# Investigating the factors affecting the net benefits and change in user behaviour in technology push scenarios in Smart cities

**AFNAN N M N A ALKALDI**

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**AFNAN N M N A ALKHALDI**

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# Abstract

**Afnan Alkhaldi**

**Investigating the factors affecting the net benefits and change in user behaviour in technology push scenarios in Smart cities**

**Keywords** – Smart City, Internet of Things, Blockchain, Performance Expectancy, Information Quality, Service Quality, Trust in Provider, User Satisfaction, behavioural and attitude change. Technology Push, Benefits of Technology.

**Purpose** – The aim of this study is to investigate the factors affecting the net benefits and change in user behaviour in a technology push scenario in Smart Cities.

**Design/methodology/approach** –The research was conducted using a quantitative approach. Hence, quantitative data was obtained by devising and distributing a questionnaire adapted from the literature to serve the purpose of this research. Data was analysed by using SmartPLS software, since this tool allowed for the creation of a Structural Equation Modelling (SEM).

**Contributions** –The research is expected to help foster an understanding of the factors affecting citizens' satisfaction with technology-supporting smart cities. The focus of this research was on the scenario where technology was introduced by the government to support the development of smart cities, and where citizens 'do not have a choice' and are 'pushed' to use them. The research contributes a model for assessing the role of satisfaction in enhancing the net benefits of smart city technologies on the lives of citizens, as well as the change in individuals' behaviour towards smart city technologies when they are 'pushed' for use. The findings provided insights to enable policy makers to implement smart cities in developing countries while ensuring the satisfaction of the users.

**Originality/value** – The originality of this research is centred around determining how satisfied citizens are with smart cities and the net benefit of smart cities within a developing country (Kuwait) context. The research is also unique in that it examines the role of citizens' satisfaction in changing their behaviour towards 'push' technology within smart cities.

**Theoretical Contributions** – This study examined the factors that led to acceptance of smart cities in Kuwait. Hence, this study used the theories related to user acceptance of technology and added to its trust in provider. Previous studies have examined trust as a broad concept. Moreover, this study incorporated the push theory and also examined the change in user behavior, which was not examined in earlier studies.

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# CHAPTER 1: INTRODUCTION

## 1.1 OVERVIEW

The accelerating rate of urbanisation and wealth concentration has encouraged municipal authorities to reappraise how they deliver services to their citizens. It is estimated that over 60% of global GDP is currently produced in 600 urban centres (International Telecommunication Union 2019). By 2030, it is expected that the amount of urban dwellers living in a city will increase to 6 out of 10 people and then to 7 out of 10 by the year 2050 (United Nations 2014a). The annual growth rate of urban residents is currently about 60 million and by the year 2050, it is predicted that approximately 68% of people globally will live in cities. This percentage will amount to 5.8 billion individuals living in cities (United Nations 2018), a vast amount sure to exert pressure on infrastructure, due to traffic congestion as well as presenting environmental concerns (International Telecommunication Union 2019). As the planet becomes increasingly urbanised, there is a need to change the way services are delivered (Connolly 2020). This has prompted municipal authorities to devise innovative solutions for engaging with citizens and businesses, and to come up with new ways of managing the demands of citizens in terms of the various necessities of life (such as finding a solution to overcrowded cities, increased energy consumption, resource management and protection of the environment) (Costa 2020).

In the context of continuous innovation, governments are considering methods of transforming existing cities into smart cities (Simonofski et al. 2019). A smart city is not just a way of life but is also a tool for solving many issues such as tackling poverty and inequality, unemployment and energy management (Ismagilova et al. 2019). “Culture eats strategy for breakfast” is an apt quotation from Mark Fields of Ford although it was originally attributed to the management guru, Peter Drucker. It means that culture and strategy are inseparable (Kaul 2019). In the context of this study, it is essential to know that transformations to technology use must be coupled with people being open to acceptance of technological solutions (Alam et al. 2020). Hence, the road to smart cities begins not with choosing the right technology to employ but with transforming mindsets (Costa 2020; Ferraris et al. 2020).

Technologies are being developed at a fast rate and their uses are becoming increasingly more evolved and dispersed (Sharma et al. 2017). Examples of technologies that have received great attention during the last decade are Internet of Things (IoT) and Blockchain. Blockchain was coined as a term for a technology that would help secure financial transactions through a high level of encryption (Biswas & Muthukkumarasamy 2016). Internet of Things is the ability to link several devices and services together in a seamless manner (AlEnezi & Manuel 2017). Although these technologies were not originally created specifically for smart cities, their application in this context has become important and indispensable for the success of smart cities. Cities are viewed as the most important structures that people have been able to create as they encompass social, economic, and cultural factors (Harrison et al. 2010). It is also argued that technology can bring about numerous benefits to citizens. Authors such as Lee et al. (2008) as well as Jong et al. (2015) draw attention to the efforts being undertaken on a global scale in order to upgrade existing urban infrastructure and services. The aim is to create better living conditions, protect the environment and improve people's social and economic conditions. Meijer and Bolívar (2015) state that this development was originally referred to as the creation of intelligent cities, but currently the term 'smart cities' has become a more common parlance. Smart cities refer to the "*intelligent use of digital information*" (Trindade et al. 2017, p. 1).

## 1.2 SMART CITIES FROM A GLOBAL PERSPECTIVE

Many developed countries have already started to transform their cities into smart cities (Akande et al. 2018). For example, in the United States, New York is ranked as the number two smart city across the globe (Kumar & Rattan 2020). In Europe, Amsterdam was the leading smart city in Europe, an example of a successful transformation of a city, into a smart city (Boes, Buhalis & Inversini 2016). However, London took first place in 2020 and Amsterdam dropped to third place (Kumar & Rattan 2020). Smart Amsterdam was developed by means of a partnership between private and public sectors which developed new technological solutions for improving the quality of life for the city's residents (Carvalho & Vale 2018). The transformation involved over 40 smart projects that were designed to ease the lives of residents and to cut down on the cost of offering services (Boes et al. 2016).

Another example of a European smart city is Vienna (Fietkiewicz, Mainka, & Stock 2017), which was developed by means of a joint venture between the two sectors called "TINA." TINA has been responsible for over 100 smart city projects of which the most prominent was the "Citizen Solar Power Plant". This was expected to reduce energy costs by 50% by the year 2030, albeit by means of energy generated from renewables (Kolokytha, Kolokythas, Valsamidis & Florou 2015).

In terms of developing countries, Nairobi and Cape Town are ranked as the top two places of smart city innovations in Africa (Veras 2017), with Nairobi being named as the smartest city in Africa for three years in a row. Cape Town has focused its 'smart development' on facilitating business activities (Veras 2017). In the Gulf Cooperation Council (GCC), Dubai has embraced smart technology as the principal approach to implementing Smart Dubai, a three-year programme which commenced in 2018. Smart Dubai has three main objectives: customer satisfaction, economic growth, and resource and infrastructure resilience. These are to be achieved on the foundation of six pillars: smart living, smart economy, smart governance, smart mobility, smart environment and smart people (Smart Dubai 2019; Giffinger et al. 2007).

GCC countries are dependent on oil and gas production as the principal source of revenue, as it accounts for more than 70% of the Gross Domestic Product (GDP). Also, GCC countries are obligated to provide residence to their citizens through the construction of new cities, which require a lot of financial investment as well as resources. Kuwait is projected to deliver more than 10,000 housing units in December 2020, which constitute the largest housing units distribution in the history of Kuwait (Alrai newspaper 2020). In Bahrain, citizens are on the waiting list for a new housing unit for more than 18 years (Albiladpress 2020). Focusing on smart cities will help minimize the resources required, as well as being fuel efficient, which can save on energy sources. Hence, this type of research is not important to Kuwait only, but all the GCC countries as it can provide some guidelines and directions for a brighter future that is run by smart cities.

## 1.3 OVERVIEW OF SMART CITIES IN KUWAIT

Kuwait is a small, wealthy country that depends on oil as a main source of income. The citizens of Kuwait represent 1.5 million, which is about 30% of the population

(Public Authority for Civil Information, 2020). Kuwait provides housing for all its citizens through the allocation and building of these housing units and handing it over to citizens. It has become expensive to build new cities with all the budget required for the material and resources. The government of Kuwait promulgated its vision entitled “Kuwait 2035” in 2015, which was a strategy with a set of procedures followed in order to stimulate and improve the performance of the economy over the following 20 years. One important way for achieving this vision is by reducing the dependency of the economy on oil revenues and transforming the country into a hub for international finance, trade and tourism in the region.

To this end, the Kuwaiti government has devised plans for the construction of nine smart cities. In devising these plans, the government has been mindful of the need to conserve available land resources for developments other than housing in the future. For example, some land is designated for the development of new technologies of alternative and sustainable energy sources. Additionally, the introduction of hybrid or electric road vehicles will lessen dependency on fossil fuels as well as protecting the natural environment. These measures should also prolong the life of fossil fuel reserves which will still be required for future needs (Al-Ghawi, 2016). Therefore, smart cities are important for Kuwait.

The context of this research is the development of smart cities in Kuwait as essential to the implementation of the Vision of Kuwait 2035 (New Kuwait, 2019). The main underlying thrust of that vision is the utilisation of technology in order to facilitate life for its citizens. The first smart city to be implemented in the Middle East was Saad Al-Abdullah City, which adopted a green approach aimed at the sustainability of resources (Euronews 2018). The total area of the new city exceeds 64 square kilometres. The project has an estimated budget of US$4 billion and construction is scheduled to start towards the middle of 2019. This represents a milestone on the journey of transforming the country into a destination for tourism, finance and trade. The smart city will be built by utilising the expertise of a consortium of South Korean construction companies that includes specialists in smart technology. Construction will consist of more than 40,000 units and housing for more than 400,000 citizens. The smart cities in Kuwait will be enforced on all citizens eventually and people will not have an option whether to live in one or not (New Kuwait 2019). The government is trying to develop the services and create smart cities that are capable of satisfying all the needs of their citizens. By building smart cities, the government is hoping to conserve the energy sources, which is expected to deplete in the future. Also, the intent of the government is to fulfil one of the sustainable development goals of the UN by preserving the environment using reusable building material and increase its intake of renewable energy of at least 15% by 2035 (e.gov.kw 2020). Prior to the commencement of construction, the Kuwaiti government has developed plans to use fibre optic networks to support smart city developments by providing links to facilitate and streamline the fast delivery of services (KUNA 2019). Central Information Technology Regulation Authority (CITRA) has initiated a project to change the IT infrastructure in Kuwait in order to accommodate all the new requirements of future cities (CITRA 2019). CITRA has also signed a contract with an international organisation specialized in data centres in order to build huge data centres in the country (CITRA 2019). All the IT-related databases of the country will be housed in central and local locations. This will ensure that the country will be independent and that there will be higher security and control of personal data.

Currently, air conditioning in Kuwait consumes 70% of the country's electricity (Essam Al-Marzouq Kuwait Times). The Chairman of the Kuwaiti Society of Engineers, Faisal Al-Etel, announced that the principal objective was to progress towards securing cleaner sources of energy and to reduce energy consumption. The construction of smart buildings entails the utilisation of the most energy efficient building materials (e.g., doors, window frames and walls), as well as painting surfaces with energy efficient acrylics and colours (Battista et al. 2014). For urban populations living in high-rise buildings, it is of paramount importance to consider energy efficiency and environmental protection (Cangelli & Fais 2012). One solution to this problem is the creation of vertical cities which include patios with green areas. As a first step, the Minister of Electricity and Water announced in 2018 that Kuwait had started installing Smart meters (KUNA, 2018). This allows the ministry to monitor electricity consumption and to plan for future expansion of electrical grids for cities in Kuwait. Moreover, the installation of smart meters is regarded as an important measure for raising public awareness of the benefits of smart technologies (Singh 2012).

## 1.4 RESEARCH PROBLEM

Technology push is observed as a general practice, especially in developing countries. The aim of technology push is to improve the efficiency of the current systems and solutions (Yang & Lebline 2016), through innovation and continuous development (Hartmann et al. 2012). It is about forcing change on people to replace and eradicate (Walsh, Kirchhoff & Newbert 2002) the current systems or methods of business. It is a disruptive way of introducing the technology to people (Brem & Voigt 2009), which might create many problems. One of the main problems that people might face is the lack of awareness of the technology use (Lytras & Visvizi 2018), as well as its benefits gained from the technology (Abdalla et al. 2019). People will reluctantly use the technology without a real and deep understanding of the benefits that they might stand to gain (Brem & Voigt 2009) due to a lack of choice, which will affect their level of satisfaction (Hartmann et al. 2012).

Satisfaction is an important consideration in the delivery of any service (Ene & Özkaya2014). With respect to the context of the study, which is smart city technologies, user satisfaction with smart city technologies is not easily accomplished when it is optional to use the technology (Lytras & Visvizi 2018). Regardless, it is even more difficult to achieve user satisfaction when the technology is being pushed to citizens (Singla, Sethi & Ahuja 2018). In order to ensure satisfaction, the service provider should maintain a high level of information and service quality because users appreciate the service and the technology when it is easy to understand and deploy (Carter & Belanger 2005). In addition, users expect that the technology behaves in a certain manner. As expectations are met and quality standards are raised, trust in the technology provider will tend to be positively affected (Van Zoonen 2016; Baudier, Ammi& Deboeuf-Rouchon 2018), user satisfaction will increase and the benefits of using the technology will be derived. Moreover, satisfied users of smart city technologies will exhibit changes in their behaviour towards smart city technologies (Almuraqab & Jasimuddin 2017). Earlier studies have emphasised the importance of trust in the provider for improving user satisfaction with technology (e.g. Carter & Belanger 2005; Belanger & Carter 2008; Zolotov, Oliveira & Casteleyn 2018; Sun, Yan & Zhang 2016). Moreover, citizens expect the performance of the smart cities to be of a certain standard (Ismagilova et al. 2019).

Most of the previous literature has focused on the smart cities' features (Baudier et al. 2018; Clever, Crago, Polka, Al-Jaroodi & Mohamed 2018; Yan, Liu & Tseng 2018), while some have highlighted the importance of readiness to accept the technology (Sunny, Patrick & Rob 2019). All previous studies have emphasized technology use as optional and hence have examined it from a behavioural perspective. However, there was a lack of focus on the role of user satisfaction in triggering behavioural change in the use of smart city technologies. Little importance has been attached to the role of technology push in enhancing user satisfaction and behavioural change toward smart city technologies. Accordingly, the aim of this research is to investigate the factors affecting the net benefits and change in user behaviour in a technology push scenario.

In the context of Kuwait where the literacy rate is not very high amongst the older generation, it becomes very difficult to convince this category of citizens of the benefits of smart cities (Brandt et al. 2018). The technology and the infrastructure is still being developed through the organization of rules and guidelines that govern technology. As a result, having a low level of understanding of the technology with a limited interest in the technology might make it difficult to push the technology. This is also the case when citizens have a low level of technology use skills and capabilities (Kim & Lee 2012). In addition, users might not adopt the technology because they are comfortable using their old methods, which is what faced the government of Korea when pushing the online tax filing service where only 18% used the service (Lee et al. 2011). The technology that the government is trying to push its citizens into should have some crucial elements, such as satisfying the needs and allowing the citizens to trust the service (Scott et al. 2016), where the government sometimes fails to present the real value of technology, driving citizens away from using it. However, the real impact of technology push has not been examined before, which makes this study a valuable academic addition, which can provide solutions and help prepare Kuwait for embracing its New Kuwait 2035 where smart cities is one of its pillars. The Kuwaiti context was selected because smart cities are still in the early stages of incubation and thus there is a lot to be learnt and understood in order to reach a mature level of development. When the Government of Kuwait announced that it would build smart cities, there were mixed reactions from the public between supporters and those that question its value since it is going to be imposed on the people. Thus, this study is examining the factors that leads to accepting and using smart cities in the context of technology push and also understand the net benefits from these cities.

## 1.5 RESEARCH QUESTIONS

In order to achieve the aim and objectives of the research, the following research questions were stated:

- What are the factors that influence user change behaviour of smart city technologies when they are being pushed to citizens?
- What is the impact of information quality, service quality, performance expectancy and trust in provider on citizen satisfaction with smart city technologies in Kuwait?
- What is the impact of citizen satisfaction on the net benefits of using smart city technologies in Kuwait?

## 1.6 RESEARCH AIM & OBJECTIVES

The aim of this study was to investigate the factors affecting the net benefits and change in user behaviour in a technology push scenario. The objectives of the research were as follows:

- To conduct a literature review of the smart city model thorough analysis of all the relevant studies, which include smart cities, Internet of Things, Blockchain, information quality, service quality, performance expectancy, trust in provider and the net benefits of smart cities.
- To develop a conceptual model that can be applied to examine the role technology push scenario in the acceptance and adoption of smart cities use.
- To review and propose a methodological approach to validate and evaluate the theoretical framework.
- To review and analyse the results to validate the conceptual model and research hypotheses.
- To examine the differences in demographics with respect to Net benefits and user change behaviour for the use of smart cities in Kuwait
- To provide conclusions and recommendations to policy makers in Kuwait in order to enhance and broaden the scope of smart cities in Kuwait.

## 1.7 RESEARCH METHODOLOGY

The research questions were answered by following a quantitative approach. Taking the aim and objectives of this study as the starting point, the research adopted a quantitative approach and conducted a survey to collect data from one region of Kuwait where smart meters were being piloted as a compulsory smart city technology. Sampling followed a purposive technique since the research was looking at a specific population which consisted of consumers who had smart meters installed in their homes (Gentles et al. 2015). All citizens of this region were approached to answer the questionnaire. The data collected was analysed using the statistical software SmartPLS. The total population of this research was around 9000 citizens who were currently using the smart meters and there was expected to be a minimum sample of 300respondents. The questionnaire was distributed in both English and Arabic in soft copy. The soft copy was sent to respondents via social media platforms and email, whereas the hard copy was delivered by mail. A detailed description of the research methodology is provided in the methodology chapter (Chapter four).

## 1.8 CONTRIBUTIONS OF THE STUDY

It was anticipated that the findings of this research would contribute to the literature in various ways. Firstly, this study is expected to serve as a basis for similar studies in the future, as there is currently a lack of studies conducted to examine the understanding of user change behaviour when technology is pushed to a community of users. The literature at its current stage suggests that adoption of smart cities technologies is based on user acceptance and attitude towards adoption. However, the previous studies do not explore the behavioural impact of switching to smart cities technologies. In addition, this study is expected to help us understand the factors that influence the use of smart city technologies within a developing country context. There are a mix of different factors that could have an impact. Needless to say, the majority of the studies were exploring the factors in developed countries and hence provided a number of established factors. Using the context of developing countries is important since the majority of developing countries find it difficult to manage the scarce resources that they have at their disposal. People formulate perceptions about the use of technology and how it would benefit them, which is derived from their attitudes and skills that they have. So, having low levels of technology usage skills would make it hard for the government to push the technology because people have their own perceptions about the technology based on their capabilities (Kummitha 2020). Also, the surrounding environment makes it difficult to implement push technology. Fulk et al. (1987) conducted an empirical study in a petrochemical company and found that employees' usage of the technology is a reflection of the level of the social influence that their colleagues have on them. Having said this, there is a good number of people in Kuwait that have low levels of technology skills and thus, these people influence others on the adoption of technology, which hampers the government effort to push the technology further. Thus, this study should aid in pinpointing the most relevant factors of smart city acceptance. Most importantly, this study will help us understand the impact of technology push with regards to smart cities in Kuwait.

Moreover, this research is the first of its kind in the State of Kuwait. Kuwait is the first country where the concept of push is examined between the GCC countries (Malik et al. 2019), where no similar study has been conducted in other GCC countries context. No similar study has been conducted in the past. As Kuwait is a developing country, it is striving to optimise the technological services that it offers to its citizens and also to reduce the cost of services. By adopting smart city technologies, the country can reap the benefits of automating its services and connecting all the ministries and departments of Kuwait. In addition, Kuwait will gain from providing a higher satisfaction level with the public services as the level of dissatisfaction with public services is on the rise. An important point to mention in this research is that smart cities are being enforced as a technology to all citizens and hence are considered compulsory for the citizens of Kuwait (New Kuwait 2019). There will be no option whether to accept or reject living in a smart city as Kuwait plans to transform all its new cities to smart ones. Therefore, the findings from this study will provide the basis for valuable recommendations to policy makers in Kuwait. It will allow the government to also regulate and manage the smart city technologies whilst also developing innovative and problem solving technologies. In addition, this study is expected to form the basis for similar future studies where technology is introduced as a compulsory agent and citizens are forced to use it within smart cities and in other general contexts. Since smart cities are being built, the study will be based on the use of smart meters, which is one of the smart cities' technologies. This will allow the exploration of the conceptual model on a specific domain of smart cities. Furthermore, this research explored the impact of information and service quality on user satisfaction within smart city technologies. Hence, it was anticipated that the research would identify the most important factors that contributed to user satisfaction, net benefits and also the resulting influence they had on user change behaviour when using technologies within a smart city context. No previous study has explored the role of user satisfaction on the user change behaviour of technology within a smart city context, as an outcome of information quality, service quality, performance expectancy and trust in provider. For that reason, the current research attempted to develop a conceptual model of the antecedents of user change behaviour of technology within a smart city context.

## 1.9 STRUCTURE OF THE THESIS

The thesis consists of the following chapters.

Chapter 1 provides an overview of the research, the problem statement, the research aim and objectives, the research questions and the thesis structure. Chapter 2 presents a discussion of the role of technology in smart cities, the various technologies that can be used in smart cities, examples of smart cities throughout the world and the benefits and the challenges presented by smart cities. Information is drawn from various studies regarding these topics and from research, particularly on the matter of smart cities. Chapter 3 provides the Conceptual Framework. In this chapter, the emphasis is on the factors that were used to develop the conceptual framework. Based on the initial review, these factors included information quality, service quality, performance expectancy, trust in provider, user satisfaction with technology, behavioural and attitude change and the net benefits of the smart cities technologies. Chapter 4 is the Methodology chapter. This chapter outlines and discusses the different methods and processes that are adopted in this research in collecting the data. The focus will be largely on the primary data collection and its usage. The chapter provides details of the quantitative research method which has been adopted, the survey, the questionnaire design and source, sample population, data collection, duration of data collection, and data analysis. Attention is paid to the analytical techniques which were employed by using SmartPLS. The statistical findings are explained in terms of understanding the causal relationships of the studied variables. The hypotheses to be tested are also stated. Chapter 5 presents the key findings with reference to the literature and Chapter 6 discusses the implications of these findings, makes recommendations for the implementation of smart cities in Kuwait and suggests lines of inquiry for future studies.

