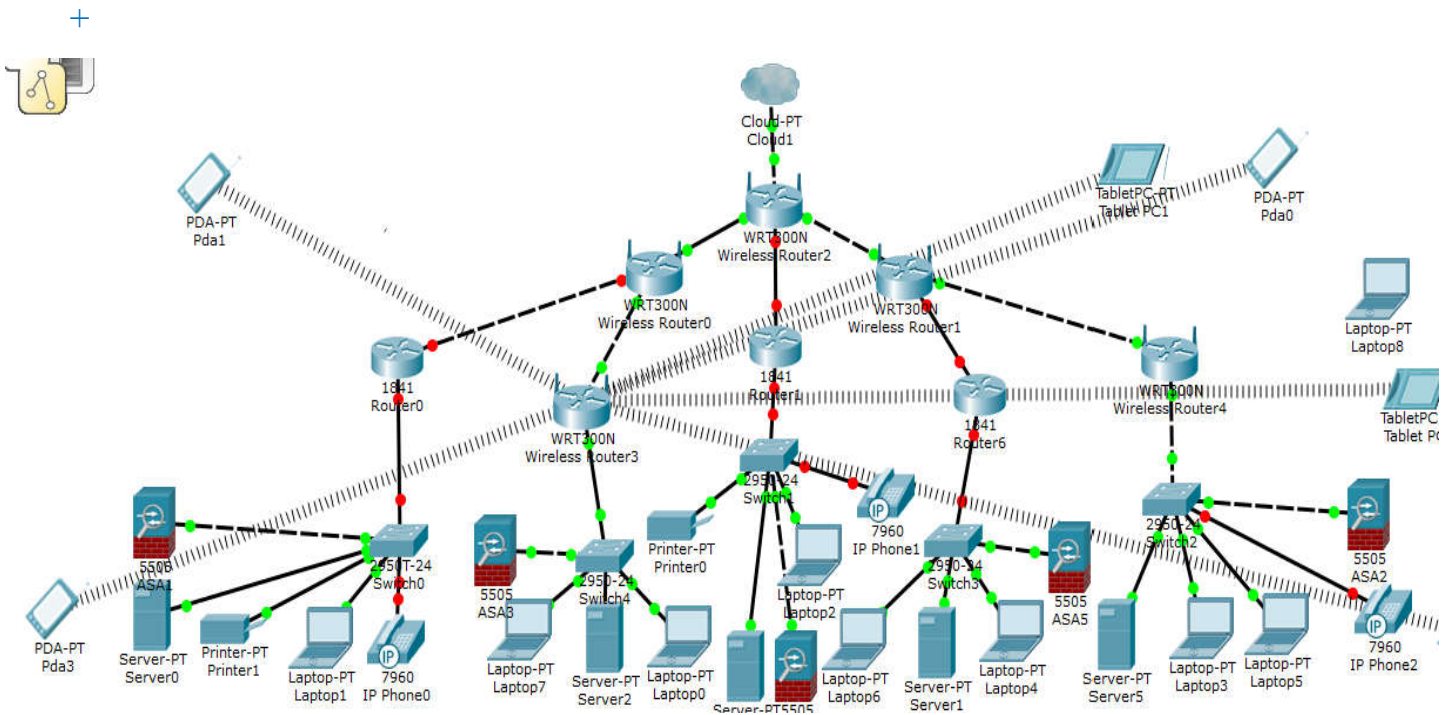


Figure 4.17: Smart City Network

#### **4.5.1 Proposal frameworks:**

1. Services should be provided in smart cities with high quality and accurate accuracy. Therefore, Wi-Fi networks must be relied on in most connections for their speed of data transfer.
2. The need to confirm security policies and give the necessary powers to people within the network.
3. Use of cloud computing to store data with the backup of data periodically without restricting local resources to reach the user at any time.
4. Accreditation in the connection of networks on the Wi-Fi for its speed and the possibility of using it to cover the entire city.
5. Use sensors networks to get accurate data and give each objects a unique ID number(IoT) within the network to facilitate data exchange between them.