# CHAPTER 2: LITERATURE REVIEW

## 2.1 ADOPTION AND DIFFUSION OF TECHNOLOGY IN SMART CITIES

Before focusing on the concept of satisfaction and the factors affecting the net benefits and change in user behaviour in a technology push scenario, it is important to critically examine definitions of smart cities gleaned from the literature, the notion of a smart city, the challenges and the benefits as well as some of the technologies that could be used to facilitate smart city applications.

### 2.1.1 Definition of smart city

Cities contribute greatly to the development of a country in terms of environment and social aspects (Albino, Berardi, & Dangelico 2015). Cities attract many people who are looking to benefit from the infrastructure services which cannot be delivered in rural areas (Ismagilova et al. 2019). With the increasing number of residents in cities, government officials have started to consider the shift towards transforming the cities into smart cities, in order to manage and mitigate the increasing demand on services (Breetzke & Flowerday 2016). Most definitions of a smart city revolve around Information and Communication Technology (ICT) in association with smart things. ICT uses the internet and WiFi to connect to smart things / devices for users to interact with them. Smart cities can be related to digitisation of the services offered to citizens (Keegan, O'Hare & O'Grady 2012), transforming the cities into intelligent cities (Tan, 1999), also known as information cities (Fietkiewicz et al. 2017). They are also about integrating the assets of the city through various IT solutions to have better management of those assets (Guo, Ma, Li, Zhang and Zhang 2017).

According to Park et al. (2018) a smart city is "*the combination and integration between ICT and urban functions*" (p. 1). In brief, it is an urban environment that utilises networking and communication to enhance its operations, compared with those of a regular city, with the aim of providing its citizens with enhanced Quality of Service (QoS) and Quality of Life (QoL).

Within the concept of a smart city, a number of definitions of 'smart home' also exist. Chief among these are the definitions of Aldrich (2003) and Lutolf (1992) who provide a comprehensive description of a smart home. Aldrich (2003) viewed a smart home in terms of its reliance on information technology and computerisation, which is configured to anticipate and respond to the needs of the family. It does this in such a way that enhances their comfort and security, as well as modes of entertainment by controlling and regulating technology, connecting the home to the outside world. This descriptive definition integrates the technological component of the smart home, various services and operations which meet the various needs of different family members. Similarly, Lutolf (1992) describes a smart home in terms of the integration of all the various services by means of an easy to control common intelligence system of coordination, which is economic, secure and highly practical.

Despite the similarity of both descriptions, they differ in terms of the services they offer to the end user in terms of their technological characteristics. A more recent description of a smart home is provided by BaltaOzkan (2013) who emphasises how sensors and domestic devices are integrated and can be remotely controlled to serve the needs of the occupants of the home. The definition states that the

> *"Smart home is a residence equipped with a high-tech network, linking sensors and domestic devices, appliances, and features that can be remotely monitored, accessed or controlled, and provide services that respond to the needs of its inhabitants".*

Another description of a smart home is provided by De Silva et al. (2012) who, rather than focusing on its technological aspects, emphasises the role of artificial intelligence in anticipating the needs of the home's occupants. The descriptions provided by Balta-Ozkan (2013) and De Silva et al. (2012) are similar in emphasising the use of automated technology in meeting the needs of the residents. The effectiveness of automated technology is also emphasised by Diegel et al. (2005), who comments on four levels of smartness, which are: smart appliances, smart control, smart management and smart sensors. These four levels work together to create a smart home which is characterised by convenience and ease of use.

Another perspective on smart homes is one which is more service or context oriented. Authors such as Kofler et al. (2012) and Scott (2007) focus on the energy efficiency aspect of a smart home. Kofler et al. (2012) stress the importance for a smart home of having a homogenous control mechanism installed which governs all energy consuming devices in an efficient and sustainable manner. Scott (2007) focused on energy consumption, especially home heating by means of smart meters. However, the emphasis is on the comfort of the family members while maintaining efficiency and sustainability.

Yet another perspective on smart homes is to be found in Chan et al. (2008) who stressed the cost effectiveness and healthcare aspects of the home, particularly for elderly people. A number of other authors also stress smart home technology for supporting the quality of life for elderly people who wish to live independently. Smart home technology can support their independence (Alam et al. 2012; Blaschke et al. 2009; Dorsten et al. 2009; Ehrenhard et al. 2014). In particular, assistive technology which can be remotely controlled, greatly supports the independent living of elderly people (Alam et al. 2012).

These descriptions of smart homes have three main features which are the application of technological solutions, provision of services and meeting the needs of home occupants. The technological solutions frequently consist of hardware and software components, which employ sensors and govern and control various home appliances. These sensors consist of electronic devices which can detect various stimuli in the home environment, as well as behavioural changes (Arunvivek et al. 2015; Orwat et al. 2008). The sensors are incorporated into a variety of household appliances, either by means of wireless or wired systems which can track the residents in such activities as sleeping, cooking, watching television, or other household activities (Orwat et al. 2008). The smart home system can control a variety of functions and services to meet the occupants' needs (Chan et al. 2008). These various sensors and controls can support a healthy and independent lifestyle by easing the burden of many household activities (Chan et al. 2009; Amiribesheli et al. 2015). Additionally, the smart home devices enable residents to control their energy consumption but, at the same time, ensure that their comfort and convenience are met (Scott 2007). A smart home can greatly enhance the quality of life for elderly people who prefer to live independently due to its virtual medical assistance module when this is required (Orwat et al. 2008). Thus, a smart home can use artificial intelligence to control all types of devices and appliances which support a range of economic, social, healthcare, security and sustainability benefits for residents.

Silva et al. (2018) also provide a neat definition of a smart city as a

> "*modern city that utilizes ICT and other technologies to improve quality of life (QoL), competitiveness, operational efficacy of urban services, while ensuring the resource availability for present and future generations in terms of social, economic, and environmental aspects*" (p. 697).

Zanella et al. (2013) also emphasises the enhancement of QoL as the goal of developing a smart city, by reducing the gap between demand and supply of services that are required by citizens in the urban area. In other words, it also relates to developing the QoS provided to urban citizens. Technology helps to evaluate the usage of various services and facilitates the authorities in understanding consumption demands and providing improved services at the required time. Ejaz, Naeem, Shahid, Anpalagan and Jo (2017) add that, based on the QoL demands arising from urban citizens, smart cities are able to focus on providing a sustainable environment through efficient solutions to managing energy, transportation, healthcare and governance. These issues are discussed further in the following section.

### 2.1.2 Smart Cities Concepts

Harrison et al. (2010) state that smart cities are founded on three types of concepts: instrumental, interconnected and intelligent. 'Instrumental' relates to real-time data that is data gathered through physical and virtual sensors. This type of data can relate to information gathered from traffic congestion, power consumption, waste management, citizens' homes and several other types of data pertaining to the city. 'Interconnected' refers to integrating the data and communicating it to various services in the city (Nam & Pardo 2011). 'Intelligent' refers to usage of these types of data through various analytical modelling and visualisation, to enable government and related authorities to make timely decisions (Batty et al. 2012). Based on these three concepts, the city can adapt to the behaviour of its inhabitants and, thereby, make optimal use of the physical infrastructure and resources (Harrison et al. 2010). For example, information related to power consumption can indicate periods of peak load and how these need to be controlled. Furthermore, as stated earlier, by installing smart devices at homes, power consumption can be controlled by automatically turning off devices that consume energy when the occupant is not at home (Froehlich et al. 2011).

Another view of smart cities is provided by Trindade et al. (2017) who state that (a) depending on broadband networks and digital devices, smart cities could create a rich environment, and (b) smart cities could have the potential to create applications based on large-scale participatory innovation processes. Nam and Pardo (2011) provide definitions of smart cities by various authors and they also provide a summary of smart city practices in various regions. What is even more interesting is how they divide the smart city into three dimensions. These are: (1) technological, which integrates hardware and software infrastructures; (2) population, which is classified as creativity, diversity or education; and (3) institutions, which focuses on governance and policies.

According to Al-Hader, Rodzi, Sharif and Ahmad (2009), the adoption of new architecture is the key to bringing about the paradigm shift from a host-centric to a content-centric environment. Therefore, it is imperative that smart cities should have a robust IoT based on the latest broadband technology in order to enhance its developments and meet citizens' needs. This research adopts the definition given by Silva et al. (2018), already cited in the previous section, as it aims to understand the initiative of government and perception of the citizens towards smart cities, in achieving better quality of service (QoS) and quality of life (QoL). As discussed in this section, technology, or more specifically, the IoT, is the key to enabling smart cities, and this will be discussed in greater detail in the next section.

The foundation for achieving the QoL and QoS for urban citizens is the digital infrastructure that provides the connectivity to devices based on Internet connectivity. The digital infrastructure connects the urban community and its citizens towards growth, efficiency, productivity and competitiveness. Depending on the extent of the IoT devices that are used in the smart cities, new services and applications can be developed (Yovanof & Hazapis 2009).

### 2.1.3 Types of Smart Home Technology Services

Two principal typologies of smart home technologies are discussed in this section, namely that suggested by De Silva et al. (2012) and the other by Bowes et al. (2012). De Silva et al. (2012) proposed that there were three main kinds of smart homes based on the types of services they offered. The first type of smart home is one which through technology is capable of responding to the identified needs of its inhabitants. This type of smart home is most suitable for elderly persons to assist their independent living, but is also appropriate for others who require health-care or childcare support. The second type of smart home operates by compiling multi-media information in the form of photographs or videos of the inhabitants' lives, an aspect of the smart home which may be controversial in terms of issues of privacy. The third kind of smart home is one based on surveillance for the purpose of alerting its inhabitants to any imminent or pending catastrophe, or natural disaster, as well as detecting suspicious activities such as burglary attempts. However, very few smart home projects of this third kind have been able to successfully protect against every possible type of threat (De Silva et al. 2012). Da Silva's typology could also be broadened to include a fourth type of smart home based on environmental protection by optimising energy usage (Balta-Ozkan et al. 2014; Balta-Ozkan et al. 2013;Chen et al. 2017; Zhou et al. 2014). The literature draws particular attention to this aspect of smart home technology, by which energy usage is efficiently monitored to promote environmental sustainability (Balta-Ozkan et al. 2014; Balta-Ozkan et al. 2013; Bhati et al. 2017; Paetz et al. 2011). The installation of sensors and automatic monitoring systems optimises energy usage automatically without the need for any behavioural changes on the part of the smart home's occupants (Lach et al. 2007).

Drawing on the findings of Doughty et al. (1996) and Brownsell and Bradley (2003), Bowes et al. (2012) recognised four generational stages in smart home technology and telecare developments. The first generation of smart homes involved technologies which did not include the use of artificial intelligence, (AI) but were reliant on responding to the occupants' activities. The second generation of smart homes did include some rudimentary forms of AI-based devices. Sensors were installed which could detect and trigger responses to environmental changes or through body-worn devices to respond to changes in health conditions such as temperature or blood pressure changes. These sensors could also monitor and control household appliances. The third generation involved the closer integration of AI devices, providing interoperability and multi-functionality with voice-activated controls which captured, processed and relayed data through a network of devices. A fourth generation of smart homes is developed in 2020, which would replace many sensors with chips located under occupants' skin. This would be expected to advance remote health monitoring and control, and utilize technologies such as Internet of Things (IoT) and Blockchain (Ko et al. 2020).

It is possible to enhance the services provided by adding additional devices as required. Thus, smart home types can be regarded as lying on a continuum ranging from the traditional home, to the fully smart home. Research into peoples' recurring behaviour patterns in traditional homes has helped to identify those needs which could be met by the types of services which could be developed in smart homes. Such research also revealed commonalities in the needs of occupants which could be met by developing various services provided by smart devices.

Nevertheless, despite the services which smart homes can offer, generally, people have been slow to embrace those services (Chen et al. 2008; Balta-Ozkan et al. 2013; Ehrenhard et al. 2014; Kim & Yeo 2015; Jacobsson et al. 2015). Thus, it is imperative that research should focus on identifying those barriers which impede the adoption of smart homes. In the following sections, current findings are discussed regarding the technological, financial, ethical, legal and psychological issues that frequently present barriers to the adoption of smart homes.

An Example of a smart city in Asia is the one in South Korea. In general, smart cities in South Korea can be categorized into three types:  First-wave smart cities (SC1), which was developed from 2009 to 2013 and smart city projects by LH and local governments, focusing on transportation and security sectors; Second-wave smart cities (SC2), launched for the purpose of providing comprehensive urban management services, including transportation information, facility management, security and disaster prevention, health and welfare, administration, and environment (including ongoing smart city projects (Lim et al. 2019). In Europe, at the end of 2017 there were 22.5 million smart homes in Europe alone, or 9.9% of European households (Sovacool & Del Rio 2020), where a growth rate of 30% is expected by the end of 2020 (Lim et al. 2019). One of the challenges of smart homes is having the proper and suitable infrastructure in place, which requires huge investment that comes at a high price (Moayedi et al. 2020). The European Union (EU) is geared towards establishing regulations for fostering smart homes technology, where it is noticed that much of the smart home revolution is originating from Europe as having the top smart cities in the world such as London, Amsterdam and Helsinki (Floridi 2020). In the context of Arab world, Abu Dhabi, Dubai and Riyadh were ranked as the top three Arab countries that contain advanced smart cities (Brahimi & Bensaid 2019).

**Technological Barriers**

The principal technological barrier to be overcome is called “technology fit” (Balta-Ozkan et al. 2013), which relates to the potential user’s perception of the compatibility, connectedness and reliability of the technological solutions which are being proposed. Thus, compatibility, connectedness and reliability are the three most important factors in determining a potential user’s perception of the usefulness of adopting the smart home technology [Park et al. 2018; Yang et al. 2017). Thus, research into the adoption of smart home technology has tended to focus on those factors which are considered as influencing perceptions of technology.

Yang et al. (2017) have identified technology automation, mobility and interoperability as factors which facilitate the adoption of home technology. However, other researchers have also included perception of usability as an impediment because of its perceptions of the system’s ease of use and reliability. In other words, the perceived level of complexity of the system can be a barrier to its adoption (Balta-Ozkan et al. 2013; Alsulami &Atkins2016). Currently, smart home devices can be complicated and perceived to be difficult to use. Indeed, perceptions of ease of use remain an under-researched dimension of willingness to adopt the technology (Czaja 2016, Diegel2005). The reliability factor concerns perceptions of the constancy of the service, provided by a product over its life-cycle of five to ten years (Balta-Ozkan et al. 2013). Over such a timespan, the customer expects that the system would be constant in meeting their needs (Kim& Shcherbakova 2011). However, there is a confidence gap whereby potential customers are dubious regarding the system’s reliability (Balta-Ozkan et al. 2013). It then remains a matter of considerable importance that marketing of smart homes should address the issue of lack of confidence in the reliability of smart home technological systems.

**Financial, Ethical and Legal Concerns**

Next, it is important to consider financial, ethical and legal barriers to technology adoption. Financial factors include the price of the technology, its installation costs and ongoing repair and maintenance. These can act as barriers to the adoption of smart home technology [Balta-Ozkan et al. 2013; Steele et al. 2009; Chan et al. 2012). Difficulties arise from misunderstandings of how smart homes can save money for customers in the longer term (Balta-Ozkan et al. 2013). Indeed, research has suggested that implementing technology within healthcare can be costly. - This casts doubt on the view that assistive home devices can be cost-effective for hospitals and users alike, by offering virtual therapy rather than necessitating home visits by a professional (Chan et al. 2008). Nevertheless, Wells (2003) has drawn attention to the fact that smart home healthcare technology remains expensive due to the high cost of staff training in the safe and ethical use of such technologies, e.g. e-prescribing and EMR technologies.

Despite the many benefits offered by smart home technology, ethical concerns have been raised about the privacy and security of personal data collected by the system (Chan et al. 2009; Balta-Ozkan et al. 2013, Jacobsson et al. 2016;Friedewald et al. 2005;Kotz et al. 2009). Some countries require the consent of citizens for personal healthcare data to be collected and stored (Sundström et al. 2002), whilst other authors have drawn attention to the reluctance of some citizens to give consent due to their distrust concerning the use and storage of their personal data.(Hanson et al. 2007). Such distrust presents a principal impediment to the acceptance of smart home technology (Jacobsson et al. 2016; Paetz et al. 2012). Privacy of personal data may be unwittingly breached within a fully automated system (Chan et al. 2009; Yang et al. 2017). However, perceptions of the risk of breaches of privacy are varied and some citizens are prepared to adopt the technology with little concern about issues of data security (Lorenzen-Huber et al. 2011), whilst others are more apprehensive regarding disclosure (Balta-Ozkan et al. 2013). However, the development and installation of data safety protocols have helped to allay fears that personal data could be compromised (Chan&Perrig2003).

There are also legal matters which can impede acceptance of technology within healthcare (Chan et al. 2008). New technologies such as e-health and smart homes have not yet been sufficiently governed by laws and legal practice, and there is an urgent need for this gap in legislation to be addressed by governments in order to reassure citizens that the security of their personal data is protected by law (Balta-Ozkan et al. 2014). Policy makers also need to enshrine such privacy law in organisations' policies and procedures in order to avoid the risk of data breaches whether accidental or intentional. This is particularly imperative in the case of smart homes sharing data with healthcare institutions, albeit that this may be in the best interests of the client (Chan et al. 2008).

**Knowledge gap and resistance to change**

There is also an issue concerning citizens' low levels of the perceived usefulness of smart homes. This may be due to a lack of knowledge of an emerging technology which underlies their reluctance or resistance to embracing this new technology, and availing of its benefits (Hu et al. 2003; Balta-Ozkan et al. 2013). This knowledge gap may explain, at least partly, why there is such reluctance and a more widespread implementation of smart homes in mass markets (Balta-Ozkan et al. 2013). One example is the reluctance to accept smart meters for energy consumption and people clinging to the more traditional approaches to energy use (Kim & Shcherbakova 2011). This, combined with dismissive verbal reports from others, can be sufficient to dissuade potential subscribers from taking up the new technology (Yang et al. 2017).

Mani and Chouk (2017) explored the obstacles to smart technology acceptance by building on the earlier theory of innovation resistance presented by Ram and Sheth (1989). Mani and Chouk found that perceived novelty and usefulness adversely affected adoption of the new technology by potential consumers. These conclusions back up the earlier findings of Alam et al. (2011) that product innovation, which was discordant with current lifestyles and would require significant behavioural changes which might not be successful in penetrating new mass markets. Earlier, Fuchsberger (2008) had also found high levels of resistance to new technologies which required significant changes of behaviour. Stringer et al. (2006) recommended that new technologies should find ways of accommodating themselves to existing lifestyles. In other words, resistance to accepting new technology can be countered by designing them to fit more closely with the established behaviour of potential customers (Edwards& Grinter 2001).

### 2.1.4 Smart City Challenges

This section discusses the benefits of smart cities and the challenges facing their implementation. Throughout the world, cities are currently in competition to become noted as providers of resources that improve the quality of life of their citizens (Jung, Lee, Yap & Ineson 2015). The development of smart cities presents many challenges in terms of urban planning, which incorporates the concentrated use of innovative solutions. These innovative solutions are based on information technologies as central to local governments' modernisation and urban retrofit (King & Coterill 2007). In order that such planning is more citizen-oriented, municipal authorities attempt to improve services by making them more personalised and by providing information which improves people’s choices, among other strategies (King & Coterill 2007). The aim is to address the current needs of citizens through the enhancement of infrastructure supporting local services. However, previous research has established that the success of these undertakings is largely contingent on a sufficiently strong uptake of these services in order to ensure that they are efficient and sustainable (e.g. Neirotti, De Marco, Cagliano, Mangano & Scorrano 2014). Yet, these efforts may prove to be ineffective if citizens do not avail of services on a frequent basis (Mulley & Moutou 2015).

Urban planners are confronted by a number of challenges in ensuring that citizens avail of the enhanced services being offered however. For example, citizens may be reluctant to avail of public transport due to their perceptions that it takes up too much time, is inconvenient or even that it is perceived to be unsafe (Tiwari, Cervero & Schipper 2011). Certain development projects may only deliver temporary and fleeting benefits (e.g. the multimodal transport system devised in Sydney for its hosting of the Olympic Games), because residents are reluctant or hesitant about making these services a part of their daily routines (Mulley & Moutou 2015). Additional transport systems serving suburban developments may be underused by citizens who prefer to commute by private transport (Mattingly & Morrissey 2014). Attempts to improve outdated infrastructures and archaic information systems may fail due to the poor perception that citizens already have, which complicate the implementation of citizen-oriented smart plans (Angelidou 2014).

Consequently, municipal authorities endeavour to devise methods which motivate citizens to make regular use of urban services (Mulley & Moutou 2015). One way is to adopt a relationship marketing approach, whereby city managers work towards greater and lasting collaboration with citizens (Belanche, Casaló & Flavián 2012). This leads to the concept of attachment as a critical relational variable, whereby citizens work cooperatively to support environmental and community building programmes (Zenker & Rutter 2014).

Nevertheless, it is worth noting that many cities have already attempted to incorporate technology (Kyriazopoulou 2015). Indeed, the adoption of technology to develop smart cities has become even more urgent over recent decades. Thus, many cities throughout the world are being transformed into ‘smart cities’, by incorporating assistive technology as one of the principal drivers (Kumar et al. 2020). However, the use of data is another important element in this transformation, as it can assist in identifying the real needs of citizens in order to find smart solutions. Collection and analysis of data can lead to intuitive designs which can result in new solutions that are based on modified human behaviour; that is a characteristic of smart city acceptance by citizens.  The final mainstay of smart cities is smart people with an emphasis on the quest for talented citizens who are crucial for fostering sustainable economic growth (Schaffers et al. 2012).

The main challenge confronting the adoption of the smart cities concept is realising the value and potential (Talari et al. 2017) of the new systems incorporated into the city. Many people fail to realise the value because they are more focused on the cost of building a smart city. The notion that a smart city only brings about services (Ismagilova et al. 2019) that the citizens can get elsewhere is prevalent. In addition, it is a challenge to make people ready for the new technological breakthrough and the solutions that the smart city provides. The concept of trust is very vital in the context of smart cities, as the entire network and connected devices and services is dependent on the efficient use of the system as well as the security of the data being transmitted. The data that is being shared on the network or through the connected devices are a means of communication with the citizens and the officials. Data that relies on GPS tracking or on exploring the habits individuals in order to increase the efficiency of the services opens the door for security and privacy concerns (Abosaq 2019; Elmaghraby and Losavio 2014). The structure of the smart cities might help in the exposure of some personal data or at least the perceptions of citizens of being exposed (Cho 2012). Also, the development of smart cities can reinforce the social inequality feelings and the convections of some of social bias instead of strengthening the ties between the community members (Datta 2015). Despite the fact that smart cities can achieve a huge success in the future by the proper and seamless integration between material and digital world (Nam and Pardo 2011), there will be people that will feel left out who do not wish to engage in smart cities and do not trust it (Joss 2018). There is also a risk that smart cities can create classes of people and segregation between those that are for the technology and those that are less educations thus risk disfranchising the entire society (Gil-Garcia 2012; Kitchin 2018). People are reluctant to embrace a smart city and to accept the idea of living in such a city (Björck & Österlin 2018). Opponents of smart cities claim that their development is a way to control people, accumulate more information (Van Zoonen 2016) about them and to even spy on them. Supporters of smart cities, on the other hand, see them as the key to unleashing potential in humans by allowing them to free their time and use their energy and capabilities in a more productive manner. Thus, an issue of trust is one of the challenges confronting the wider acceptance of smart cities.

The vast development in sensor and wireless technologies have accelerated the deployment of IoT based solutions in the context of smart cities (Rathore et al. 2016). Running smart cities is conditional on the integration and interaction between various devices and technologies like sensors, IoT, Big Data and Machine Learning. However, these technologies push the security threats to a higher level. One of the major technical risks is the vulnerability of citizens' information since it requires the transmission of data from one place to another (Baig et al. 2017). Smart cities networks need to acknowledge the security risks from the interaction between the various sets of devices, sensors and systems (Silva et al. 2018). The disparate nature of information since it comes from multiple sources requires a rigorous security systems in place (Barnaghi et al. 2015; Nam and Pardo 2011). Citizens are moving in smart cities and data are being collected on a continuous manner. Systems that protect privacy of information is important since it helps in building the trust of citizens in the technologies and the systems (Elmaghraby and Losavio 2014). People are inclined to have distrust issues when there are no solid confirmation of assurance from the government about the security and privacy of information (Oliveira and Campolargo 2015), which puts an added pressure on accepting and using smart cities.

### 2.1.5 Smart City Benefits

Providing better services to its citizens is one of the goals of the development of smart cities (Ismagilova et al. 2019). Examples of smart city services include the management of traffic (Albino et al. 2015), waste processing and management (Frost & Sullivan 2013), energy consumption and analysis (ietkiewicz et al. 2017), and many others (Benevolo, Dameri & D'Auria 2016). Albino et al. (2015) states that one of the prime objectives of developing smart cities is the provision of better QoS by the responsible agencies and authorities. However, QoS might be a prime objective, but there is also the quality of life (Ismagilova et al. 2019), as well as the better management of resources (Björck & Österlin 2018).

Smart cities refer to 'smart' and 'intelligent' solutions and technologies (Tan 1999), however smart cities need to be founded on the adoption of certain smart parameters (Frost & Sullivan 2013), as well as having smart and intelligent solutions (Samouylov et al. 2019) that can satisfy the needs of people. These are discussed in this section. A smart city may not adopt all of these parameters, but many of them have to be adopted and incorporated for the city to be classified as smart (Fietkiewicz et al. 2017). There are eight smart parameters.

The first parameter of smart cities is Smart Governance and Smart Education (Chourabi et al. 2012), which includes digital services that are built on policies which promote the adoption of intelligent and eco-friendly solutions by offering incentives or subsidies. The second is the enhancement of healthcare as the services become smart. This refers to the use of eHealth and mHealth systems (Solanas et al. 2014). - These are systems that are connected to medical services through which the health and well-being of citizens can be promoted and monitored with an emphasis on prevention through early diagnosis rather than treatment (Li et al. 2017). Thirdly, smart buildings represent a significant future direction for most developed countries. Smart buildings imply constructions that they are energy efficient, eco-friendly and intelligent through incorporating advanced automated infrastructure in their planning and design (Zanella, Bui, Castellani, Vangelista & Zorzi 2013). Energy consumption can be optimised by computerised controls for lighting, heating and security with only minimal human intervention (Ismagilova et al. 2019).

Fourthly, the parameter of smart mobility signifies intelligent means of travel and commuting through solutions based on the use of innovative technologies, such as the adoption of low emission vehicles and integrated multimodal transport systems (Benevolo, Dameri & D'Auria 2016). However, this implies the development of smart infrastructure, a fifth parameter, which is related to smart mobility by incorporating intelligent travel networks (Lee, Hancock & Hu 2014). But smart infrastructure also comprises intelligent energy supply and telecommunications as well as smart water and waste management systems.  A sixth parameter is the adaptation of smart technology in order to connect  home, office, car and mobile devices by means of a single wireless IT platform (Harshini & Sreeha 2017). This would necessitate the integration and coordination of a smart grid system, smart home solutions and a high-speed broadband connection which represents another parameter.

Smart applications are also appropriate for energy conservation by installing an advanced meter infrastructure (AMI) (Ismagilova et al., 2019), better distribution grid management and high-voltage transmission systems (Frost & Sullivan 2013), as well as for a demand-led response for the intelligent and efficient distribution of power (Kyriazis et al. 2013). The final parameter is the development of smart citizens who are conscious of the need for green and sustainable practices in everyday life (Frost & Sullivan 2013) and who choose smart products and make healthy lifestyle choices (Cook et al. 2018).

These eight parameters were found by some scholars (Zanella, Bui, Castellani, Vangelista & Zorzi 2013; Benevolo, Dameri & D'Auria 2016; Chourabi et al. 2012; Harshini & Sreeha 2017; Lee, Hancock & Hu 2014; Solanas et al. 2014) to be the most important is smart cities. However, there was a debate in the literature on whether these parameters are the only ones that matter for smart cities. For example, there is also the efficient use of resources (Khansari et al. 2014), which was deemed for some countries such as the UK or Netherlands as crucial to the transformation of smart cities. Nevertheless, smart cities can offer a lot of benefits to individuals, as well as the government (Wang et al. 2019) in terms of the savings in time and effort.

The need for smart cities varies from country to country. Ismagilova (2019)) provides an overview of the smart city goals that can drive the building of smart cities to achieve the desired objectives. There are 11 objectives based on economic, quality of life and ecological perspectives. These are: (1) smart mobility; (2) smart safety; (3) smart energy, water and waste; (4) smart buildings and living; (5) smart health; (6) smart education; (7) smart finance; (8) smart tourism and leisure; (9) smart retail and logistics; (10) smart manufacturing and construction; and (11) smart government.

Frequently in the literature, the adjudged advantages to be acquired from smart homes are viewed in terms of both instantaneous and more enduring, subsequent benefits. Examples of these immediate and more enduring benefits are to be found in authors such as Kun (2001) and Peek et al. (2014). A number of exploratory studies of these felt advantages of smart homes have focused on identifying the driving factors underlying the adoption of the smart home technology (e.g. Kim & Shin 2015; Paetz et al. 2012). However, distinguishing between perceptions of immediate and more long-term advantages is often difficult (Masera et al. 2018) due to the similarities and dissimilarities between both. Nevertheless, investigating both perspectives is important in order to clearly identify the determinants of acceptance within the market. It is useful to explore these factors within four main categories of benefits: health-related, environmental, financial and the psychological benefits. These are examined in turn in the following sub-sections.

**Health Related Benefits**

One perceived advantage of smart home technology is the services it can deliver to the elderly and people suffering from chronic illnesses (Chan et al. 2008; Demiris et al. 2008; Courtney et al. 2008). Technology can be observed as offering improved monitoring (Chan et al. 2009), consultancy and efficiency in delivering treatment (Czaja 2016) which benefits recipients by enhancing their access (Finkelstein et al. 2004) to a high quality of healthcare. However, there is another benefit of smart homes in healthcare which is its vigilance function for detecting and diagnosing ill-health conditions (Czaja 2016). In particular, the technology is capable of assessing the mental state of older citizens (Javadzadeh & Rahmani 2020) and can respond appropriately to sudden or unexpected changes in behaviour. This enables remote health monitoring and facilitates early diagnosis (Solanas et al. 2014) and, if necessary, early intervention and medical care (Chan et al. 2009; Finkelstein et al. 2004). As postulated by Cavicchi & Vagnoni (2017), monitoring includes the integration of ehealth records, remote management and electronic e-prescriptions in order to update the data and health records with a high degree of accuracy. Another healthcare advantage of the smart home is its consultancy function by which virtual visits (Pramanik et al. 2017) can be made by offering therapeutic aid and virtual social stimulation for the elderly (Finch et al. 2008).

However, for all its benefits and efficiencies, such an approach to healthcare is not always welcomed (Javadzadeh & Rahmani 2020) and can appear to depersonalise the elderly person. This may result in their reluctance to adopt this technological solution (Rahimpour et al. 2008) to their healthcare. Marikyan et al. (2019) found that some elderly people tended to be dubious about the claims made for smart home technology. The contrary findings of Marikyan et al. (2019) however, must be understood in terms of the geographical context (Matlabi et al. 2012) of the study, within which the participants might have had low levels of technology awareness.

**Environmental Benefits**

An outstanding environmental advantage of smart homes is their energy efficiency. This is particularly important in the face of the challenges presented by global warming and oil price fluctuations (Balta-Ozkan et al. 2014). Innovative technologies based on energy efficient devices enable the optimisation of energy usage, as well as the minimisation of wastage (Chen et al. 2017; Kyriakopoulos & Arabatzis 2016). In particular, four different technological applications have been found useful for enhanced energy efficiency. These were: 1) monitoring devices collecting information on energy consumption (El-Hawary 2014), 2) remote devices for directly controlling consumption patterns (Balta-Ozkan et al. 2014), 3) management devices which enable the optimisation of energy consumption (Kyriakopoulos & Arabatzis 2016) and 4) a consultancy module (El-Hawary 2014). Applied across the nation, smart home technology can minimise carbon emissions (Aye & Fujiwara 2014) and prepare for a more eco-friendly alternative to conventional means of energy production (Fadeyi et al. 2020). Therefore, various environment energy sources such as wind, solar, biomass and geothermal energy can be used as a sustainable source of energy (Mohanty et al. 2016), which can help in the conservation of resources in the near future (Zhou et al. 2016).

Nevertheless, some studies focused more on individual perceptions of the benefits of energy efficiency rather than the wider benefits of a more sustainable natural environment (Balta-Ozkan et al. 2013). A comparative study aiming at understanding differences of perspectives of rural and urban citizens was conducted by Aye & Fujiwara (2014). An interesting finding of this study was that rural citizens were more conscious of the need to protect the natural environment than urban dwellers. This result is at least partly explained by the stronger role of economic benefit in the perspectives of urban citizens, which outweighs environmental concerns. Other differentiating factors included the housing type, the availability of services and social contact (Kyriakopoulos & Arabatzis 2016).

**Financial Benefits**

Both the health related benefits and the environmental sustainability also have implications for financial savings. Even though the shift to greater energy efficiency (Balta-Ozkan et al. 2013) has longer term implications for the sustainability of the natural environment, it is the more immediate financial efficiency of the smart home (Paetz et al. 2012) which impacts on significantly on many citizens of a smart city. Smart meters can raise awareness of the financial savings (Jiménez-Bravo et al. 2019) which can be derived through monitoring energy usage (Rey-Moreno & Medina-Molina 2020) as the result of the installation of smart meters. Secondly, smart meters also make it possible to compare between various suppliers and their tariffs (Darby & McKenna2012), which can assist consumers in managing their consumption levels. In fact, some studies (Li et al. 2019; Bennett et al. 2017) have made perceptions of financial efficiency as the principal motivational factor to be investigated. They also considered this factor to be most influential in consumers' willingness to adopt the smart technology, even though consumer studies have not definitively concluded that this is the case. For example, due to perceived maintenance costs and relatively low savings (Chen et al. 2016), users do not find financial benefits a reason for adoption. Balta-Ozkan et al. (2013), for example, has found that many potential smart technology perceive energy savings to be low and mostly outweighed by expensive installation and maintenance costs. Perceived savings by smart home adoption are not sufficiently motivating enough (Paetz et al. 2011) to be considered as a principal driver, and expected financial savings are mostly perceived as a rather poor return on investment (Angelidou 2014). Two other aspects of perceptions of expected financial savings may also be important; one of these is the geographical location of citizens (Balta-Ozkan et al. 2014) and the second, their socio-economic status (Park et al.

2017) may affect their perceptions of expected financial benefits of smart home adoption.

In comparison with other perceived benefits, the financial factor could have either a principal or a secondary influence (Steele et al. 2009) on adoption intention. In some cases, convenience and compatibility may exert more influence than expectations (Balta-Ozkan et al. 2013) of any financial benefit. One example is the issue of connectivity with other components in the household, and the reliability of those connections to enhance consumers' satisfaction (Park et al. 2017). However, financial benefits can be perceived as being related to health-related benefits, whereby smart homecare can be economically beneficial (Ehrenhard et al. 2014). Nevertheless, perceptions of the cost effectiveness of smart healthcare over the more conventional methods of healthcare may not be so clear cut, (Solanas et al. 2014) and could vary depending on the particular medical needs of individual persons (Kun 2001).

**Psychological wellbeing and Social Inclusion**

Smart homes can help people to overcome their sense of isolation by means of social stimulation (Chan et al. 2008; Percival & Hanson 2006). Although this can be done virtually, it can, nevertheless, be stimulating in providing support (Chan et al. 2008). Smart home technology can support people in their daily activities in ways which improve their self-esteem, their sense of personal efficacy and autonomy leading to enhancing their self-image. Self-perception is defined as a psychosocial impact (Van der Geld et al. 2007), and refers to a person's assessment of their own position in life with respect to their context, culture and values, and also relative to their expectations (Brandt et al. 2011). However, not many studies on perceived benefits support this position. For example, some people may be reluctant to adopt assistive technology (Carroll et al. 2017) due to their feelings and perceptions of being stigmatised (Marikyan et al. 2019) and labelled as being disabled or vulnerable. Demiris et al. (2004) argued that the greatest objection to the supposed psychological benefits of the smart home is that, far from enhancing socialisation, it may result in less person-to-person contact and add to feelings of isolation. The disadvantage of a tendency towards self-isolation as a consequence of greater reliance on technological solutions, especially for the elderly, has also been noted by Kim et al. (2013); who considered the psychological benefits and disadvantages of the smart home as a coin which had two sides.

## 2.2 THE ROLE OF TECHNOLOGY IN THE DEVELOPMENT OF SMART CITIES

The aim of governments around the world is to improve the quality of life and services for their citizens (Albino et al. 2015). This can be done in many ways but mainly by seeking all methods and means to make citizens more comfortable. Enhancing the quality of life is also linked to improving the quality of services (Yovanof & Hazapis 2009). Essentially, it is this that lies at the heart of governments' moves towards implementing smart cities.

Axelsson & Granath (2018) consider that a smart city is one which invests in its human and social capital and in the development of modern ICT infrastructure which leads to economic growth and the enhancement of the quality of life of its citizens. While some scholars have considered quality of life as a significant dimension of a smart city (Yan et al. 2018; Clever et al. 2018), others have included quality of life along with sustainability as outcomes of smart cities (Baudier et al. 2018; Sunny et al. 2019).

The past few decades have witnessed an increase in the migration of people from rural to urban areas. This movement of individuals is expected to grow at a rate of 60 million per year (International Telecommunication Union 2019). As the lives of people are evolving, so are their needs. With the increased populations of urban cities, there is a need to develop and improve the services being offered (Ismagilova et al. 2019).

Emerging smart technologies can assist in raising the level of efficiency and effectiveness of the offered services (Wang, So& Sparks, 2017). Smart technology innovations are becoming the driving factor of business and personal lives of individuals (Marinova et al. 2017). Smart technology operated by humans can produce outstanding results and systems can evolve to become even smarter (Caputo, Scuotto, Carayannis & Cillo 2018).

In the early days of automated services, people tended to be sceptical about the new technology and the benefits it offered (Anadon et al. 2016). Prior to adopting new technology, it is expected that some people have concerns and are cautious about its use (Kim 2018). Individuals need to be ready to use and accept the technology. Technology readiness, therefore, is the willingness of people to adopt and use new technology to achieve their objectives (Wang et al. 2017). Technology readiness consists of positive (Optimism and Innovation) and negative (Discomfort and Insecurity) dimensions (Wang et al. 2017). Readiness to embrace the technology contributes to the actual adoption of smart cities (Marinova et al. 2017).

The smart city concept originated in response to the need for a comprehensive term to embrace the various aspects of the urban technological evolution. The concept of smart cities was developed by scholars in the late 1990s. They proposed ideas and perceptive embracing aspects of the use of ICT for various functions in urban life and meeting the needs of local citizens. The passion to create smart cities has been fuelled by the drive to invest and support smart city initiatives (Akande et al. 2018). According to Serbanica and Constantin (2017), this is demonstrated by the support and funding of Research and Development (R&D). One of the main initiatives for progressing towards the transformation to a smart city is that of potential economic growth (Martin et al. 2018). The reasons for moving towards smart cities may include the digitisation of the infrastructure, the development of a smart electricity grid and the enhancement of the water system (McLean, Bulkeley & Crang 2016; deWijs, Witte & Geertman 2016; Lee et al. 2014).

## 2.3 ENABLING TECHNOLOGIES IN SMART CITIES

Technology adoption for providing a more efficient and effective lifestyle is not a new concept. Technology has been intertwined with daily processes in order to automate and facilitate services. With the slow movement of the world towards Industry 4.0, it has been notices that a lot of technologies are being employed to arrive at a smart and sustainable lifestyle. Smart cities is the blueprint of this direction towards employing technology for smart lifestyle. Today's interventions has facilitated the way to make smart cities a reality. A smart city is mainly seen as a network of connected devices and entities. Providing and securing connectivity for all component of smart cities is an important consideration. The use of cloud/edge computing can help in securing the seamless connected network which can be always on (Ahad & Biswas 2019; Ahad, Tripathi, Zafar, & Doja 2020). Also, Big Data management can take care of data processing and analysis through software such as Hadoop, Cassandra, Quantcast etc (Ahad & Biswas 2019). Devices are connected in smart cities using sensors which allows for the integration of physical devices and the services in one network. There are a number of technologies that can be used in smart cities, which are discussed next.

### 2.3.1 Blockchain technology and smart cities

Information technology (IT) is developing at a fast rate and there are many technologies that have received much interest. An example of one of the most disruptive technologies is blockchain (Huckle, Bhattacharya, White & Beloff 2016). Blockchain was first devised as a technology that dealt with financial transactions involving cryptocurrency. It is a secure method of transmitting data or information in a speedy and safe manner. The added security of the blockchain system makes it an optimal choice for entities seeking to secure data. Blockchain technology is utilised in various smart cities around the world as the data transmitted can be sensitive and confidential (Biswas & Muthukkumarasamy 2016). It is important, therefore, to run smart cities using this technology because of the increased security that blockchain technology provides (Sharma et al. 2017).

Blockchain is one of the technologies that has caught the attention of practitioners and academics all over the globe. Seebacher & Schuitz (2017) define blockchain as

> *"A distributed database, which is shared among and agreed upon a peer-to-peer network. It consists of a linked sequence of blocks, holding time-stamped transactions that are secured by public-key cryptography and verified by the network community. Once an element is appended to the blockchain, it cannot be altered, turning a blockchain into an immutable record of past activity" (p. 4).*

Blockchain technology is characterised by a high security level of data, which makes it virtually impossible to intercept. It decrypts data in blocks that form chains using unique codes. This feature makes blockchain technology very appealing for smart cities to use through the development of shared services that can be beneficial to all

(Sun, Yan & Zhang 2016). Moreover, blockchain technology enables the utilisation of the same platforms for various services as the data is encrypted in a similar manner (Biswas & Muthukkumarasamy 2016), thus, resulting in huge savings in cost and resources to deliver high quality services to the public (Alford & O'Flynn 2009). The key issue here is the ability to share services and resources in a secure and trusted manner, which paves the way for a new technology called "Internet of Things" (IoT).

### *2.3.2* **Cloud/edge computing**

The cloud computing technology was a breakthrough in many industries and helped in the acceleration of technology use since it provides cost efficient and faster solutions with respect to operating platforms, software, infrastructures. There is virtually no investment at all in terms of the infrastructure and physical equipment which are made available through a cyber network from providers such as Amazon, Microsoft and Google etc (Armbrust et al., 2010; Mell & Grance, 2011). Edge computing is useful because it can provide users with the ability to conduct quick calculations on network edge without having to upload the data on the could for processing (Hu, Patel, Sabella, Sprecher, & Young, 2015; Mao, You, Zhang, Huang, & Letaief, 2017), which will increase the response time of the systems. Using cloud/edge computing for smart cities allows for the speed of doing the calculations and the talk between the devices, which could enhance the response time and increase the satisfaction level (Vimal et al. 2020).

### *2.3.3* **Big data**

Smart cities requires processing huge amount of data in order to keep its efficiency level high. Here comes the role of Big Data, which provides the ability to process the data in real time and provide useful information (Osman 2019). The power of Big Data lies in the analytical capabilities, which would harvest the huge amount of data in providing quick responses to help maintain the systems at all times. Since there are huge number of devices connected in smart cities, each device sends a considerable amount of data. Big Data helps in putting these data together and preparing them for analysis and conducted fast analytical tasks, which will aid in the maintenance and sustainability of the smart cities (Ahad & Biswas 2019; Ahad et al. 2020; Labrinidis & Jagadish 2012; McAfee, Brynjolfsson, Davenport, Patil, & Barton 2012).

### *2.3.4* Geospatial technology

Geospatial technology is one of the most important technologies that are taking a bigger role in this new era. A key advantage of geospatial technology is that it helps in the urban planning of smart cities. One of the most important and major impediments to smart cities development is the ability to gather accurate locations for all the entities in smart cities, which can be of huge value in decision making (Li et al. 2020). There are a number of technologies such as LiDAR and remote sensing, internet mapping, GPS and GIS that can take an active role in the planning and development of smart transportation, parking and other related services, as well as the management of all the facilities in the smart city (Elayyan 2021). Geospatial technologies helps in the planning of the required infrastructure for smart cities through developing the most appropriate and suitable communication layout between all the processes, devices and entities in the smart city (for example, healthcare, transportation, waste management, tracking services and navigation (Al-Hader, Rodzi, Sharif, & Ahmad, 2009; Li et al., 2009).