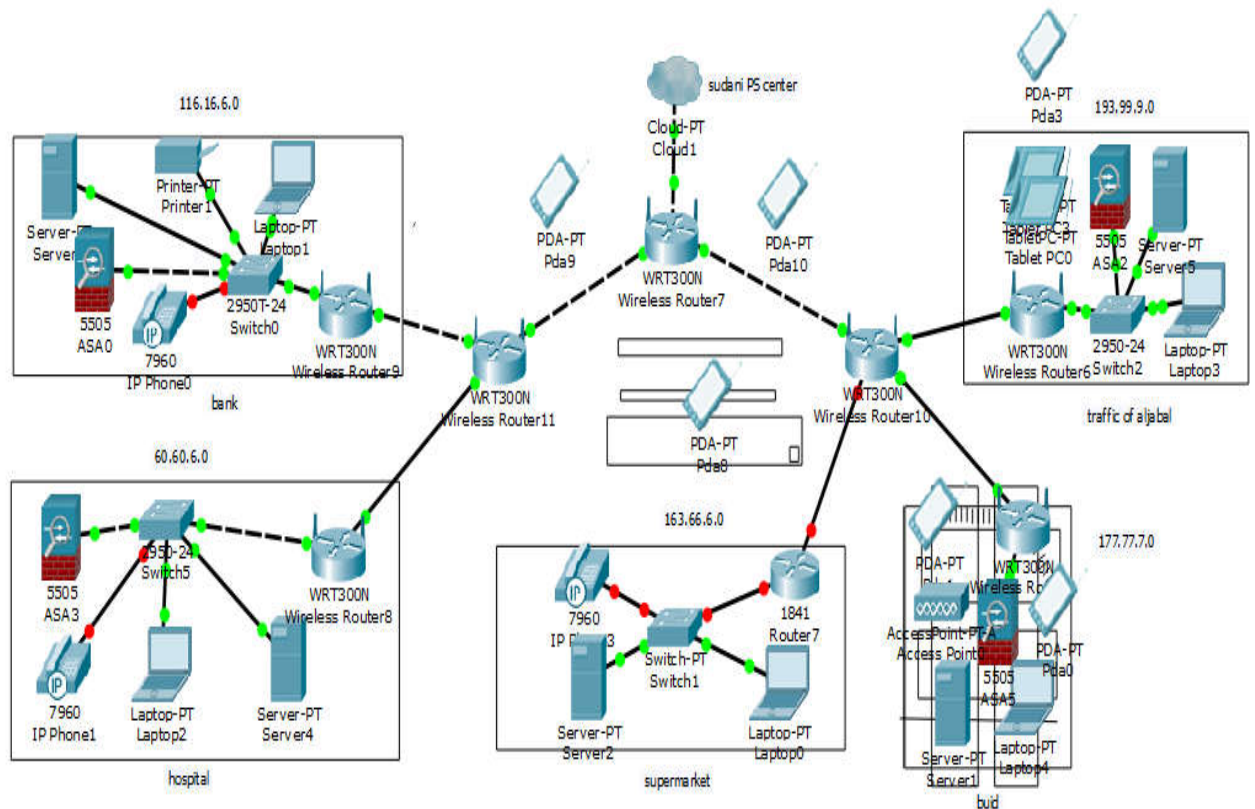


Figure 4.18: Proposal Framework for Smart City networks

#### 4.5.2 Network configuration:

The network should cover all parts of the city and be on a high speed and accuracy model, and the whole network will be connected to each other so that data can be transmitted through it and accessed from anywhere on the network, support all devices with a unique ID number , what is known as internet of things, and users also with IP Their phone.

1. The first network, which is considered the main gateway to the traffic circles from the south side for Khartoum city, the traffic circle of Aljabal, where the network is connected to each other, which consists of an access point where the computers connect to the wire, a server which is storing all the data for all the vehicles During which some of them are handled locally in the same area for security purposes, and some are passed through the router to the private traffic to the other traffic and other data taken from ambulances are sent to hospitals. The router connects wirelessly with

all traffic circuits within the city so that the exchange of All roads are monitored by high-definition cameras and equipped with a Wi-Fi network to monitor the traffic and identify the congestion and the faster way to take out, which is also connected to the network and know a unique number. The network is equipped with a firewall for protection purposes and also protection programs for network-related devices. Granting powers to persons authorized to enter them.