### 2.3.5 IoT technology and smart cities

IoT basically allows for the integration of various technologies and devices to ‘talk to each other’ and share information (Da et al. 2014). The significance of the development of IoT devices principally lies in its application to the construction of smart cities, because IoT is the entity which makes cities smart (AlEnezi & Manuel 2017). IoT is able to link all the applications and services in a smart city in a seamless manner, which gives this technology power of the future (Gubbi, Buyya, Marusic & Palaniswami 2013). Smart cities are the backbone of the government and IoT is the backbone of the smart city. This assertion is evidenced by the relationship, which exists between IoT, smart cities and the government. Evidence from Gartner research on the forecasts for IoT developments estimated that there would be around 3.3 billion connected things which would be used in smart cities by 2018 (Georgakopoulos & Jayaraman 2016). From an overall perspective of connected things, the figures are expected to rise to 20.4 billion in the next ten years (AlEnezi & Manuel 2017). This implies that IoT is advantageous in the sense that it provides the key to a super network of connected devices that are capable of communicating with each other in the future (Centenaro, Vangelista, Zanella & Zorzi 2016).

IoT refers to the use of technology for accessing various devices through internet connectivity. In brief, devices have to be technology-enabled and this is controlled and monitored through the internet. There is ample evidence that smart cities have played an important role in bringing about urban development and sustainability through the use of IoT. For example, Piro, Cianci, Grieco, Boggia and Camarda (2014) state that IoT has enabled the development of smart cities and has brought about urban sustainability. The study by Atzori, Iera and Morabito (2010) focuses on a survey of IoT. A similar study was carried out by Alaba, Othman, Hashem and Alotaibi (2017). The study by Atzori et al. (2010) was conducted at the early stages of the development of this technology; the authors talked about wireless and wired communication solutions with the next generation of the internet as the key to the development and control of smart objects. Atzori and Colleagues study is being confined to the earlier stages of the development and focuses on providing a general view of IoT.

IOT helps in delivering the services offered by Smart Cities. In the early stages of smart cities' life, the dependence of IOT had not yet been significantly developed (Stankovic 2014). As time progressed and IOT became more widely adopted as a solution, so did the services that it offered to smart cities. IoT brings about different devices and connects them together, allowing them to share information and to process data at a faster speed. The early usage of IoT in smart cities was very humble and did not live up to current expectations (Townsend 2013). This is mainly because the IoT was still being developed and because the number of devices that could be connected together was still fairly small. As the technology progressed and the ability to connect more devices in IoT increased, smart cities started to evolve and prosper.

The development of a smart city begins with infrastructure that consists of various technologies and sensors, and the environment that supports this infrastructure in the urban areas. Among these, to achieve the success of the smart city, the IoT is considered to be the most important (Jing et al. 2014). According to Aidasani, Bhadkamkar and Ashyap (2017), IoT is the kernel of smart cities. This means that IoT is at the heart of smart cities and is indispensable. Based on a very simple perspective, IoT is the "*interconnectivity of smart objects in order to automate the ordinary tasks of humans*" (Aidasani et al. 2017; p. 8). In another definition by Park, del Pobil and Kwon (2018), IoT is described as "*a set of technologies for accessing the data collected by* *various devices through wireless and wired Internet networks*" (p. 1). These different perspectives on IoT definitions share a common focus on the capacity of IoT to provide valuable information based on smart devices using wireless technology, with the Internet as the gateway.

The IoT is a recent technological paradigm that has caught the attention of individuals, agencies, businesses, and governments. The paradigm includes the development and equipping of objects that are used every day with communication technology which can be controlled by users through the Internet. The internet can also permeate certain boundaries, such as the geographical limitations within most wireless technology. Therefore, the Internet becomes the integral part and becomes even more pervasive and universal (Zanella et al. 2013).

Users can gather a large amount of data based on the IoT devices. For example, the data gathered from home appliances, monitoring sensors and surveillance cameras, smart vehicles, and several other devices that are driven by technology can help users analyse the data to provide better services to citizens, companies and government administration authorities (Zanella et al. 2013). Table 1 compares information on IoT devices connected worldwide in 2019 with those connected in 2020. Based on the information provided, there was a total of over 5.1 billion devices in 2019 in various areas; that number was expected to increase to over 5.8 billion in the following year.

Table 1: Number of IoT devices connected worldwide in 2019 and 2020, by type (in billions)

| **IoT Devices** | **2019** | **2020** |
|---|---|---|
| Connected & smart home | 2765.8 | 3543.1 |
| Smart cities | 501 | 529.6 |
| Personal IoT | 598.3 | 623.7 |
| Industrial IoT | 937.2385 | 869.1474 |
| Medical IoT | 199.4 | 209.5 |
| Connected car | 98.4 | 123.7 |
| **Total** | 5100.139 | 5898.747 |

Source: statista.com (2021)

Of these, the biggest contribution to the increase in 2018 comes from smart homes that use different types of IoT connected devices. Here, the number has grown from 2.7 billion in 2019 to 3.5 billion in 2020 (statista.com 2021). Thus, there is considerable growth in this area. The need for connecting to devices that are being used on a daily basis is growing. Simple examples of these are the Bluetooth connectivity that is used to connect headsets and smartwatches. In addition to these, TVs and music devices are also being connected through either Bluetooth or WiFi connectivity making controlling between the devices easier (statista.com 2021). Examples of other home products are fridges, washing machines and air purifiers. Sloo et al. (2018) argued that companies such as Nest provide products such as thermostats and security monitoring devices, including cameras, locks, doorbells, alarm systems and smoke detection systems (Scalisi et al. 2015). - These products can be connected to the homeowners' smartphones through the internet; thereby the user can be alerted to receive real-time updates. Examples of the companies include Google, Yale smart door locks, LIFX & Philips smart lights, Fitbit (wearable devices), MyQ (smart garage). Additionally, several other smart devices can be connected to Nest (Sivaraman et al. 2015). These companies and others are utilising wireless technology and the Internet to keep users connected on a real-time basis.

The growth of IoT has had an impact in several areas, but the focus of this research is on the application and perspective of IoT in the development of smart cities; which has also been discussed throughout this document. Baudier et al. (2018) provides a list of the building components of IoT in smart cities. Information on the usage of IoT and connected devices and applications are managed and processed to provide better handling of day-to-day operations. Smart cities utilise ICT and related technologies to improve the performance efficiency of tasks that are conducted in conventional cities to improve the QoL and QoS of urban citizens (Macke, Casagrande, Sarate & Silva 2018).

## 2.4 EXAMPLES OF SERVICES FACILITATED THROUGH IOT IN A SMART CITY CONTEXT

IoT can play a significant role in the development of a smart city. IoT has prompted the invention of numerous new applications which can process large volumes of data extracted from diverse sources including individuals as well as private and public organisations (Ahmed & Rani, 2018). These applications include the smart home, smart energy management and smart grids, smart environment, smart traffic control and smart farming (Goulden et al. 2014; Wolsink 2012). The mix of various devices reveals that there are many potential solutions for each of these challenging domains.

However, not all proposed solutions using IoT are efficient in practice (Lilis, Conus, Asadi & Kayal 2017).The goal is that practical utilisations of IoT should make the Internet more embedded in solutions. These solutions attempt to integrate devices such as security cameras, vehicles, domestic devices and actuators. Nevertheless, among all these applications, the smart city concept remains the most interesting concept (Macke et al. 2018).

### 2.4.1 The use of technology in smart meters

The smart meter relies on an advanced technological solution to the problem of the efficient use of energy by means of a meter (Zhou & Brown 2017) that measures each consumer's energy consumption and transmits this information to the computer database of the utility company. This is a very remarkable development when compared with conventional energy meters, as smart meters can monitor the consumption of energy in real-time within a home or office; it also includes the values of voltage, phase angle and the frequency. However, the most noteworthy innovative feature of the smart meter is its capacity for bidirectional communication of data (Coelho, Gomes & Moreira, 2019), which permits the assemblage of data relating to the energy that is fed back to the power grid from customers' premises (Depuru et al. 2011).

Smart meters have the capacity to optimise energy usage for lighting, heating, air conditioning and other appliances through computerised programming (López et al. 2019). Furthermore, smart meters can assist utility companies in detecting fraudulent energy consumption and theft and thereby improve distribution efficiency (Molina-Solana, Ros, Ruiz, Gómez-Romero & Martín-Bautista 2017). The programming of smart meters ensures that consumers are only billed for actual energy consumed from the utility grid and not for power generated from solar panels or storage devices (Van Aubel & Poll 2019).These meters can also be programmed to set a maximum limit to the amount of energy consumption and even terminate or re-connect supplies remotely (Vojdani 2008; Hart 2008).

#### 2.4.1.1 Electricity Consumption

Although still hotly debated, there is growing evidence that there is a strong correlation between the consumption of fossil fuels, and the dramatic, and often adverse changes to the climate (Pittock 2017). In 2015, it is estimated that globally 13.6 GT of oil equivalent (GTOE) was produced and an alarmingly high proportion of this energy (82%) was generated from fossil fuels (Ali & Alsabbagh 2018). This level of energy consumption in 2015 represents a 55% increase over the previous 25 years, but without any significant change in the percentage of this energy being generated from fossil fuels. In the Gulf Cooperation Council (GCC) countries, there is a particularly heavy reliance on fossil fuels. This can be explained, at least partially, by the fact that 23% of global oil and 11% of global natural gas is produced in GCC countries, which account for 39% and 21% of world known oil and natural gas reserves respectively (Kubursi 2015).The principal source of electricity in the GCC countries is fossil fuels with only 0.1% being produced from renewable sources (Ali & Alsabbagh 2018). Per capita consumption of electricity in the GCC countries is comparatively high, ranging from 6.6 MWh in Oman to 20.2 MWh in Bahrain in 2015 (ibid.). Easy availability of energy generated from fossil fuels accounts for the relatively high per capita carbon footprints of the GCC countries, five of which are ranked among the top ten countries in the world in terms of carbon emissions per capita (ibid.).

However, a solution based on home automation can result in greater efficiency in energy consumption. Most significantly, the IoT has the potential to provide intelligence and analytics which are contextual and in real time in order to address the need for greater energy efficiency and conservation at local level (Liao & Chen 2017). Furthermore, the development of smart, energy-efficient and green homes is expected to lead to the development of “liveable” interconnected communities through the implementation of green city architecture in the future (Mendes, Godina, Rodrigues, Matias & Catalão 2015). Hence, improved energy efficiency in smart homes is a key imperative in the design and building of smart cities (Ejaz et al. 2017). Efficient energy consumption consists of demand side management (DSM), peak load reduction and reduction of carbon emissions (Hsu et al. 2017), which is important for industrialised countries which rely on significant supplies of electrical energy.

#### 2.4.1.2 Heating, Ventilation, and Air Conditioning (HVAC)

From the late 1940s, air-conditioning systems have become common features of house construction which prompted Dick Hughes, an American builder, to remark that including air-conditioning in home building designs had become as ordinary as an electric plug for a refrigerator (Troy, 2012). The author pointed out that the global demand for the air conditioning of homes and buildings had become a billion-dollar industry and that, in particular, the Asia Pacific region had become the fastest growing and most significant market for air conditioning. The Japan Refrigeration and Air Conditioning Industry Association (JRAIA) published a report that shows the amount of energy consumption by air conditioners across the world. From this report, the statistics for GCC states are extracted and provided in Table 2.

Table 2: Overall AC Demand

| GCC States | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
|---|---|---|---|---|---|---|
| Saudi Arabia | 1666 (60%) | 2226 (80%) | 2238 (80%) | 2164 (78%) | 1926 (69%) | 1827 (66%) |
| Kuwait | 147 (5%) | 214 (8%) | 217 (8%) | 225 (8%) | 211 (8%) | 209 (8%) |
| UAE | 493 (18%) | 713 (26%) | 737 (26%) | 763 (27%) | 731 (26%) | 718 (26%) |
| Bahrain | 82 (3%) | 82 (3%) | 78 (3%) | 77 (3%) | 80 (3%) | 81 (3%) |
| Oman | 217 (8%) | 297 (11%) | 321 (12%) | 320 (11%) | 296 (11%) | 286 (10%) |
| Qatar | 179 (6%) | 275 (10%) | 284 (10%) | 286 (10%) | 278 (10%) | 244 (9%) |

Source: JRAIA (2018)

Kuwait has extreme climatic outdoor conditions with mean ambient temperatures of approximately 45˚C during the summer months. This means that in the months from April to October there is high demand for energy for running air conditioning systems. Buildings in Kuwait are exposed to high ambient air temperatures, as well as strong solar radiation, which can reach 940 W/m2 on a horizontal surface during the heights of the summer season (Al-ajmi & Loveday 2010). Although Bahrain has the highest electricity consumption state in GCC, Qatar contributes to the highest C02 emissions. This is then followed again by Kuwait (JRAIA, 2018). There is also one more reason for the high usage of electricity in Kuwait. The data provided by Statista.com (2021) provides the cost of electricity in GCC between January and July 2016 (in US dollars). Kuwait has the lowest cost of electricity compared to the other GCC countries (Al-Faris 2002). This acts as a factor in the increased use of electricity by the citizens. It also adds to the need for monitoring the electricity consumption in the country.

Kuwait needs smart cities to ensure that electricity consumption can be kept under control. Due to the low cost of electricity, coupled with long and hot summers, the usages of heating, ventilation, and air conditioning (HVAC) units are high (Alotaibi 2011). These units are left running almost entirely throughout the day which increases electricity consumption. Smart cities, equipped with IoT and smart meters, can clearly identify the usage and the areas where electricity consumption is high and where it needs to be controlled by studying the causal conditions.

A smart meter system consists of the actual smart meter and an infrastructure based on communication and control devices that support the efficient operations of the meter. These meters have the capacity to receive and execute control instructions both remotely and locally (Al-Wakee et al. 2016). Smart meters are capable of monitoring a wide range of appliances and devices in the customers' homes. Since communication is bi-directional, the meter can also convey diagnostic information to the distribution grid, and home appliances can communicate with one another to coordinate their functions (Coelho et al. 2019). They can also monitor electricity consumption from the grid, as well as supporting eco-friendly alternative generation sources such as solar panels and energy storage devices, and can make appropriate automatic adjustments to the billing of the customer (Depuru et al. 2011).

The literature indicates several measures which can help to reduce domestic energy consumption (Kwac et al. 2016; Rausser et al. 2018). These measures can be categorised into two main types: demand-side or supply-side management programmes. For example, demand-side management includes the control of electrical loads and energy fed into the system which is generated from renewable sources. Measures from the latter category include the reduction of electricity consumption from the end-users by improved efficiencies in energy performance, economic electricity tariffs, differentiating energy sources, the use of smart meters and behavioural change on the part of consumers to cut down on energy wastage (Ali & Alsabbagh 2018).

A recent development in information and communications technology has been to place the end user at the centre of innovations and this is evidenced by the fact that many organisations, in implementing innovative technological solutions, have focused on making these more user-friendly (De Moor et al. 2010). Pushing technology to individuals might lead to alienating them (Schaffers et al. 2012) and making them repel against using the technology. Individuals do not like to feel forced to adopt a new technology without being convinced (Kumar et al. 2020), which can lead to lower satisfaction levels (De Moor et al. 2010). Hence, this study is important in the sense that understanding the impact of technology push on users' behaviour and how they react to using the technology. In the context of Kuwait, this study will be very valuable because there is a general direction from the government to build smart cities which were enrolled in the New Kuwait 2035 vision.

## 2.5 CHAPTER SUMMARY

The main challenges and benefits of smart cities have been reviewed in this chapter. The technologies discussed represent those which are most used in building cities; they are smart in nature with the aim of improving the quality of life and services. In the following section, the factors affecting citizens' satisfaction of the compulsory smart city technologies are examined, as well as exploring any concomitant changes in citizens' behaviour. Additionally, the net benefits of using smart city technologies are discussed.

# CHAPTER 3: CONCEPTUAL MODEL

## 3.1 INTRODUCTION

The previous chapter presented a general overview of smart cities as well as exploring the important role of technology in enhancing the lives of people. The literature review resulted in the realization that there are very few studies that have explored the factors that impact user satisfaction and their influence on user behaviour in relation to smart cities technologies when the technology is pushed to users. Yang & Lebline (2016) define technology push as “measures to reduce the cost and improve the efficiency of a particular technology through RD&D and learning by doing” (p.3). This means that technology push comprises the steps taken to try to reduce the cost of services and enhance the benefits of smart technology to individuals. In a way, it is a procedure that is followed to improve performance and efficiency of services. Hartmann et al. (2012) provided a different explanation for technology push when they described it as developing and innovating a new technology that would induce business process change. Technology push is about a creative, new way of doing things (Walsh, Kirchhoff & Newbert 2002). In other words, it is a radical replacement of the current methods with new technologies that can be characterised as being innovative (Brem & Voigt 2009). Scholars postulate that the advancement that is witnessed now in all walks of technology is a step in the right direction to introducing technological changes (Lubik, Lim, Platts & Minshall 2012). As argued by Choi (2018), technology push is a major force in changing the shape of this world and how businesses are run.

In the context of smart cities, the supporting technologies are pushed to consumers due to the promise of their many benefits such as reduced bills and convenience of conducting various services. It was demonstrated that there were few studies that explored the importance of information and service quality, along with trust and performance expectancy on user satisfaction with smart cities technologies in the light of technology push. Also, the literature did not focus on the impact of user satisfaction on changing user behaviour toward smart city technologies. This chapter provides a thorough analysis of the factors to be employed in the study and proposes the research hypotheses.

This chapter follows a systematic structure. Sections 3.2-3.8 discuss the research factors in greater depth. The research conceptual model is presented in Section 3.9. Finally, the chapter summary is provided in section 3.10.

## 3.2 INFORMATION QUALITY

Information quality (IQ) has become a main interest of many organisations, especially in the public sector. With the accelerating movement towards digitizing the services, there is an increasing shift towards turning cities into smart cities (Hollands 2015). One of the most important elements to make smart cities succeed is information quality (Schedler, Guenduez & Frischknecht 2019). Information is the core of smart cities where processes and procedures are fed with information to produce the desired output. In this research, information quality is measured by data quality. Data quality has many characteristics such as being concise, being easy to understand and completeness (Klein, Guo & Zhou 2016). The information provided to users of smart cities should be in a language that any novice user can understand. Simply, it should be in plain English with clear instructions and guidelines. Moreover, the information should be complete. For example, when users are asked to run a certain process, all the information about the process should be given, as well as the steps that users should take. This will help in building a complete comprehension of all the processes and technologies of smart cities. Researchers have considered the importance of the quality of information (Kang & Namkung 2019; Tilly, Fischbach & Schoder 2015; Bizzi, Ghezzi & Paudyal 2017). A study was conducted to measure the variables affecting the success of information systems, where those elements were used extensively in the field of research in this area (Gürkut & Nat 2017). In the public sector, information quality becomes integral to the use of government services (Sharma 2015).

Information quality is a process that ensures elements such as being proactive, timeliness, frequency and responsiveness are available in the information being shared (Jiang, Liu, Ding, Liang & Duan 2017). These attributes of information sharing in the public sector reflect the degree of paying attention to the needs of the citizens (Gürkut & Nat 2017). Paying attention to needs of individuals means giving them all the required information and understanding their requirements, leading to a mutually beneficial relationship. A successful relationship between an individual and the public entity is developed based on mutual trust. Such trust is generated through the credibility of information exchange happening between the individual and the public entity; thus the desire to use the public services. Therefore, quality of information is an important aspect of the quality of government services to citizens (Popovič, Hackney, and Coelho & Jaklič 2014). Ahearne, Jelinek and Jones (2007) defined information quality as a communication process through which regular information about a service is conveyed in a clear and concise manner. When the government communicates information of high quality to individuals, they tend to utilise this information to get the most out of their service (Marshall, West & Aitken 2013).

In the tourism sector, various scholars have explored the importance of information quality (Tilly et al. 2015). A study by Kim, Lee, Shin and Yang (2017) assessed the role of information quality in the travel sector in enhancing the image of a destination. It determined that high quality information can provide tourists with accurate and precise information, which helps them to decide their travel arrangements. Providing accurate and concise information plays a role in establishing trust in the service provider. This leads to enhanced satisfaction and user experience when the experience matches the tourists' expectations. In the health sector, Gaardboe, Nyvang and Sandalgaard, (2017) conducted a study to test the Mclean and Delone IS Success model in the health industry. The study was conducted in 12 hospitals in Denmark to explore which factors contributed most to business intelligence. It found that even though a positive association existed between system quality and use and user satisfaction, and a positive association existed between information quality and user satisfaction, no such association was found between information quality and use. However, the study was able to demonstrate that system and information quality are crucial for ensuring patient satisfaction in the health industry.

Fadahunsi et al. (2019) conducted a study to identify dimensions within existing information quality frameworks in eHealth and to develop a new information quality framework for the assessment of eHealth. Their study was conducted based on a systematic literature review approach, where it was able to come up with a conceptual framework that defined the broad lines of information quality's importance in maintaining a clean eHealth file system. In the e-government sector, meanwhile, Sá, Rocha and Cota (2016) conducted a study on information quality in e-government. The study determined that the quality of information for all the services that the government offered should be high in order to leverage the services and get the most benefits. Finally, Janita and Miranda (2018) conducted a study to identify the key dimensions that the government should pay attention to when designing their online services. It was determined that four dimensions were important, and this included information quality. Information quality is a main criterion when looking to encourage as many people as possible to use the e-government services.

In the context of smart cities, providing concise information to users is found to contribute positively to the enhancement of smart cities use, and to the betterment of user satisfaction (Mora, Gilart-Iglesias, Pérez-del Hoyo and Andújar-Montoya 2017). Providing concise information also helps individuals to understand the smart cities technologies in an easy manner. Hui, Sherratt and Sanchez (2017) pointed out the importance of providing information that is easy to understand to users of smart cities. . It is important that complete information is provided as this helps users to develop full knowledge of the smart cities' technologies and in becoming confident in its use. Complete information will help users in grasping the potential benefits of the smart cities. Hence, it would reflect positively on the use of smart cities technologies and provide users with more satisfaction (Chatterjee et al. 2018). Zygiaris (2013) argued that the transformation to smart cities has led to granting users' access to real time information, which assisted individuals in making their decision to utilize the smart cities services. The availability of real time information is a main building block for smart cities as it connects the physical world with the information needed to deliver high quality services to the citizens. Xiao, Lim and Ponnambalam (2017) carried out a study on the application of information systems on the technological services delivered by individuals in smart cities. The study found that information quality was contributing towards the use of smart cities technological services. Moreover, the study also determined that technology use is essential especially with the increasing demands on services offered by the public sector.

However, Belanche-Gracia, Casaló-Ariño & Pérez-Rueda (2015) took a different perspective and examined the adoption of smart cards rather than smart cities. Their study found that the most important elements are information quality, privacy and security. In some other studies (e.g. Biswas et al. 2016; Shin 2010; Van Zoonen 2016), privacy and security were considered to be two sides of the same coin. It was argued that the security of information helps in ensuring the privacy of users and their personal data. Belanche-Gracia and Colleagues introduced privacy and security as two different constructs. In fact, the study found that by demonstrating the possession of good quality information, users will continue to use the services and hence user satisfaction will be increased. Furthermore, it demonstrated that securing and ensuring the privacy of users' information tended to make them feel satisfied. Providing individuals with the needed information in a concise and clear manner is necessary for smart cities. Based on the discussion of the studies above, the following research hypothesis has been proposed:

**Hypothesis $H_1$:** Information Quality of technology has a positive and significant impact on the user satisfaction with smart city technologies.

## 3.3 SERVICE QUALITY

Organisations are now shifting towards offering customers services rather than products (Scuotto, Santoro, Bresciani & Del Giudice 2017). Hollands (2015) mentioned that a smart city offers its residents various services that could help to facilitate their lives. These services can range from services that manage the utilities, their own consumption, the effective use of resources and the use of the public services, such as: renewal of official documents or managing the municipality services. Hence, it is important to focus on delivering a quality service. In today's competitive environment, the pursuit of service quality has become the differentiating element (Santos 2003) that service providers must incorporate within their strategy. For the government services, many individuals use their services for various means (Ceresola 2018). Oliveira & Campolargo (2015) postulated that a smart city is developed by the government in order to enhance the services offered to its citizens.

The goal of building smart cities is to enhance the outcomes of public services and to manage the resources. Management of the resources is a critical task as there is an increasing pressure being placed on the services (Perboli, De Marco, Perfetti & Marone 2014). With evidence of higher levels of service quality leading to higher satisfaction (Kuo et al. 2009), government officials are now focusing their interest on strategies to measure and improve the quality of service encounters (Johnson & Sirikit, 2002; Brown & Bitner 2007). This will benefit the citizens (Karami et al. 2016) and help in better management of resource consumption (Oliveira & Campolargo 2015). Measuring service quality has proven to be the key element in many of the service quality improvement programs, as it enables the government to discover their strengths and weaknesses in quality as perceived by the citizens (Tseng, 2016). In addition, measuring service quality of government services is essential to understanding methods of improvement and optimal utilization of services. Negi (2009) contends that successful governments measure service quality regularly and accurately through the eyes of the citizens in order to maintain the quality of the service. One of the methods of measuring service quality is through the collection of feedback from users. However, identifying and selecting the appropriate instrument poses as a challenge for service firms. This challenge is based on the fact that most measurement methods are based on perceptions and cannot be regarded as accurate. Chen et al. (2015) described service quality as one of the principal factors of the McLean & Delone IS success model, which is important for gauging the value of the services offered.

Parasuraman, et al. (1988) developed a Service Quality model, which was termed as SERVQUAL. Service Quality is understood in terms of the degree of congruence between customers' assessments of the quality of the services offered by a particular company and the expectations they had of the quality of those services. SERVQUAL contains five dimensions: Tangibles, Reliability, Responsiveness, Assurance and Empathy.

Tangibility refers to the appearance of the physical facilities, equipment, personnel, and communication materials. (Parasuraman, Zeithaml & Berry 1985). It constitutes the first impression customers have of any service. Moreover, it measures the modern equipment, attractive optical facilities (Clow et al. 1998), expedient business hours and the visually appealing materials associated with the service. For the smart city, it is important that the government creates appealing smart cities to encourage citizens to relocate to these cities and utilise the services they offer (Hollands 2015). Reliability was defined in terms of the capacity to deliver the promised service speedily, responsibly and to the expected standard of quality (Zeithaml, Bitner & Gremler 2010). As explained by Hashem et al. (2016), it is about the government providing smart city services as promised, the responsible handling of citizens' service problems, delivery of quality services correctly the first time, providing services at the promised time and keeping citizens informed about when the services would be carried out. Paswan et al. (2004) described responsiveness as the government's willingness to be helpful to citizens by delivering a good, fast and quality service through smart cities. In the context of smart cities, responsiveness delivers services that are diverse and at speeds that are satisfying to citizens (Torres et al. 2005).

Seth et al. (2004) defined assurance in terms of the knowledge and good manners shown by employees, and their ability to gain the trust and confidence of citizens. Smart cities assure citizens to be provided with accurate details and information. Smart cities portray to citizens a sense of confidence, follow the laws and regulations and make citizens feel safe in their transactions (Zeithaml et al. 2010). Empathy was defined as the provision of caring, personalized attention that the organisation provides to its customers to make them feel special with extra value gained (Shoham & Gavish 2016). Smart cities give citizens individual attention and deal with them in a caring manner in order to satisfy their needs (Zeithaml et al. 2010).

In a marketing context, research conducted in a number of settings established that high service quality led to greater degrees of loyalty towards the service provider (Nunkoo, Teeroovengadum, Thomas & Leonard 2017). Users will tend to become loyal to the service provider if they perceive that the services providers demonstrate high quality. Several studies of e-service quality found that perceived high levels of e-service were positively correlated with high levels of e-loyalty (Abou-Shouk & Khalifa 2017; Pee, Jiang & Klein 2018; Toufaily & Pons 2017). In an Information Systems context, the loyalty of an individual was found to be manifested by their intentional and continued use of the system. Loyalty will be evident in the form of continued use and will not be visible in a physical manner. For this very reason, Kim, Hong, Min and Lee (2011) were able to use 'continuance intention' as a proxy for loyalty and found a significant correlation between service quality and intention to continue using the service. In a recent study conducted by Yang, Shao, Liu and Liu (2017), a positive association was found between students' perceptions of the quality of service being offered in online learning and their intention to persist in their online studies.

In the context of service quality of technology, the most important factors in relation to smart cities were responsiveness, accuracy, reliability and technical competence

(Veeramootoo, Nunkoo & Dwivedi 2018). The first dimension is responsiveness, which is the ability to give customers the service they need. It is stated that the investment in technological services is a driver for enhancing service quality of all the services offered to citizens living in smart cities. Digitizing the services increases the level of satisfaction and helps with the delivery of high quality services to the citizens. In return, these smart city technologies will replace many of the traditional services and help make life easier for the citizens (Walravens 2012).

In the context of smart cities, developing smart city technologies that are responsive and have a very high and fast response rate will positively impact the use of smart city technologies, as well as raising their level of satisfaction (Huang, Xing, Shin, Hou & Hsu 2018). More importantly, the smart cities technologies must be accurate and provide the correct response to users (Van Zoonen 2016). Correctness will have its influence on the use and satisfaction with smart cities technologies. A related factor is reliability. Responsiveness and correctness feeds into reliability, making the information credible and trustworthy. Reliability is the ability to provide consistent results from time to time (Calvillo, Sánchez-Miralles & Villar 2016). When smart cities technologies are reliable, this means that individuals can count on them to provide the same results every time, which instills confidence in smart cities. Reliable smart cities technologies are the basis of success for governments in order to ensure a model and unique experience for all users. Finally, technical competence is the ability to overcome any technical issues in a short time (Leleux & Webster 2018). Smart city technologies should include a technical competency component in order to be successful. This means that the technologies will deliver the same experience even if they were down and came back to service after a time. Also, users trust that their transactions can be completed at the point where it stopped without any effect on the outcomes. When technical competence of the smart city technologies is high, then individuals know that any downtime of the services will not be long, and that issues will be resolved and that the system will be up and running again soon. High technical competence promotes increased use of smart city technologies and raises the level of satisfaction with the system (Huang et al. 2018). Moreover, higher technical competency means that the technologies are easy to use and interact with. Hence, the following research hypothesis is developed:

**Hypothesis $H_2$:** Service Quality of technology has a positive and significant impact on the user satisfaction with smart city technologies.

## 3.4 PERFORMANCE EXPECTANCY

Performance of the system is one of the criteria that are first checked by users (Riquelme & Rios 2010). Users expect a system to perform in a specific manner (Sarikaya 2017). For government service, individuals who use the services are interested in getting the required results as promised by the service provider (Lovelock & Patterson, 2015). Performance expectancy is defined in terms of the anticipated benefits, which are expected to be derived from use of the technology in order to efficiently perform certain activities (Venkatesh, Thong, Chan & Hu 2016). It is one of the four factors of the Unified Theory of Acceptance and Use of Technology (UTAUT). UTAUT is an extension of the Technology Acceptance Model (TAM), which was criticised for not being a complete model because it did not determine the factors that influenced perceived ease of use (Venkatesh, Thong & Xu 2012). The main elements of UTAUT are Effort Expectancy (EE), Performance Expectancy (PE), Facilitating Conditions (FC) and Social Influence (SI) (Kuciapski 2017; Venkatesh, Thong & Xu 2003). The most important and relevant item from this theory is the performance expectancy (Gao & Bai 2014). The other factors are not considered in this study. Performance expectancy is critical as it will assist in the establishment of a comparison or reference point where users compare the expectations with the actual experience of using the smart cities technologies. Hence, it links with user satisfaction in a homogenous manner (Jeong, Kim & Jeong 2015).

Riquelme and Rios (2010) studied performance expectancy from the perspective of its usefulness. They concluded that it was the performance expectations which citizens had which drove them to realise a positive appraisal of the value of using the technology that the government offered. Park et al. (2007) found that performance expectancy played a pivotal part in delineating the perceived value for technology users. Utilising government services, citizens will evaluate the performance of the public services from various perspectives, including the ease of use (Wirtz & Kurtz 2016). Evaluation of the government services will assist in determining its performance and whether it matches their expectations or not. In the context of using mobile services for banking, Lu, Wang and Hayes (2012) found a causal relationship between performance expectancy and enhanced levels of technology use based on realised perceived value. Users' expectations of the mobile banking were met with the high value gained from using the service. Thus, users' expectations of the technology use were critically important for acquiring value from technology use. Studies have pointed out that performance expectancy has a direct and positive relationship with technology use of government services and satisfaction (Chopra & Rajan 2016; Napitupulu et al. 2020). Those individuals who use the government services realize the value of these services in terms of savings in time and effort. Thus, users tend to become satisfied with the outcomes of the government services.

In the context of smart cities, individuals who hold high expectations of the performance of smart cities will exhibit high levels of use of smart city technologies (Zolotov et al. 2018). Optimised smart city services will save individuals time and even money in some cases. Thus, users will be prompted to use these smart city technologies more often. According to Leong et al. (2017), performance expectancy affects user satisfaction. Gao et al. (2015) stated that the impact of performance expectancy on smart cities technologies is not limited to smart cities, but also extends to other types of technological services in various sectors. This means that performance expectation is a feature that ought to be present in various industries and not just in smart cities. In a nutshell, performance expectancy is associated with the expected outcome of using the service. The individual would have expectations or predetermined notions of the performance of the technology (Zolotov et al. 2018). To this end, performance indicates the expected outcomes that the smart cities technologies can deliver, which can satisfy the users of smart cities' technologies (Sun et al., 2013). One of the most obvious benefits that individuals could gain from smart cities is receiving the output of the smart cities' services as intended, and without pain or frustration (Park, Jung, Shin, Kim & Yoon 2015). This means that there will be multiple savings on the part of users in terms of time, money and effort. Based on this discussion, the following hypothesis was formulated:

**Hypothesis $H_3$:** Performance Expectancy of technology has a positive and significant impact on the user satisfaction with smart city technologies.

## 3.5 TRUST IN PROVIDER

A key factor that leads to the successful implementation of smart city projects is trust (Van Zoonen 2016). This is defined as the perception an individual has about the safety and ease of use of the technology where the trust is founded on the robust and reliable guidance the individual received for the use of the technology (Belanger & Carter 2008). Trust is defined as the confidence that an individual has in the reliability and integrity of another person (Palmatier, Dant, Grewal & Evans 2006). Trust is a crucial element in any service or interaction and is considered as important for building a successful relationship. This is based on the belief that a service provider would stand by his/her words, fulfil promised role obligations and his/her commitment towards his/her customers. Trust is a two-way relationship between a receiver and a service provider. Trust brings about long-term relationships and repeats usage of the service by reducing uncertainty and opportunistic behaviour on the part of the provider (Hausman 2001). Users perceive that the other party is worthy of their confidence and will not try to take advantage of them. This is because a relationship develops between the service user and provider is based on trust and dependability. In other words, long-term shared interaction between relational partners strengthens trust (Verhoef et al. 2002), and enhances the interaction between the two parties (Hausman 2001).

Trust is a decisive factor in the decision to use smart cities technology (Zolotov et al. 2018). Individuals tend to avoid utilising smart city technologies unless they feel confident that such usage is both secure and beneficial (Carter & Belanger 2005). Being confident means acquiring the trust of the service provider and vice versa. However, when smart cities are enforced by the government on residential buildings, individuals have no choice but to use the services of the smart cities. In this sense, trust is a must, considering the fact that users are obliged to use smart cities services. It is crucial, nevertheless, that individuals trust the provider whois managing the smart city services. In most cases, the provider or smart city is a private entity employed by the government in order to manage and monitor the use and applicability of smart cities. In other instances, the service provider is a government entity running the smart city technologies. Trust may be understood as an implicit set of beliefs based on a feeling of confidence and certainty that the trusted service provider will not act towards the service user in such a way as to take advantage of them (Ridings, Gefen & Arinze 2002; Hosmer 1995; Moorman, Zaltman & Deshpande 1992).

In the absence of guarantees from the government towards service users or regulations from the government on smart technology providers, trust plays an even more enhanced role in the provider-user relationship. This occurs in virtue of the provider being perceived to act in a responsible and non-exploitative manner (even when the opportunity to do so might exist). This degree of trust leads to greater openness in the relationship between the provider and the end-user (Butler & Cantrell, 1994). Regulations from the government agencies must be developed and enforced on smart city technology providers when it is of private nature. Thus, trust in the provider is based on the avoidance of opportunistic behaviour (Luhmann 2000). And trust in the provider is all the more important in a smart city context where government regulations are absent, and the relationship is based on goodwill and benevolence between the parties. What is more, the importance of trust in the provider may prove to be a decisive factor in enhancing the usage of smart cities. Trust in the provider is synonymous with the confidence that the service provider will provide the users with the services as intended. However, a survey of the relevant literature reveals the complex and rather problematic nature of trust (Hawlitschek, Notheisen & Teubner 2018; Poppo, Zhou & Li 2016), as it is often dependent upon the situation in which it is being considered (Yamamura, Tsutsui, Yamane, Yamane & Powdthavee 2015; Luhmann 2000). In other words, trust in the service provider can depend on the context or the industry. Trust in the provider is developed between an individual and the provider of the smart cities technology, eventually providing a positive outcome for individuals in the society. As the trust in the provider increases, the user satisfaction would also tend to increase (McLean & Delone 2003). Based on this discussion, one further research hypothesis has been formulated:

**Hypothesis $H_4$:** Trust in the technology provider has a positive and significant impact on the user satisfaction within smart city technologies.

## 3.6 USER SATISFACTION

Smart cities aim at making citizens' lives easier (Hollands 2015). By doing so, the goal of smart cities should be to enhance the satisfaction of citizens (Polese, Barile, Caputo, Carrubbo & Waletzky 2018). Several standards have been developed for measuring user satisfaction (Pizam, Shapoval & Ellis 2016; Montesdioca & Maçada 2015; Schaffer, Haddad & Wickramasinghe 2017). Zeithaml et al. (2009) proposes a fine definition of satisfaction as the consumer's fulfilment response. This involves the discernment that a certain product or service has led to a congenial feeling of fulfilment on the part of the consumer. In simpler terms, Zeithaml et al. (2009) viewed satisfaction as meeting the customer's expectations of a service or product and dissatisfaction in terms of failing to meet the consumer's expectations. In other words, satisfaction is delivering on customers' expectations and providing them with what they need. Satisfaction is linked to feelings. Thus, satisfaction involves a response which is emotional in nature (Atorough & Salem 2016). Based on an evaluation of the quality of government services, satisfaction is the overall customers' evaluation of the perceived government service compared to the expectation of citizens (Malik, Shuqin, Mastoi, Gul & Gul 2016).

In the hospitality context, Kim, Vogt and Knutson (2015) conducted a study to investigate the extent to which levels of customer satisfaction influenced loyalty. As well as this, they wanted to gain an understanding of the multiphasic loyalty framework, which they considered as including cognitive, affective, and conative loyalties. This study lends support to those models of customer satisfaction which view it as having a causal relationship with loyalty and signifies a consumer's feelings of delight that are based on cognitive, affective, and conative loyalties. Moreover, the study also found that loyalty is a direct result of becoming satisfied and meeting the customer's needs. A study by Radojevic, Stanisic and Stanic (2015) found a significant association between hotel characteristics and customer satisfaction. This confirms the effectiveness of star rating systems which signify the level of customer satisfaction which can be expected.

In the context of smart cities, higher user satisfaction with smart city technologies indicates that the users would be happy with its outcomes and that the benefits would be great (Belanche-Gracia et al. 2015). In addition, users will realize that the smart cities technologies are fulfilling their requirements and hence, pleasing them. It is not easy to fulfil the needs of users but when achieved, it gives users pleasure and joy with the service and delivers many benefits to them. Amongst the many benefits is the comfort of performing all the services that the smart cities offer in one place. A study by Xiao et al. (2017) was performed to analyse how the attachment to the services of smart cities allows individuals to reap the benefits of smart cities. Furthermore, satisfaction causes an individual to relate with the services and to use them more often and be happy with its use. Moreover, more frequent use of smart cities enhances the engagement with smart cities, therefore, increasing citizens' satisfaction and allowing them to make greater use of the e-government services (Zenker & Rutter 2014). Smart cities are supposed to promote happiness and well-being (Lara et al. 2016). In fact, happiness is synonymous with satisfaction. Ensuring that users are happy with the smart cities is crucial to the continued use of smart cities. As long as an individual is happy with the services offered through a smart city, he/she will benefit from the services offers. Furthermore, the study established a framework for factors influencing the benefits of smart cities. Hence, hypothesis $H_5$ is proposed for testing:

**Hypothesis $H_5$:** User satisfaction has a positive and significant impact on the net benefits of smart city technologies.

## 3.7 USER CHANGE BEHAVIOUR

The success of smart cities is contingent on a change of behaviour on the part of citizens. Belanche, Casaló and Orús (2016) emphasise that it is important to study the citizen's attitude towards smart cities. These authors also propose a number of theories of behaviour and attitude, including the theory of reasoned action and the theory of planned behaviour to explain human behaviour and attitude towards using urban services. Individuals' judgments and behaviours are contingent on the emotional attachments they develop, including attachments to a certain location (Lyons 2018). Emotional attachment is one of the indicators of the change of behaviour of individuals which gauges their perception towards a particular service. Because users' attitudes are formed by their affective and evaluative responses based on certain beliefs, the bonding to the smart city may also be formative in terms of their attitudes towards entities or behaviours related to the smart city. This means that individuals might exhibit affectionate behaviour towards smart cities because they like and have good feelings towards its technologies. Earlier studies have already established the pivotal role of place attachment in influencing judgments about place-related issues (Yuksel, Yuksel & Bilim 2010).

Previous studies also found that people with strong attachments to a place tend to evaluate local features more favourably (Bonaiuto, Breakwell & Cano 1996). The emphasis here is on citizens' attachment to the city so that they feel that they are part of the city, and thereby make use of the services intelligently. With the advent of technology and its intricate intertwining in our daily lives, it becomes easier to become attached to smart cities' technologies. The attachments to a particular city are based on strong affective ties between a person and a particular city which results in the individual maintaining a close affinity with that city (López-Mosquera & Sánchez 2013). Affection towards smart city technologies implies that consumers are satisfied (Daskin & Kasim 2016), which is also an indication of continued use of smart city technologies. This attachment can find its expression in certain systematic behavioural tendencies, such as a greater propensity to support local initiatives, greater uses of the locality or a preference for remaining in close contact with that urban environment (Lewicka 2008). People who have high levels of attachment to a place tend to engage more often in local initiatives and endeavours to meet their needs, and to actualise a sense of participation in the everyday life of the locality and its community (Yuksel et al. 2010). Attachment to a particular city has been found to be correlated with pro-environmental behaviours (Raymond et al. 2011), but it may also be a driver of other behaviours, such as those driven by a sense of allegiance to the place (López-Mosquera & Sánchez 2013), joining in neighbourhood events or in supporting local enterprises (Zenker & Rutter 2014). Consequently, it is expected that the more an individual is satisfied with smart city technologies, the more they are likely to avail themselves of the services offered in the locality and to exhibit changes in attitude toward the use of smart city technologies (Baron & Kuźnik 2017; Lyons 2018). Hence, hypothesis $H_6$ is proposed for testing:

**Hypothesis $H_6$:** User satisfaction has a positive and significant impact on user change behaviour toward smart city technologies.

## 3.8 NET BENEFITS OF SMART CITY TECHNOLOGIES

Net benefits is defined as the degree in which information systems play a significant role in the success of individuals, groups, organizations, industries, and government (Bastola et al. 2019). Examples of net benefits can be improved decision-making ability, enhanced productivity, improved sales, reduced cost, enhanced profits and customer satisfaction (DeLone & McLean, 2016; Petter et al., 2008). Net benefits was also defined as the evaluation of citizens for the positive outcomes that they acquire from communications with the information system, which might include costs and time savings, and better system performance (Wang and Liao, 2008; Chen et al, 2015). According to Petter et al. (2008), net benefits is mostly at individual and organizational level. Net benefits encapsulate the real value attained from information systems and affects different layers and stakeholders such as customers, suppliers, employees, organizations, markets, industries, economies, and even societies (DeLone and McLean 2003). In the context of smart cities, the use and satisfaction with information systems would ensure that net benefits are gained. There are many uses and interpretations of net benefits as an output variable in the context of information system (Norzaidi & Salwani, 2009; Son et al., 2012). In this study, net benefits is defined as the degree to which the system usage effect the knowledge acquisition, communication quality and decision quality.