2. The second network is a network of residential building. Where all parts of the network (sensors, smart phones, computers, smart phones) are connected to each other through the access point which is in turn connected with the router.

All objects in the house are made up of a number such as refrigerator, potage, water faucets, and so on and have an application that the owner can browse and handle in his mobile phone. And to provide sensors to read the temperature and adjust the amount of oxygen in the place and all these indicators are sent to the phone of the person to give orders and directions. The router connects and exchanges data from sensors through Wi-Fi with all parts of the house and with other networks.

3. The third network is a commercial network and consists of a network of laptop computers connected with a dash and surveillance cameras. The data center will be used to store the data of the citizens, their homes and their IPs, to back up the data and to provide the network with the power to work and save the data, in addition to the router that directs the data inside and outside the network. The network is equipped with firewalls for protection purposes as well as protection programs for network-related devices with the authority of authorized persons to enter them.

4. The fourth network is the network of the hospital. All the equipment of each department is connected by a separate wire. Each switch is connected to the router. It receives the data sent by the ambulances from the Aljabal traffic circle router through the Wi-Fi network and routed to the hospital router. and the medical record for processing the place for him. The network is protected by a firewall for protection purposes, as well as protection programs for devices connected to the network, giving the powers of persons authorized to enter them. There will be a data center room to store data for patients, to make backups, and to provide the network with the power to work and save data.

5. The network of the bank. All the floor equipment shall be connected to each other from computers, printers and wireless phones via the switch, which is also connected to the router of the bank. The network must be equipped with a firewall for protection purposes, as well as protection programs for network-related devices with the authorization of authorized persons to enter them. There will be a data center room to store the data of the company and customers and to make backups and provide the network service energy for its work and data preservation.

6. There is also the service provider which is the company that provides all these networks service to work with paid values.

7. As we need high services at the moment and all these services depend on the network and on each other it is necessary to store data and integrated services without restricting local resources to reach the user at any time and processing periodically and to achieve that must use cloud computing.

8. It has been relying heavily on the network Wi-Fi and the fast speed of data transfer and the possibility of covering the whole city and connects with each other.

## **Summary**

This chapter presented the results and findings of the study with regard to providing Guideline or framework for results of questionnaire and interview, more participants in this questionnaire they have a background of the smart city. Also, they people can interactive with smart city idea and they want the change .And data analyzed using SPSS. And from interviews Professional interview had a solid background about smart city and how to manage it. Finally we present the simulation design for network.

# **Chapter Five**

## **Conclusion and Recommendations**

## **Chapter Five**

### **Conclusion and Recommendations**

#### **5.1 Conclusion**

This section summarizes the findings of this study and provides answers to the research questions. In this study present a framework for the management of smart city networks. The city of Khartoum was selected as case study. The information for this study was derived from discussions with experts in the fields of networks. A questionnaire was also prepared for specialists in different fields of networks to take their views on the subject and arrive at the appropriate design. The study was designed to develop a framework to improve the management of smart city networks to provide accurate information in real time, continuity, monitoring, control and security of the network. Also present topology of smart city network and explain configuration it.

The design and configuration of network is careful process and every little detail was hard to cover in this work. I prepared sample configurations, but it is obvious that in a scale of such a big network there are a lot of things to consider and more technologies must be implemented.

#### **5.2 Recommendations**

This research study considers framework of smart city for network management can be used to improve network management in smart city. The work, like any other worthwhile project provides direction for future improvement. We recommending Study how networks affects smart cities and how new technologies provide solutions to renew, replace and repair network components. We recommend also studying other factors for smart cities, such as policies, environmental and economic factors.