The benefits of smart cities technology are numerous (Venkatesh et al. 2016), and may have varied impacts on users' lives depending on the type of technology and the way it is used. The impacts of Information Systems have evolved over years. McLean & Delone in their old Information Systems success model (1992) focused on the individual and organisational impacts only. However, researchers over a decade have introduced other benefits such as those related to society (Seddon 1997) and industry (Clemons & Row 1993). McLean & Delone (2003) eventually concluded, in their updated information system success model, that it is more convenient and simpler to combine all impact measures into a single variable, benefits. McLean & Delone did not define who the recipient of the benefit was. The application of their model simply defines the beneficiaries.

A study by Park et al. (2018), set in a healthcare context, aimed at investigating the causal factors underlying peoples' readiness to accept a Health Information Exchange (HIE). In the course of the investigation, constructs from the Technology Acceptance Model (TAM) were examined to discover whether any correlations existed between these constructs. It was found that most respondents accepted the new technology of HIE and intended to make use of it based on their perceptions of its usefulness and the fact that it was user-friendly. Respondents' attitudes and intentional behaviour to use the HIE were significantly influenced by their perceptions of the usefulness of the HIE. They were also influenced by the fact that hospital patients would appreciate the benefits to be derived from using the new technology and would be influenced to do so. This means that patients of a hospital would realize the benefits gained from using the technology and hence would start and continue using the services. A study conducted by Alonso, Arambarri, López-Coronado and de la Torre Díez (2019) explored the use of blockchain in offering high levels of security for patients' data. This enhanced level of security is likely to offer further reassurance for patients to use new technologies in healthcare. The technology also paves the way for improving the quality of life since e-medical record updates will be easier to track and to share with physicians and doctors. Thus, the benefits of using the technology are numerous and show the strength of the technologies used.

In the context of smart cities, the benefits gained from using the technology are enormous for both individuals and the government (Albino et al. 2015). The individuals would be able to perform the services that they need and to continuously monitor all their related transactions (Mohanty, Choppali & Kougianos 2016). The government would be able to monitor the capacity and usage of services and to plan ahead for future expansion (Calvillo et al. 2016). By doing so, the government can take corrective measures in order to enhance the user experience of smart cities' technologies. It would also make it easier for the government to keep track of the issuance of new services and to determine how to link various services together. Eventually, the benefits of smart cities' technologies would increase because they would speed up transactions and reduce the number of errors (Albino et al. 2015).

As discussed earlier, when the quality of the service and information is high, this will yield a high usage and result in high satisfaction rates and accordingly positive benefits (Albino et al. 2015). On the other hand, increased use of low quality smart city technologies will be definitely linked to high dissatisfaction rates and accordingly negative benefits from smart cities' technologies (Mohanty et al. 2016). Thus, it is not definite that the mere use of smart cities' technologies will generate satisfaction. When the services offered are not as expected and have low quality, users will be dissatisfied with the outcome. As stated by Delone & McLean (2003), benefits can have either a positive or negative impact on user satisfaction. An example of where the impact on user satisfaction will be negative is seen when net benefits are high for the government but not for consumers.  However, high consumer benefits will indicate that users will most likely be satisfied with the smart city technologies (Wilson, Hargreaves & Hauxwell-Baldwin 2017). Hence, hypotheses $H_7$ is proposed for testing:

**Hypothesis $H_7$:** Net benefits have a positive and significant impact on User satisfaction with smart city technologies.

A number of studies have examined the impact of demographics on the use of smart cities. For example, a study by Peng et al. (2017) examined individuals' awareness of one of the smart cities applications which is smart parking in London. Gender can be a crucial and important factor in the determination of user acceptance and satisfaction with smart cities. Peng et al. (2017) found that there are no differences between males and females when it comes to awareness of smart parking. However, females realize the benefits of smart cities and its technologies, (Nesti 2019) and hence, exhibit higher perceptions than males. According to Chatterjee & Kar (2018), females tend to be more educated that males in India and thus it is noticed that females in India are more willing to adopt information technology services in smart cities. Mustafa et al. (2020) took a different approach and examined the digital service failure in smart cities instead of success. The authors concluded that individuals are interested in getting the services as promised and thus when the service fails, they lack trust in the information technology systems of smart cities and would lead to reduction in the usage or avoiding smart cities services. This study have shown that males are more worried about service failure and hence will not be willing to jump in and adopt the smart cities services compared to females. On the other hand, studies have shown that males are not resistant to change and are willing to accept and adopt a new technology. Hence, the following hypothesis $H_8$ is proposed.

**Hypothesis $H_8$:** There is a statistically significant difference between gender and Change in User Behavior and Net Benefits when using the smart meters in Kuwait

A study by Peng et al. (2017) found that there are significant differences with this demographic variable where younger people were not aware of the existence of smart parking in London; thus, older people were more aware of smart parking and smart cities initiatives. One the other hand, Bolin & Westlund (2008) have found that younger generations are more aware of and inclined towards technology, and show higher levels of understanding of its benefits and uses. This was confirmed by Hurst et al. (2020), who found that people that are in age group 26-35 years old tend to have higher and positive intentions towards the use of smart gas meters in Ireland. Thus, this study has found that younger people tend to have positive thoughts and opinions about smart technologies because they are able to realize the benefits better than others. Therefore, the following hypothesis H9 is proposed:

**Hypothesis $H_9$:** There is a significant statistical difference between the Age and Change in User Behavior and Net Benefits of using the smart meters in Kuwait.

Educated people have more knowledge and might have more reading about the smart cities. Nam & Pardo (2011) have found that the more people are educated, the more they are informed about smart cities and its benefits. However, Peng et al. (2017) found that education has no significant statistical differences on the awareness of people of smart parking in London. A study was conducted by Hurst et al. (2020) to examine the differences between educated people in their opinion and acceptance of smart gas meters in Ireland. The study have shown that people with higher educational level tend to have higher interest towards reducing the gas bills and thus are more willing to use the smart gas meters. This implies that those people are able to realize the long-time benefits of using the smart technologies and hence and more receptive to smart technology than others. Therefore, the following hypothesis $H_{10}$ is proposed:

**Hypothesis $H_{10}$:** There is a significant statistical difference between the Educational level and Change in User Behavior and Net Benefits of using the smart meters in Kuwait.

Smart cities and its applications are useful for all people. However, families might enjoy more benefits from smart cities as the savings and reduction of resource use is higher. A study by Stratigea et al. (2015) found that married people have higher expectations of the benefits of smart cities and are willing to adopt and use it.

Nevertheless, contradictory results were suggested by Shapiro (2006), which showed that marital status does not have an influence on the awareness of smart cities benefits and the change in behavior, since all people, married or not, will enjoy the same benefits. The same result was confirmed by Kamnuasilpa et al. (2020) who showed that there are no significant differences between married and single people with respect to their awareness of the benefits of smart cities, in the study conducted in Taiwan. Hence, the following hypothesis H11 is proposed:

**Hypothesis $H_{11}$:** There is a significant statistical difference between Marital status and Change in User Behavior and Net Benefits of using the smart meters in Kuwait.

The bigger the size of the family, the more responsibilities, and hence more awareness of the savings and benefits of smart cities. Blanton & Trybula 2020) has shown that big families tend to exhibit higher levels of awareness of smart cities technologies and benefits and thus are more willing to adopt and use it. On the other hand, small families can appreciate smart cities technologies and might be willing to adopt and use it (Iram et al. 2018). Ul Haq et al. (2020) conducted a study to examine the benefits of solar energy in smart cities. The authors have found that families with big number of members tend to be more aware of the benefits of using solar energy in smart cities and thus have higher adoption rate than others. This is attributed to the realized benefits that they would get in the energy bills and thus it is more feasible to them than others. Therefore, the following hypotheses $H_{12}$ is proposed:

**Hypothesis $H_{12}$:** There is a significant statistical difference between the Number of children and Change in User Behavior and Net Benefits of using the smart meters in Kuwait.

The size of the house is one of the demographics that is of interest. When people live in big houses, their approach and perception of smart cities technologies might change since there will be a lot of expenses put into their houses (Nagpal et al. 2018). Le (2017) showed that people that have big properties are more perceptive of the benefits of smart cities technologies. Thus having higher willingness to adopt it since there will be savings in the resources needed to maintain their house. In addition, smart cities technologies will be very beneficial to big houses as the efficiency of the house could increase substantially (Himawan Kunto et al. 2018). Hurst et al. (2020) concluded that type of dwelling is one of the factors that could help in determine the acceptance level of smart gas meters in Ireland. A number of dwelling were examined in this study. It showed that people living in terraced houses are more willing to use the smart technology than others, due to their visual realization of the savings made on their energy bill. Therefore, the following hypothesis $H_{13}$ is proposed:

**Hypothesis $H_{13}$:** There is a significant statistical difference between the Type of house and Change in User Behavior and Net Benefits of using the smart meters in Kuwait.

## 3.9 BUILDING THE CONCEPTUAL MODEL

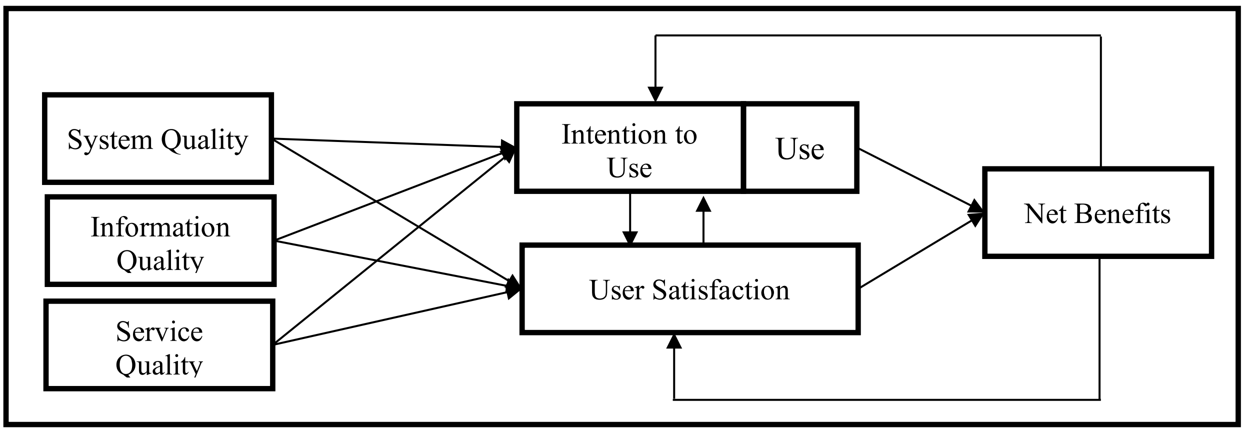
Drawings of the findings related to the four models of IS success of DeLone and McLean (2003), UTAUT model of Venkatesh et al. (2003), and Trust in Provider of Ridings et al. (2002) and the Behaviour model of Subramanian, Gunasekaran and Gao (2016), a conceptual model has been developed. The conceptual model is built by using a cornerstone study. A study by DeLone and McLean (1992) made a significant contribution to the task, in the current study of finding the success factors of information systems. This contribution has the consensual support of most of the researchers in this area. DeLone and McLean (1992) stated that "in searching for an IS success measure, there are nearly as many measures as there are studies" (p. 61). The information system is the main backbone of firms. The information system usually helps companies and organisations to make decisions and manage their operations by collecting information to achieve a competitive advantage. In other words, information systems can help firms to improve their operations and efficiency in order to compete with other companies and firms.

After more than 180 empirical studies in this field, researchers were able to identify the elements and success factors of information systems (Garrity & Sanders 1998; Ishman 1996; Rai, Lang, & Welker 2002). They identified six elements of information system success: system quality, information quality, use, user satisfaction, individual impact, and organisational impact. Delone and McLean (1992) mentioned that these elements were interrelated and interdependent and led to forming a model for IS success. There are more than 200 journal articles identified by Delone and McLean (2003), which were used in their success model. Researchers have used this model and developed it based on the nature and type of their study (Garrity & Sanders 1998; Ishman 1996; Rai, Lang, & Welker 2002). They also approved the other part of the model which assumed that both system quality and information quality can positively influence both system use and user satisfaction (Igbaria & Tan 1997; Seddon & Kiew 1996).

One of the main purposes of SERVQUAL is to measure the service quality of IT departments. Some researchers suggested that it could add service quality to the D&M model. For example, Pitt, Watson and Kavan (1995) suggested adding service quality to the D&M model after revising the information system research. SERVQUAL can measure user expectations and their perceptions of the IT department. Although some researchers resist this change of the Delone and Mclean (1992) model, others like (Jiang, Klein & Carr 2002) agree to add some modifications to the D&M model.

The reason that Seddon (1997) disagrees with modifying and making these changes is that he thinks the whole model is confusing due to both process and variance being combined together,resulting in shortcomings for this model. He also suggests that the modifications introduced by Seddon reduced the strength of the D&M model and minimised its impact. Delone and McLean (2003) argue that this combination is one of the strengths of their model. Some researchers add knowledge management and e-commerce to the model to acquire more evaluations such as (Kulkarni, Ravindran & Freeze 2006; Delone & McLean 2003; Zhu & Kraemer 2005). The updated IS success model by Delone and McLean is shown in Figure 1.

Figure 1: Updated D&M IS Success Model

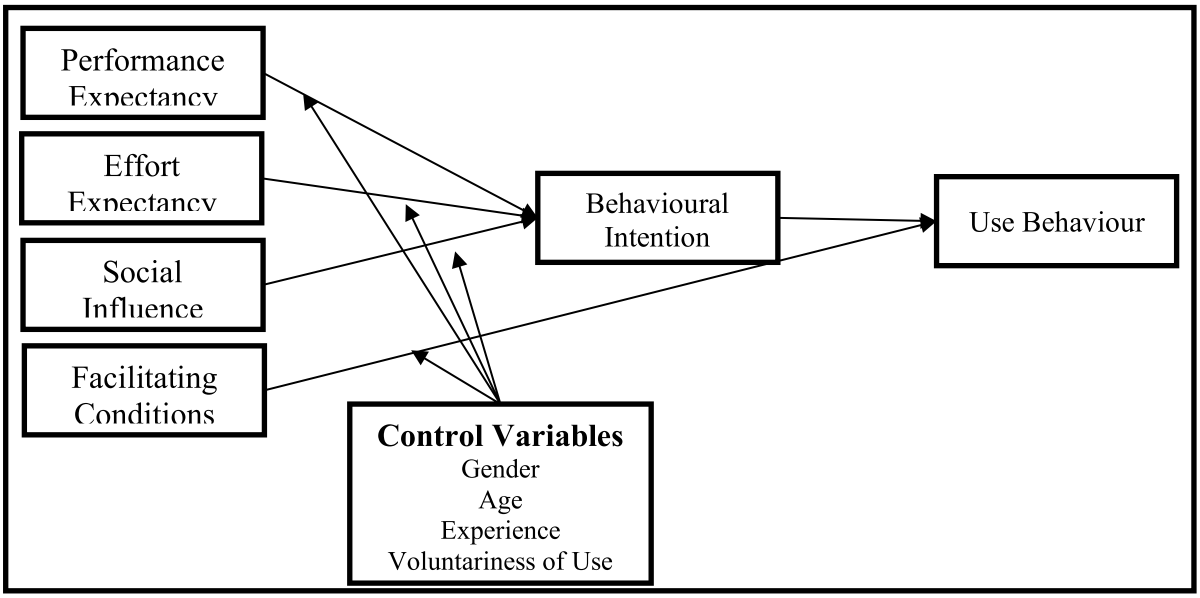


Source: Delone and McLean (2003)

Another study was conducted by Venkatesh et al. (2003). This study reviewed the literature related to user acceptance and evaluated eight prominent models. This evaluation led the authors to devise a unified model which integrated elements drawn from all eight models. The eight models reviewed were: the theory of reasoned action, the technology acceptance model, the theory of planned behaviour, a model combining the technology acceptance model and the theory of planned behaviour, the motivational model, the innovation diffusion theory, the model of PC utilization and the social cognitive theory. Data was collected from four different organisations over a period of six months. Based on three points of measurement, the eight models explained between 17% and 53% of the variance in the data related to user intentions to use information technology.

A model, called the 'Unified Theory of Acceptance and Use of Technology' (UTAUT), was then devised. This model incorporated four key determinants of intention and usage, and as many as four moderators of the principal relationships. Following the use of eight discrete models, UTAUT was tested using the data originally used in the other eight models and was found to have outperformed each of the eight discrete models. UTAUT, as a model, was then confirmed with data from two new organisations with similar results. UTAUT is, therefore, a useful instrument for managers who require some means of assessing the likelihood of success for introducing a new technology. It is also useful for those who need to understand what factors may influence end users' acceptance so that a more proactive approach can be adopted in design interventions (including training, marketing, etc.). It is specifically targeted at groups of users who have been previously identified as being reluctant to use technology. This is shown in Figure 2.

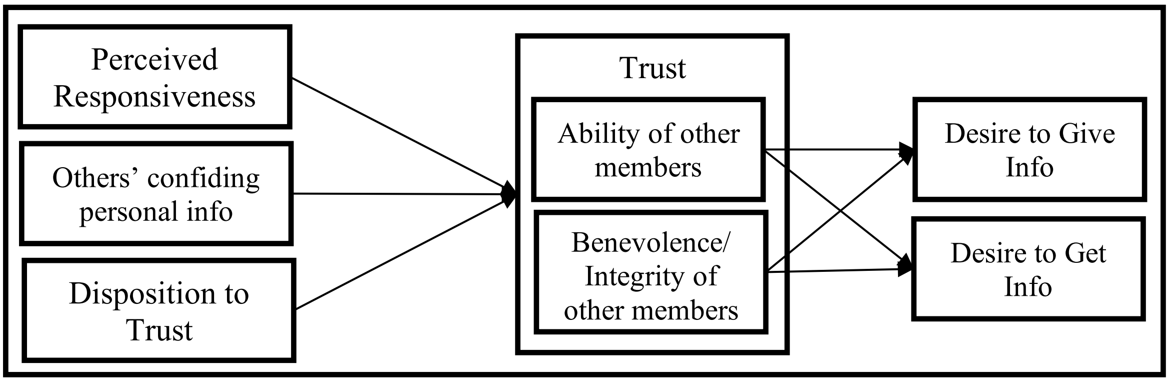
Figure 2: Unified Theory of Acceptance and Use of Technology (UTAUT)




Source: Venkatesh et al. (2003)

The third study was conducted by Ridings et al. (2002). This study investigated a number of downstream effects of trust in virtual communities and identified the antecedents of trust in this special kind of environment. The study determined that there was an impact of trust on the intention to use the technology, as well as satisfaction with the technology. The model of this study is seen in Figure 3.

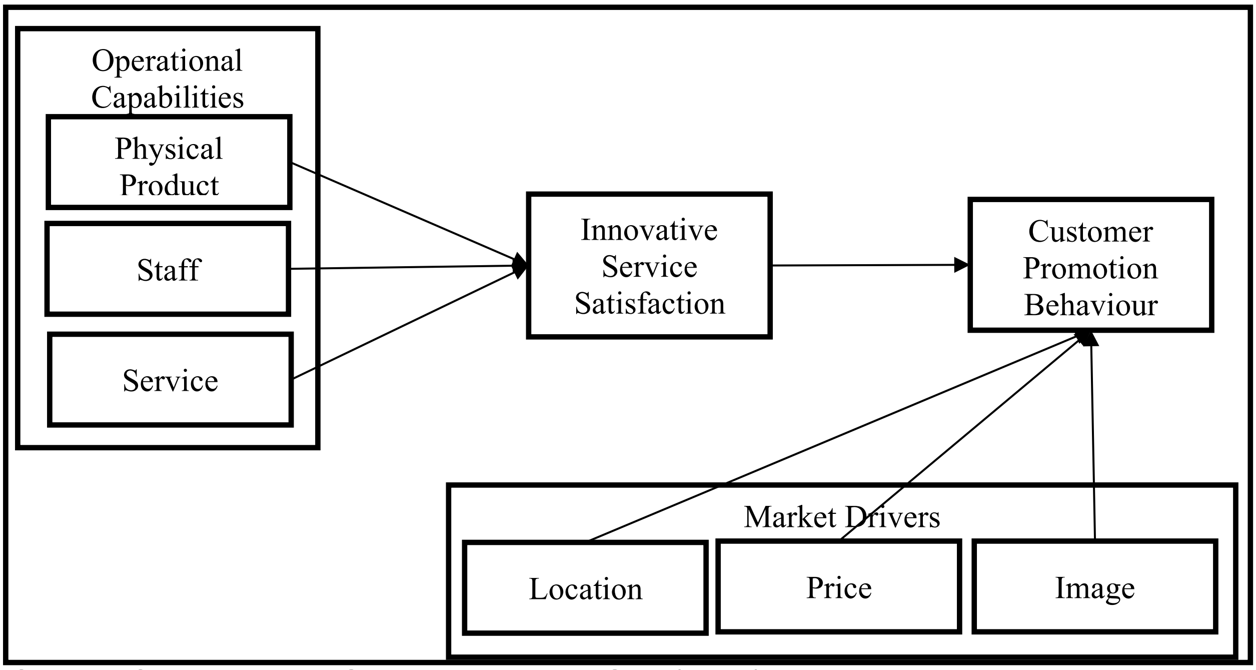
Figure 3: Antecedents and effects of trust model




Source: Ridings et al. (2002)

Another study was performed by Subramanian, Gunasekaran and Gao (2016). The study was based in China and attempted to examine the impact of satisfaction on customer promotion behaviour. It examined the role of operational capability and a competitive market in ensuring customer satisfaction and how this reflects positively on changing their promotion behaviour in the Chinese context. Results of the study demonstrated that operational capabilities had an impact on customer satisfaction while market drivers influenced the change in consumer behaviour.

Figure 4: Innovative Service Satisfaction and Customer Promotion Behaviour model




Source: Subramanian, Gunasekaran and Gao (2016)

Interestingly, the study also showed that innovative service satisfaction had a positive and strong association with customer promotion behaviour. The model of this study is shown in Figure 4. In the context of their study, Subramanian and colleagues found that when translating satisfaction with budget hotels to change behaviour, hotels can ensure success.

Drawing on the strengths of these four models, the conceptual model designed for this study is illustrated in Figure 5. Based on the success model, the conceptual model of this study proposes that information and service quality factors determine the level of user satisfaction with smart meters. Ultimately, this leads to a change in user behaviour and numerous benefits from using smart meters. The Success model helps in understanding the mediating role of user satisfaction between quality factors and user change behaviour and net benefits. According to this theory, individuals who experience high quality of information and service using smart meters will tend to exhibit satisfaction. In addition, satisfied customers with smart meters will experience the benefits of using smart technologies.

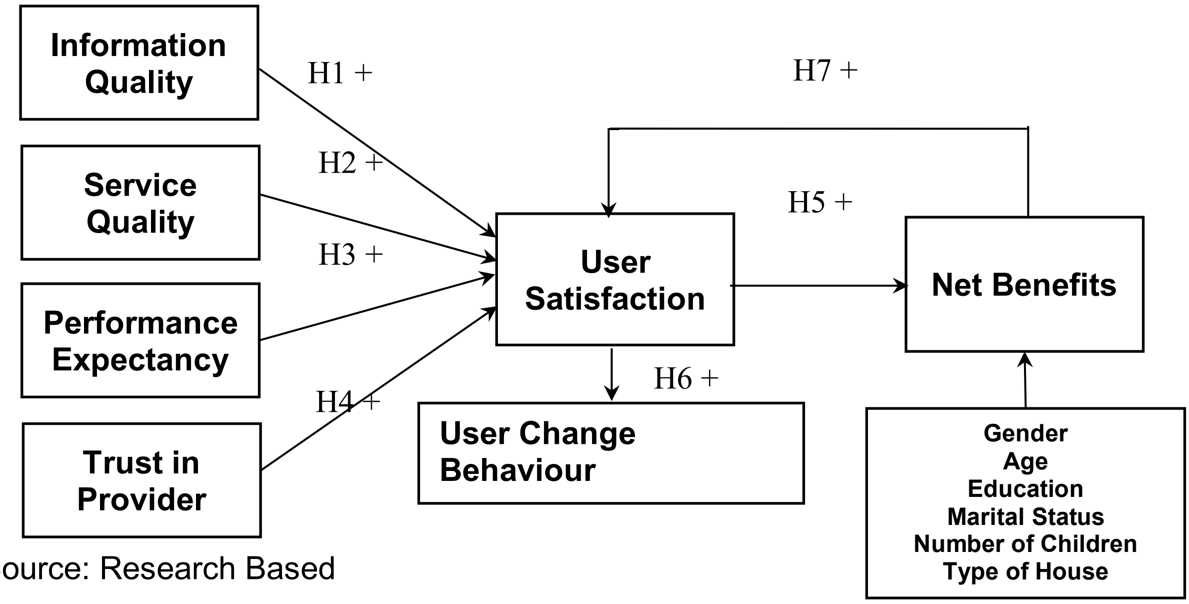
In addition, the UTAUT theory explains how specific factors influence users' intention in order to lead to the exhibition of increased use. There are a number of factors that are influencing user behavioural intentions such as performance expectancy, effort expectancy, social influence and facilitating conditions. However, this study only employs performance expectancy since smart city technologies are enforced to citizens. By applying the theory to the conceptual model, when users have high performance expectancy of smart city technologies, they will be more satisfied and will hence experience a change in behaviour and net benefits.

Furthermore, the Ridings et al. (2002) theoretical framework suggests that trust in providers has a significant impact on the desire to give and get information. Applying this finding to the conceptual model of the current study, the trust in providers propels the individuals to interact with the smart city technologies which, in essence, is a form of satisfaction. Hence, the theoretical framework of Ridings et al. (2002) is useful in explaining how citizens that live in smart cities utilise its technologies, trust the provider and hence display an intense level of satisfaction.

Since Kuwait is yet to establish a full eco-system of smart cities. It has already installed smart meters in various cities of Kuwait and will continue to roll them out this year as the initial step towards establishing smart cities. - This study is based on user satisfaction with smart meters. It is also to be noted that the technology is being pushed to consumers since they have no choice but to use the smart meters. The model depicts the impact of information quality, service quality, performance expectancy and trust in providers on user satisfaction. The study also examines the impact of user satisfaction on user change behaviour toward smart city technologies and on the net benefits gained from using smart city technologies. In addition, the study also examines the mediating role of user satisfaction between the antecedents of user satisfaction and net benefits, as well as change in user behaviour. Based on the study by Delone and McLean (2003), there is a two-way association between user satisfaction and net benefits. In this sense, satisfied users are hypothesized to get the net benefits from using the technology. On the one hand, reluctant users can also get the benefits as they become more satisfied with the technology.

The current study is based in Kuwait. As Kuwait is in the process of building smart cities – it has already commenced the rollout and use of smart meters for electricity consumption management and monitoring – the study will focus on examining the factors of smart meters satisfaction as a test case, and also explores the resultant benefits from such systems.

Figure 5: Proposed Conceptual Model for evaluating the factors affecting the net benefits and change in user behaviour in a technology push scenario in Smart Cities




Source: Research Based

## 3.10 CHAPTER SUMMARY

This chapter was conceived to build the conceptual model. Before doing so, the variables of the conceptual model were individually explored and analysed. The research hypotheses were proposed in this chapter. Various studies have focused on examining the impact of TAM and/or UTAUT on intention and attitude towards technology. There was a lack of studies that focused on trust as well as information and service quality. This research attempts to fill the gap in the literature by focusing on quality, trust and performance expectancy as determinants of user satisfaction. Moreover, the study will also examine the impact of user satisfaction on the change in behaviour toward smart city technologies. Hence, the study is the first one applied in Kuwait to determine the benefits of smart cities. This study is also a unique study as it attempts to examine the impact of information quality, service quality, performance expectancy. It also attempts to study trust in providers in the context of technology push, as smart city technologies are enforced on all citizens. It is not a mere option to choose whether to use smart city technologies or not. Hence, this study provides a new perspective on the satisfaction and benefits of smart city technologies when the technology is being pushed, and how it can have an impact on user behaviour. The following chapter discussed the methodological issues involved in this research.

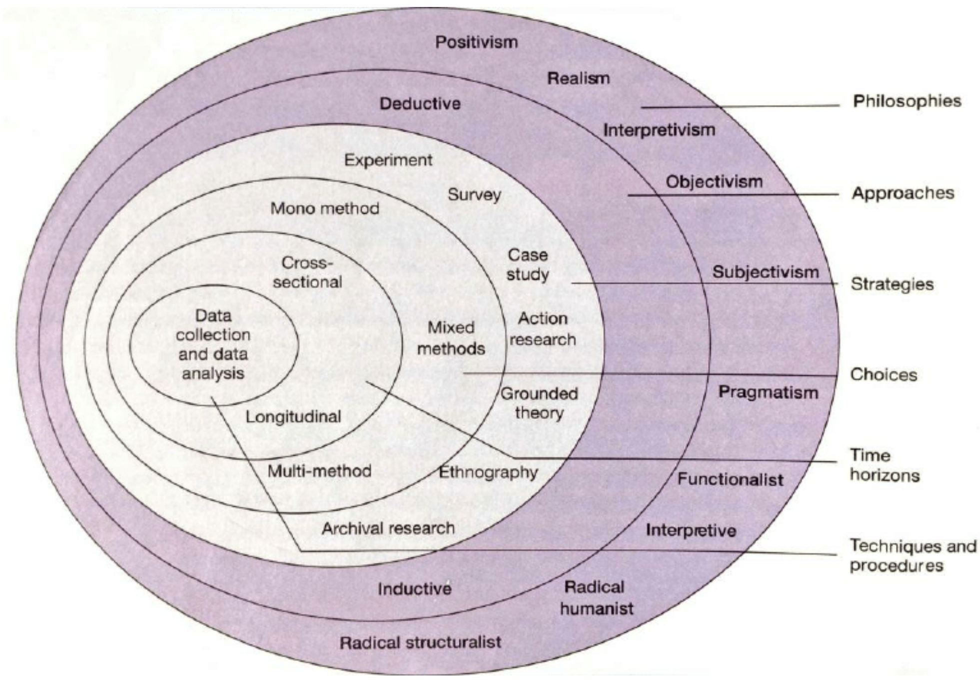
# CHAPTER 4: RESEARCH DESIGN AND METHODOLOGY

## 4.1 INTRODUCTION

The methodology research onion is utilised to guide the design of the research and to address methodological issues in a systematic way. Saunders et al. (2012) depicted the research design as a research “Onion”, which helped to frame the various approaches available to the researcher as shown in Figure 6.

This chapter commences by exploring the research questions and objectives. It then describes the various philosophical approaches before selecting the most appropriate. Next, it discusses both inductive and deductive approaches and pinpoints the most suitable approach. After that, the chapter explores the methodologies available before selecting the quantitative methodology. This is followed by the strategy layer where the surveys are chosen and justified. Then, it determines that questionnaires are the best method for collecting data. Finally, the chapter provides an overview of the target population as well as data analysis tools and ethical considerations.

Figure 6: The Research Onion




Source: Saunders et al. (2012)

## 4.2 RESEARCH PHILOSOPHY

Research philosophy involves the establishment of what constitutes valid knowledge as well the methods we can use to acquire it (Saunders et al. 2012). The advancement of knowledge is achieved by postulating an innovative theory or finding answers to a specific problem or phenomenon in a specific context. The researcher's philosophical stance aids the process of devising a better conceptualisation based on assumptions of how the world is structured. These shaped assumptions will aid the researcher in taking the most appropriate decision on the most suited research strategy as well as on the methods to employ their own research (Saunders et al. 2012). In terms of assumptions, the key ones that are used as pillars when starting a new research are the ontological and the epistemological assumptions (Collis & Hussey 2009) underlying the research. Ontology is concerned with the nature of reality or of a particular phenomenon. On the other hand, epistemology is concerned with what constitutes valid knowledge in a given context (Bryman and Bell 2011). Epistemology is considered as one of the primary philosophical assumptions that can be used to draw the research path for any study (Myer 1997). Various scholars have considered epistemology to be crucial for research because it helps in selecting the most suitable research strategy, as well as the concomitant means for collecting empirical evidence (Orlikowski and Baroudi 1991). However, epistemology is divided into three main types which could be employed depending on the nature of the study. These types are: positivist, interpretive and critical (Straub, Gefen & Boudreau 2005). Positivists postulate that reality is present in an objective manner, can be measured due to its nature and is not related to the researcher tools. Interpretivism postulates that the reality is subjective and is present in our minds in a social manner by which it can be meaningfully shared inter-subjectively between people (Collis & Hussey 2009). Finally, critical theory is about providing a critical evaluation of the social reality that the researcher is intending to investigate in order to effectively transform it in an emancipative manner (Orlikowski and Baroudi 1991).

### 4.2.1 Positivist approach

The positivist position posits a mind-independent reality which can be known by the researcher through objective means of inquiry. This occurs when the researcher remains objectively detached from the phenomenon under investigation in order to avoid any distortions due to researcher bias (Hussey and Hussey 1997). Studies that follow the positivist approach examine a theory or a set of theories in order to arrive at a better understanding of a particular phenomenon. As explained by Orlikowski and Baroudi (1991, p. 5), positivist studies are “premised on the existence of a priori fixed relationships within phenomena which are typically investigated with structured instrumentation.” This approach stipulates that social phenomena are measurable through their attributes. Hence, these types of studies are associated with methods susceptible to measurement and which are based on the numerical analysis (Collis & Hussey 2013). The current study aims to investigate the factors affecting the net benefits and change in user behaviour in a technology push scenario.

### 4.2.2 Positivism as a philosophical approach for this study

Positivism purports to provide unambiguous and accurate knowledge of the external world. The term itself implies something that is posited (i.e. something that is already given, in this case a pre-existent theory). Positivism within human or social studies is interested in the development of a comprehensive society by applying the scientific method to the study of society and human beings for their benefit. Positivist science is based on direct experience, rather than on speculation. Within this paradigm, knowledge is only grounded in something that is posited or given, not in something arrived at speculatively. Therefore, positive science (or positivism) is defined in terms of what is posited or given through direct experience; what is observed by scientific methods. Crotty (1998) sees contemporary positivism as linked to empirical science as closely as ever. The positivist philosophy is the foundation of the natural sciences which leads to law-like generalisations as is the case in physics or the other natural sciences (Saunders et al. 2012). Scientific knowledge is both accurate and certain, and has been successfully applied in fields of technology and medicine, which explains the great confidence which people have in the application of science. However, positivism is not without its critics and its claims to discover absolute truth obtained by completely objectivist methods have been challenged so that, currently, the term post-positivism is preferred as the limitations of the scientific method have been acknowledged.

For the purpose of achieving the aim of the research, a conceptual research model has been devised from the various scholarly studies which have been examined, as well as some hypotheses to examine the model. The study at hand attempts to examine the conceptual model in a quantifiable manner and is aided with the use of five measurable hypotheses; hence, interpretive more explanatory approaches are not suitable for this particular study. Furthermore, the critical theory approach is not an appropriate research approach as it is not related to providing a societal critique nor is it directly aiming at providing an emancipatory or political critique (Bryman and Bell 2011). Thus, having evaluated all three methodologies, a positivistic approach as this appears to be the most appropriate for answering the research questions. This research will employ the positivist approach for carrying out this study, as the key focus of the research is to examine the impact of information quality, service quality, performance expectancy and trust in providers on user satisfaction with smart city technologies in Kuwait. The study also attempts to examine the influence of user satisfaction on the net benefits of smart city technologies. As the smart city technologies are enforced and not optional to use, the study also assesses the role of user satisfaction in triggering change in user behaviour toward smart city technologies.

In the positivism philosophy, researchers deal with issues objectively without impacting the real problem being studied. Thus, positivism philosophy needs very well structured methodology, quantifiable observations and statistical analysis (Remenyi et al. 2005). Consequently, it is a basic assumption of positivism that only an objective and detached approach should be adopted by in analysing and interpreting collected data (Saunders et al. 2012). The observations of this study are quantifiable through the use of well-structured questionnaires to collect the data, which calls for the use of positivism as a philosophy (Creswell & Creswell 2017).

## 4.3 RESEARCH DESIGN

Design is an important aspect of any research due to its role in steering the research towards meeting its aims and objectives (Polonsky & Waller 2018). The research design entails important decisions regarding the Research Approach, the Research Types, and the Research Methodology, as well as decisions about sampling and data collection.

### 4.3.1 Research Approaches

This involves a choice of whether to follow a deductive or an inductive approach. A deductive approach examines various theories in the literature which have been advanced to explain the phenomenon under investigation. The researcher then adopts the theory which is considered as the most appropriate to explain that phenomenon (Robson 2002). However, theories are rather tentative and can only be adopted when there is sufficient evidence to support them. Usually the selected theory results in a number of hypotheses which are then tested using quantitative methods. Since the proposed study is largely theory driven, a deductive approach is adopted to test the theory by quantitative means and statistical analysis (Creswell & Creswell 2017). Thus, a deductive approach will be used in this study since there is an abundance of material available and theories have been formulated. Based on theory, hypotheses are formulated in order to either confirm the theory, or to disconfirm it if the evidence is insufficient to support it.

### 4.3.2 Research Types

There are three main research purposes, which are used by different scholars. These purposes are descriptive, exploratory and explanatory (Creswell, 2013). A researcher will use the exploratory purpose when the research problem is still fairly unclear, or when the research is still in the development phase. This approach would be used because it allows the researcher to shed some light on new findings from their own research (Yin, 2003). The researcher does this through asking some questions and trying to analyze the answers to these questions (Anderson, 2004; Ruto et al., 2009). As explained by Saunders et al. (2012), an exploratory research is conducted by reviewing the available literature, conducting focused interviews with professionals and experts in the field of study or through arranging for focus groups sessions.

As for the descriptive purpose, it is used when there are some clear facts and findings associated with the research problem (Yin, 2003; Ruto et al., 2009). However, Anderson (2004) earlier argued that the descriptive research is evaluating and analyzing data, whether quantitative or qualitative, in an attempt to define the problem and understand the data. Therefore, and as argued by Creswell & Creswell (2017), it is vital that the researcher has a clear structure in place in order to be able to collect the proper data needed.

Finally, the explanatory purpose is used when the research problem is clearly defined and understood but, establishing the links between the research variables are missing. Investigating the links or causal relationships is done with the aid of already established hypotheses by the researcher and through analyzing the data with the available statistical tools. The explanatory purpose, therefore, determines the existence and strength of these links between the research variables (Bryman & Bell 2011; Ruto et al., 2009; Saunders et al., 2012). Research reported herein has an exploratory orientation. Literature was explored to gain an understanding of the subject and to formulate the main questions and research hypotheses. Examination of hypotheses is facilitated via data collection and subsequent analysis. After collecting and gathering the data with the aid of a structured questionnaire based on items that have already been used in previous published research, explanatory analysis was used to support initial understanding of data. Formal statistical data analysis will allow the relationship between the research variables and understanding user change behaviour when technology is pushed on them to be explored.

### 4.3.3 Research Methodology

The research methodology is used to make sure that dependable knowledge is conducted through the research process. According to the research problem and the available and collected data, the research methodology is considering quantitative and qualitative approaches that can be mutually illuminating and informative to the study of leadership, and can also be combined (Bryman & Bel 2011). An integral research orientation could help move the data from a narrowed perspective to richness, contextualized theory developing a better interpretative and explanatory potential. So, the concern is determining the variables and factors, setting and examining the hypotheses and propositions, mediators, antecedents, outcomes and their relations.

The first step of this research methodology is dealing with quantities and numerical analyzed data. Saunders et al. (2012) stated that Quantitative research is used to attach different numbers to relationships between variables. The quantitative research was categorized into three classes; comparative, descriptive and prescriptive. Comparative research is used to compare statically analyzed data for both dependent and independent variables. Descriptive research means using numbers to quantify phenomenon. Prescriptive research is used to describe the relationship between the cause and effect in the form of equations. This research is considered as hypothesis testing research, to test the theory where the hypothesis is determined from. It is essential to have sufficient information of the phenomenon to be able to explore the relationship between different variables (Creswell & Creswell 2017).

Qualitative research is focusing on obtaining the data on form of words rather than numbers (Saunders et al. 2012). Qualitative research can offer answers and feedback to the research questions which are not primarily questioned. Most leadership studies adopted a qualitative approach because it is highly sensitive to the context of leadership (Bryman & Bell 2011); however, this research needs more effort and time to collect the required data. As Saunders et al. (2007) stated that the multiple approaches can be used for any research type. The main difference between this methodology and the Quantitative method is that this methodology is used to come up with propositions, as opposed to testing hypotheses within the previous type. We will use the quantitative methodology because it will give us the chance to test relationships between the independent and the dependent variables (Creswell & Creswell 2017).

For this research, it was observed from the literature that many of the relevant publications on smart cities were conducted as a quantitative study, which was evident in the use of questionnaires to collect data. Prior to choosing the appropriate research methodology, various methods were investigated. However, it was found that this methodology was the most suitable since the population of this study is huge (Scott et al. 2016), and it would not add value to conduct a qualitative study; as some citizens might not be fully versed in technology (Lee et al. 2011) and can articulate their thoughts on use and adoption of technologies in smart cities. The literature has helped in gaining a good perspective and allowed for the selection of this methodology.

### 4.3.4 Time Horizon

Two types of time horizons are possible; a research can have either a Cross-Sectional or a longitudinal time horizon. A longitudinal time horizon is appropriate where a phenomenon is being observed over time in order to investigate how that phenomenon changes over time (Bryman and Bell 2011). Thus, it is appropriate for sociological studies of how young people grow from childhood to adulthood in a given culture, or for medical studies where the interest is to examine how certain diseases develop over time. However, that is not the aim of the current study where a Cross-Sectional time horizon is appropriate to obtain a snapshot of a certain phenomenon within a relatively short and well-defined timeframe (Saunders et al. 2012).

## 4.4 DATA COLLECTION TOOL AND TECHNIQUE

Data was collected by means of a self-administered questionnaire. The questionnaire consisted of closed-ended questions which were designed to elicit responses based on a 7 point Likert scale. This facilitated ease of answering the various questions on the part of the respondents. The questionnaire was made of two parts. Part one includes all the demographics such as gender, age, marital status, educational level, number of children in the house and the type of House. Gender is important since some owners of home might be females that are divorced or widowed. Hence, gauging the opinion of both will help in determining if there are differences in perceptions. Age is the second variable. Older people tend to prefer an old fashioned way of doing things. Therefore, it is vital that we test whether age is a factor in user satisfaction and user change behavior. The study also asked about the marital status of the respondents. Married people might think twice about the consumption of electricity. Therefore, this question will help us in analyzing the differences between individuals from different social backgrounds. Then, it asks about education, as this variable might prove relevant in understanding the impact of technology push on people, especially the educated ones. Then, the number of children in the household is included. As the house gets bigger and more children are there, it might be useful to monitor electricity consumption. Using smart meters will achieve this. Hence, this question will help in examining the differences of perceptions between users with different size families. Finally, the type of house is asked to determine the type of house that has a smart meter. With bigger houses, it might be wise to use smart meters efficiently in order to get the most benefit. However, it is interesting to see if those with bigger houses will get more benefits from smart meters than those with smaller houses.

Part two contains statements that were developed using the literature. These statements attempt to measure the research variables, which will help in understanding the impact of technology push on people. Table 3 presents the source of the research questionnaire.

Chatterjee et al. (2018) conducted a study to examine the success of IoT in smart cities in India. The authors employed the TAM model in order to examine the acceptance and use of smart cities technologies. Factors such as information quality, system quality, service quality, user satisfaction and net benefits were used. By examining these factors, there were some similarities on the context of these factors and the statement it's measuring. However, the statements were modified to fit the needs of this study in the context of Kuwait, and especially the use of smart meters. An example of information quality measure is "the information that the smart meter generates is accurate. An example of system quality is "the smart meter enabled services are easy to use," an example of service quality measure is "The service quality of smart meter is reliable to ensure users get the service they need," an example of user satisfaction measure is "I am confident that the data generated from smart meter will help the government in decision making process," and an example of net benefits measure is "Using smart meters will help me doing things quicker."

One of the seminal studies in the literature is conducted by Venkatesh et al. (2003) where the authors examine the use and adoption of technology. It examined many factors which also included performance expectancy, which is one of the factors researched in this study. The performance expectancy measures were modified to fit the needs of this study in the context of smart meters. An example of performance expectancy measure used in this current study is "I would find the smart meters useful in my job." With respect to trust in providers, this factor was adapted from a study by Riding et al. (2002), where the study examined the antecedents and effect of trust in virtual communities. An example of a trust in provider measure is "I generally have faith in smart meters." For user change behavior, which is linked to the impact of push technology on individuals, the measures of this study were adopted mainly from a study by Gefen (2003). An example of user change behavior measure is "I would use smart meters instead of the traditional methods of conducting the services."