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## Appendix A-Questionnaire paper



جامعة السودان للعلوم والتكنولوجيا - كلية الدراسات العليا - ماجستير تقنية المعلومات

استمارة استبيان

التاريخ 17 / 11 / 2018

إيماناً منا على دور البحث العلمي في التقدم ،أضع بين أيديكم هذه الإستبانة وهي إحدى المتطلبات الدراسية للحصول على درجة الماجستير علوم الحاسوب و تقنية المعلومات تخصص شبكات ، بعنوان (تطوير اطار عمل لإدارة شبكات المدن الذكية ). حيث أنني أؤمن بأنكم خير مصدر للمعلومات المطلوبة ، توجهت إليكم وكي أمل في أن أجد التعاون المطلق من قبلكم وذلك من خلال الإجابة على أسئلة هذه الإستبانة. أرجو من سيادتكم التكرم بقراءة كل فقرة بعناية و وضع علامة صح أمام الاختيار المناسب للوصول إلى نتائج دقيقة وموضوعية علماً بأن الإجابة ستعامل بسرية وتستخدم لغرض البحث العلمي فقط ،شاكره لكم حسن تعاونكم .

اولاً: البيانات الاساسية:

.....			1. الاسم (اختياري)
<input type="checkbox"/> ذكر	<input type="checkbox"/> أنثى	2. الجنس	
.....			3. اسم المؤسسة
.....			4. التخصص
<input type="checkbox"/> أقل من 35	<input type="checkbox"/> 45-35	<input type="checkbox"/> أكثر من 45	5. العمر
<input type="checkbox"/> 5 سنوات فأقل	<input type="checkbox"/> من 6-10	<input type="checkbox"/> أكثر من 10 سنوات	6. سنوات الخبرة

ثانياً: الاسئلة

درجة المعرفة					العبارات	م
منخفضة جداً	منخفضة	إلى حد ما	عالية	عالية جداً		
					Is the idea of a smart city understandable to you? هل فكرة المدينة الذكية مفهومه بالنسبه لك؟	1
					Will you interacting with the idea of a smart city? هل من الممكن ان تتفاعل مع فكرة المدينة الذكية؟	2
					Will you expect the People interact with the idea of a smart city? هل تتوقع ان يتفاعل الناس مع فكرة المدينة الذكية؟	3
					Do you believe we need to this idea “smart city framework”? هل تعتقد نحن فى حوجه لهذه الافكار؟	4
					in the Is possible Khartoum becomes smart city	5

				future? هل من الممكن أن تصبح الخرطوم مدينة ذكية فى المستقبل؟	
				Do you rely on technology in your daily transactions? هل تعتمد على التكنولوجيا فى حياتك اليومية؟	6
				Do you accept by transformations that imposed the technology today? هل تقبل بالتحويلات التى تفرضها التكنولوجيا اليوم؟	7
				Are you seeing the government have role in transfer to digital life? هل تعتقد الحكومة لها دور فى الانتقال الى الحياة الالكترونية؟	8
				Do you believing that transfer to E-life come with benefits for people? هل تعتقد أن الانتقال الى الحياة الالكترونية يأتى بفوائد على الناس؟	9
				Are you seeing the transfer to digital life influence for joblessness? هل تعتقد أن الانتقال الى الحياة الالكترونية يؤثر على البطالة؟	10
				Would you like to transfer to electronic life? هل تريد الانتقال الى الحياة الالكترونية؟	11
				Are you see the people have enough aware to dealing with technology? هل تعتقد بأن الناس لديها الوعى الكافى للتعامل مع التكنولوجيا؟	12

## Appendix B - interview Questions

Sudan University of Science & Technology

College of Postgraduate Studies

Master of information technology

### **Development Framework for Smart Cities Network Management (Case Study Khartoum City)**

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#### Personal Interview

Name (Optional) ..... Sex Male  Female   
Email..... Telephone  
number.....

#### Interview Questions

Q1: How would you define a 'smart city'?

Q2: What services we can present it in smart city?

Q3: How can manage smart city network?

Q4: Do you see Khartoum as a good option for smart city?

Q5: How can aware the people by digital transformations and deal with them?

Q6: Is it possible to develop this research it and implement it with international specifications?

Q7: Can you indicate what, in your opinion, makes a "smart city"

Project useful for the citizens?

Q8: What assets and resources do you have now to support smart city development and what will you need in the future?

Q9: How do you currently involve citizens and other users in developing new technologies, applications or services and how would you like to see them involved in the future?

Q10: What is the role of government play for build and apply smart city?

Q11: What is your future vision for this research?