Table 3: Source of the questionnaire

| Statement | Source |
| --- | --- |
| **Information Quality** | |
| The information that the smart meter generates is accurate | Chatterjee, S., Kar, A.K. and Gupta, M.P., 2018. Success of IoT in smart cities of India: An empirical analysis. *Government Information Quarterly*, *35*(3), pp.349-361. |
| The information that is processed by the smart meter is secured | |
| The Information available through the smart meter is relevant for me | |

| | |
|---|---|
| The information presented by smart meter is displayed in a useful format | Seddon, P. and Kiew, M.Y., 1996. A partial test and development of DeLone and McLean's model of IS success. *Australasian Journal of Information Systems*, *4*(1). |
| The information that the smart meter generates is clear | |
| The smart meter provides sufficient information to users | |
| The smart meter provide up-to-date information to users | |
| The information that the smart meter generates is produced in time | |
| The information that the smart meter generates is precise | |
| The information that the smart meter generates meet your needs | |
| **System Quality** | |
| The smart meter enabled services are easy to use | Chatterjee, S., Kar, A.K. and Gupta, M.P., 2018. Success of IoT in smart cities of India: An empirical analysis. *Government Information Quarterly*, *35*(3), pp.349-361. |
| The smart meter is up to global standard | |
| The smart meter ensures privacy of the users | |
| Smart meter is user friendly. | Seddon, P. and Kiew, M.Y., 1996. A partial test and development of DeLone and McLean's model of IS success. *Australasian Journal of Information Systems*, *4*(1). |
| Compared to other IT systems, Smart meters are easy to learn. | |
| I find it easy to get a Smart meter to do what I want it to do. | |
| It is easy for me to become skilful at using a Smart meter. | |
| I believe that Smart meters are cumbersome to use. | |
| Using Smart meter requires a lot of mental effort. | |
| Using Smart meter is often frustrating. | |
| **Service Quality** | |
| The service quality of smart meters is reliable to ensure users get the service they need. | Chatterjee, S., Kar, A.K. and Gupta, M.P., 2018. Success of IoT in smart cities of India: An empirical analysis. *Government Information Quarterly*, *35*(3), pp.349-361. |
| The support staff of smart meters will be competent to provide the needed support. | |
| The call centre representatives of smart meter always help me when I need support with smart meter | Sharma, S.K. and Sharma, M., 2019. Examining the role of trust and quality dimensions in the actual usage of mobile banking services: an empirical investigation. *International Journal of Information Management*, *44*, pp.65-75. |
| The call centre representatives of smart meter always pay personal attention when I experience problems with smart meter | |
| The call centre representatives of smart meter have adequate knowledge to answer my queries related to smart meter | |
| **User Satisfaction** | |
| I am confident that the data generated from smart meters will help the government in the decision making process. | Chatterjee, S., Kar, A.K. and Gupta, M.P., 2018. Success of IoT in smart cities of India: An empirical analysis. *Government Information Quarterly*, *35*(3), pp.349-361. |
| Smart meters make my life easy. | |
| I would truly enjoy using smart meters. | |
| I am pleased that the smart meter meets my needs. | Seddon, P. and Kiew, M.Y., 1996. A partial test and development of DeLone and McLean's model of IS success. *Australasian Journal of Information Systems*, *4*(1). |
| I am content that the smart meter is efficient. | |
| I am happy with the effectiveness of the smart meter. | |
| Overall, I am satisfied with the smart meter. | |
| **Net Benefits** | |
| **Using a smart** meter will help me do things quicker. | Chatterjee, S., Kar, A.K. and Gupta, M.P., 2018. Success of IoT in smart cities of India: An empirical analysis. *Government Information Quarterly*, *35*(3), pp.349-361. |
| The smart meter will help me to improve the quality of life. | |
| I think the overall cost of using the smart meter is going to be reduced in the future once the smart meters are fully operational. | |
| The smart meter helps reduce my energy bills. | |

| | |
|---|---|
| The smart meter increases my understanding of my energy usage. | Gable, G.G., Seder, D. and Chan, T., 2008. Re-conceptualizing information system success: The IS-impact measurement model. *Journal of the association for information systems*, *9*(7), p.18. |
| The smart meter helps me make better decisions about energy usage. | |
| The smart meter helps me to compare my energy usage to neighbours. | |
| **Performance expectancy** | |
| I would find the smart meter useful in my job. | Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. MIS quarterly, 425-478. |
| Using the smart meter enables me to accomplish tasks more quickly. | |
| Using the smart meter increases my productivity. | |
| If I use the smart meter, I will increase my chances of saving the public resources. | |
| **Trust in Provider** | |
| I generally have faith in smart meters. | Ridings, C.M., Gefen, D. and Arinze, B., 2002. Some antecedents and effects of trust in virtual communities. *The Journal of Strategic Information Systems*, *11*(3-4), pp.271-295. |
| I feel that smart meter are generally reliable | |
| I generally trust smart meters unless there is a reason not to. | |
| I trust smart meter to offer secure service | Sharma, S.K. and Sharma, M., 2019. Examining the role of trust and quality dimensions in the actual usage of mobile banking services: an empirical investigation. *International Journal of Information Management*, *44*, pp.65-75. |
| I find smart meter is secure in executing tasks | |
| I find smart meter is safe for receiving consumption statements | |
| **User change behaviour** | |
| I would use a smart meter instead of the traditional methods of conducting the services. | Gefen, D., 2003. TAM or just plain habit: A look at experienced online shoppers. *Journal of Organizational and End User Computing (JOEUC)*, *15*(3), pp.1-13. |
| I am very likely to provide needed information to the smart meter in order to better serve my needs. | |
| I use the smart meter to get energy information about my residence. | Gable, G.G., Seder, D. and Chan, T., 2008. Re-conceptualizing information system success: The IS-impact measurement model. *Journal of the association for information systems*, *9*(7), p.18. |
| I use the smart meter to better understand what the energy terms mean. | |

As recommended by Saunders et al. (2012), a pilot study was carried out in order to determine that the questions were unambiguous and fit for purpose in the interests of ensuring validity. A small number of people were selected to evaluate the questionnaire to ensure that it could be understood by the general population. The people taking part in the pilot study were informed about the aims and objectives of the proposed study and were asked to comment on the structure of the statements, the layout, the ease of answering the questionnaire and to draw attention to any ambiguities. Based on their feedback, appropriate modifications were made to the instrument.

### *4.4.1* Pilot Study

As mentioned in the previous section, the questionnaire was developed in order to collect data for this study. The questionnaire was based on a 7 point Likert scale ranging from strongly disagree to strongly agree. However, there was a need to pre-test the questionnaire in order to determine face validity and how well suited the questionnaire for this study. Van Teijlingen & Hundley (2002) explains that a pilot study is taking a small scale sample and allow the sample to scrutinize the questionnaire to determine clarity of the measures. The authors also mentioned that pilot study helps in the evaluation of feasibility of the study and the cost and duration of a research design. So, it is a chance to improve the questionnaire before running the final version to the sample population. For this study, a sample of 15 random respondents were selected to take part of the pilot study. These participants were approached at their homes in the areas that contain smart meters. The researcher introduced herself and then gave a brief description of the aim of the researcher. The participants were asked whether they approve to participate in the pilot study. All gave their verbal consent. Then, the participants went through the measures of the questionnaire. Most of the statements were clear to participants. However, some participants pointed out that information quality is not clear as it was not understood who is supplying the information; the customer or the smart meter service provider. Suggestions were made to improve these statements and make it clear that this information is from the service provider to the customers. Also, some participants mentioned that the statements about trust are clear, however, there was no link with security as these are intertwined. Based on their feedback, one of the trust statements was adjusted to reflect security aspect in using smart meters. There was one respondent that raised a point to the researcher concerning the number of children as the original statements did not have a statement that reflect having no children. This option was added to the demographic question. Overall, the participants were happy with the questionnaire and had only minor comments and/or suggestions.

## 4.5 RELIABILITY AND VALIDITY TEST OF THE SURVEY

- **Reliability**

In order to examine the reliability of the findings, the CronBach Alpha was employed since it is the frequently used method for examining the reliability of a measurement scale (Hayes & Hayes 1998). The resulting coefficient measures the consistency amongst a set of measurement items, which range from 0 to 1. In order to conclude that a scale is reliable for a study, the CronBach Alpha coefficient should be at least 0.7 or higher. By achieving this value, it can be concluded that the scale is reliable for measuring the factor (Hair *et al.* 2016; Pallant2013). In this research, reliability was measured by running Cronbach's Alpha test. A value ≥ 0.7 indicates that the measurement items are reliable.

- **Validity**

A test of validity determines how well the measurement instrument actually measures what it supposed to measure (Burns and Bush, 1995). There are various types of validity which can be used, including the following:

**Content validity:** Content validity is primarily about getting the agreement on the measurement scale from a number of professionals. The professionals provide their subjective agreement that the instruments used do actually meticulously measure what they are putatively designed to measure (Cooper and Schindler 2001). In the current research, a test for content validity was conducted by the following procedure. Firstly, the variables that have been previously identified in the literature were selected and used (Churchill and Iacobucci 2004). The variables were carefully defined in the light of the relevant and prevailing literature, explored in the previous chapter. This provided the researcher with a measurement instrument grounded in concepts adopted from the literature. Secondly, a panel of professional and trusted experts were asked to provide their judgment and professional opinion on the questionnaire by going through all the individual items of the measures. This was followed by gathering their observations on the items and applying them to it. Thirdly, a pilot study was conducted using a randomly selected sample from the population in order to gauge their opinion of the questionnaire's fitness for purpose.

**Construct validity:** Construct validity is about examining how well a number of constructs theoretically relates to one another in order to measure the conceptual model, which was built based on a number of theories (Zikmund et al. 2003). The conceptual model used in this research was evaluated using factor analysis to determine the placement of the items under their relevant dimensions. In addition, construct validity was established by conducting tests for convergent validity and discriminant validity.

1- *Convergent validity*: this means that the items of a construct are measuring the same construct and correlate positively with one another (Malhotra & Galletta 1999). Convergent validity is similar to criterion validity (Zikmund et al. 2003) and to correlational analysis, and is one way of establishing construct validity in a research. It assesses the extent to which two measures representative of the same construct are correlated. If they are highly correlated, this indicates that both are likely to be representative of the same construct. In other words, the measures can be said to converge on the same underlying construct with high correlation indicating that the scale is measuring its planned concept. Demerouti et al. (2003) suggests that a value of 0.5 indicates an item-to-total correlation. Item-to-total correlation was performed for this study where all values of 0.5 or higher would indicate the convergent validity of the instrument.
2- *Discriminant validity:* it is used to establish the uniqueness of items and their distinct nature in relation to other items representing different constructs (Hair et al.2016). According to Van Saane et al. (2003), discriminant validity is an indication of the non-correlation between theoretically unrelated constructs. Saunders et al. (2012) argues that discriminant validity can be tested by examining the cross-loading within factor loading. In principle, it is required that the loading value of the item under its construct to be higher than all the loading values under other constructs, indicating discriminant validity.

## 4.6 POPULATION AND SAMPLING

Since smart cities are already in the process of being built in Kuwait but are not yet finished, smart meters will be used as a test case since smart meters are part of smart city applications. The study will be based in Kuwait. The population for this research is all the citizens of Kuwait who already have a smart meter in their residence. Hence, the sampling technique to be used was purposeful sampling (Gentles, Charles, Ploeg & McKibbon 2015). Data was collected over a period of three month through mail, email and also through sharing the link to the questionnaire on through telephone.

The researcher is a sponsored student by the Kuwaiti Ministry of Higher Education. The researcher has obtained approval from the Ministry of Higher Education to conduct this study. In addition, the Ministry of Electricity was addressed and an approval to conduct such study was granted. The student was fully insured by the government as well as government officials. As a practice intended to ensure the willingness of each subject to participate in the study, the government official informed the participant that the decision to participate was fully optional and that there was no obligation to take part. Then, the government official stepped back and allowed the researcher to explain the purpose of the study to the participant and asked if they were willing to participate in the study. This assisted the participants in feeling comfortable and not pressured. After explaining the purpose of this research, participants were asked to fill out the consent form. The addresses and contact information of all smart homeowners was obtained from the Ministry of Electricity. Participants were also contacted via the phone to ask if they are willing to participate in the study. If consent was obtained, the link to the questionnaire was sent to them. For those participants that have outdated contact information, a hard copy of the questionnaire was sent via mail to them. The other method was to acquire the phone numbers of homeowners who were willing to participate and send them the link to the questionnaire through a message. The phone numbers of the participants who were willing to take part were acquired from the Ministry, as they have generated a list of all the addresses and contacts of those who have smart meters. Phone numbers were not supplied initially but were provided after gaining the approval of the homeowner to participate in the study.

Currently, there are 9000 houses that have been equipped with smart meters. It was determined that the required minimum sample size was 300 participants that had smart meters and used them. The Ministry of Electricity and Water initiated the project with this number of houses and the entire country’s meters will be replaced with smart meters soon. The project is a national project and hence smart meters are enforced on all houses and users are obliged to use it. The study will therefore be focused on the user satisfaction triggering change in user behaviour toward smart city technologies.

## 4.7 DATA ANALYSIS

Despite the fact that the PLS-SEM algorithms were developed and in use several decades ago, it is only recently that studies in business have begun to adopt their use (Hair et al. 2016). The slow uptake of this algorithm in business research can be partly attributed to the fact that it took some time to make these algorithms in a format which was user-friendly for the researcher (Temme et al. 2010). However, currently, a number of software packages that support PLS-SEM such as PLS-GUI, Visual-PLS, PLS-Graph, Smart PLS, SPAD-PLS have been developed (Temme et al. 2010). Although each of the aforementioned software packages support PLS-SEM, some of them have distinctive features in terms of options available. In this study, Smart-PLS was used as it contained all the requisite features for evaluating a PLS model. Firstly, compared with other packages, Smart-PLS was available for download free of charge from the Smart-PLS community website. Secondly, Smart-PLS allowed the researcher to automatically build product terms for interaction and moderation analysis. Thirdly, this package has the blindfolding feature required to evaluate the predictive relevance of the model. Nevertheless, the package did have one disadvantage. The package does not return a P-value to determine the significance of the path coefficients. However, a t-statistic value is provided and along with bootstrapping it is possible to calculate the P-value of the pathways. SmartPLS v. 3.2.9 was used to interpret and present the data. Hair et al. (2016) postulated that SmartPLS is excellent for analysing data since it allows for the creation of a Structural Equality Modelling (SEM). In addition, SmartPLS allows a researcher to examine any set of data regardless of its size. Finally, SmartPLS does not assume the normality of data, which is an added advantage for using this statistical software (Hair et al., 2016). The information was generated after conducting various analyses of the data of this research and several frequency tables for the studied variables were created.

## 4.8 ETHICAL CONSIDERATIONS

Every work of research needs to give careful consideration to the ethical dimensions of the research being planned (Bell, Bryman & Harley 2018). The principal ethical considerations in this research are the issues of confidentiality and protection of personal and private data. The study was designed and performed following the University of Bradford's Ethical protocols and approval. Participants were made aware of their rights of confidentiality and of the security of their data and that these would not be disclosed in any way. Data would be held in secure cabinets or password protected on a computer. Following the research, participants were advised that their personal data would be disposed of securely. For this purpose, the researcher assured the respondents that the collected data in this study would only be used for research purposes. Citizens agreeing to take part were assured of their right to have their data withdrawn if they changed their minds within a reasonable timeframe. In addition, the respondents were assured that their answers would remain anonymous and they could therefore express their honest opinions.

Participants were handed a consent form. The consent form explained the nature of the study and also informed confidentiality. Participants were assured that their data is confidential and will remain so in the research with no names of individuals or organisations being identified. In addition, the preamble to the questionnaire explained about the rights of the participants in this study and the assurance that their confidentiality of information and data is to be protected. Participants received the contact information of the researcher and were free to withdraw from the study at any stage of the survey, including after completion (within a two week period), and did not have to provide any justification for withdrawal. The participants were offered the choice to indicate their contact details if they wished to be kept informed of the research findings and recommendations.

## 4.9 CHAPTER SUMMARY

This chapter discussed the various methodological issues involved in the proposed study and, having clarified its underlying philosophical assumptions, a justification was presented for the appropriateness of a deductive quantitative for adequately addressing the research questions driving the current study.

# CHAPTER 5: RESULTS

## 5.1 INTRODUCTION

This study collected data from the target population of people living in smart homes in Kuwait between January 2020 and May 2020. The aim of this study was to investigate the factors that were thought to be influential for the acceptance of smart meters in Kuwait, and ultimately the net benefits of using smart meters. A total of 325 responses were collected through the use of survey that were sent to the target population through mail, phone numbers and email. After inspecting the data, it was determined that 25 responses were not completed. Therefore, a total of 300 valid responses were carried over to the analysis.

This study employed the SmartPLS version 3.2.8 to conduct Structural Equation Modelling (SEM). Convergent Based (CB) SEM was used to carry out the validation of the measurement model, while Path of Least Square (PLS) SEM was used to examine the structural model. Tests such as reliability, Average Variance Extracted (AVE), Convergent, and discriminant validity were administered based on the measurement model presented in this section. This is followed by examining the structural model through a series of statistical tests and hypothesis testing. Next, means comparison tests were conducted using SPSS v. 23. The final section presents the results and a chapter summary respectively.

## 5.2 DEMOGRAPHIC VARIABLES ANALYSIS

The demographic characteristics of the 300 respondents are presented in this section. These characteristics include information unique to each respondent and cover age, gender, level of education and position in the organisation. Table 4 presents the demographic characteristics of the participants in this study.

As shown in the table, there was a fairly even balance in terms of gender, with slightly more males (53%) than females. By examining the age distribution, it can be seen that respondents in the age range 35-44 are the most frequently occurring (33%). The demographic of age of participants allows for a variety of perceptions on the use of smart meters which is assessed in this study. The next highest age group is 25-34 (31%).

Table 4: Demographics Distribution Summary

| Variable | Percentage | Variable | Percentage |
|---|---|---|---|
| **Gender** | | **Marital Status** | |
| Male | 53% | Single | 14% |
| Female | 47% | Married | 69% |
| **Age** | | Divorced | 14% |
| 18-24 years | 9% | Widowed | 4% |
| 25-34 years | 31% | **No. of Children** | |
| 35-44 years | 33% | No Children | 8% |
| 45-54 years | 18% | 1-2 Child | 40% |
| 55 years and above | 9% | 3-5 Children | 24% |
| **Education** | | 6-8 Children | 24% |
| Less than High School | 12% | 9 or more | 5% |
| high school | 10% | **Type of House** | |
| Diploma | 10% | Apartment | 22% |
| Bachelor (BA) | 57% | Low Income House | 25% |
| Masters/PhD | 11% | Villa | 53% |

In terms of education level, it is noted that 57% had a bachelor's degree, followed by 12% with less than high school, 11% with a Masters/Ph.D. and 10% with high school and diploma. The marital status distribution shows that the majority of the respondents are married (69%). This is followed by 14% of participants as single and divorced. Finally, only 4% of the participants were widowed. As observed, 40% of the participants stated that they had either 1 or 2 children. Moreover, participants that had '3-5' or '6-8' are represented by 24% each. Participants with no children represent 8% of the total, while participants with 9 or more children represent 5% of the total number. For the type of house, it is observed that the majority of the respondents (53%) stated that they lived in a villa. This is normal as the majority of the housing units in the newly developed areas in Kuwait are villas. Participants that live in low income houses represent 25% of the total, while the apartment type accustomed for the lowest percentage in the table.

## 5.3 FACTOR LOADING AND KAISER-MEYER-OLKIN (KMO)

Factor analysis allows the researcher to decide on the relative redundancy of each item as well as assessing the sampling adequacy of each variable. The item redundancy is measured on a scale ranging from -1.0 to 1.0 (Creswell & Creswell 2017). Factor analysis breaks down the volume of data into more manageable samples and examines these samples for any overlapping patterns. Confirmatory factor analysis (CFA) was used as this was appropriate for hypothesis testing. Items with values < 0.3 were immediately excluded from the analysis (idre.ucla.edu, 2017a). To measure the sampling adequacy for each variable, the Kaiser-Meyer-Olkin (KMO) test. The test indicates whether or not the data is suitable for factor analysis. In this test variables with values < 0.6 indicate that their sampling is inadequate (Creswell & Creswell 2017), if that is the case, some remedial action is required by the researcher to improve the sampling adequacy. Table 5 presents the results of the factor analysis with their respective factor loadings and KMO values. With the exception of 'Change in User Behaviour' all the other items were above the loading threshold of 0.3 and all the variables had KMO values > 60% so we conclude that the sampling was adequate and that it was appropriate to proceed with further analysis.

Table 5: Explanatory Factor Loading and KMO

| **IQ: Information Quality** | **KMO: 85.2%** | **Loading** |
|---|---|---|
| [IQ01] The information that the smart meter generates is accurate | | .548 |
| [IQ02] The information that is processed by the smart meter is secured | | .819 |
| [IQ03] The Information available through the smart meter is relevant for me | | .646 |
| [IQ04] The information presented by the smart meter is displayed in a useful format | | .870 |
| [IQ05] The information that the smart meter generates is clear | | .626 |
| [IQ06] The smart meter provides sufficient information to users | | .651 |
| [IQ07] The smart meter provides up-to-date information to users | | .868 |
| [IQ08] The information that the smart meter generates is produced in time | | .794 |
| [IQ09] The information that the smart meter generates is precise | | .711 |
| [IQ10] The information that the smart meter generates meets my needs | | .752 |
| **EQ: Service Quality** | **KMO: 81.9%** | **Loading** |
| [EQ01] The service quality of the smart meter is reliable to ensure that I get the service I need. | | .796 |
| [EQ02] The support staff of the smart meter is competent to provide the needed support to me. | | .698 |
| [EQ03] The call centre representatives of the smart meter always help me when I need support with the smart meter | | .763 |
| [EQ04] The call centre representatives of the smart meter always pay personal attention when I experience problems with the smart meter | | .712 |
| [EQ05] The call centre representatives of the smart meter have adequate knowledge to answer my queries related to smart meter | | .771 |
| **PE: Performance Expectancy** | **KMO: 76.4%** | **Loading** |
| [PE01] I find the smart meter useful in my daily life | | .728 |
| [PE02] Using the smart meter enables me to accomplish related tasks more quickly | | .809 |
| [PE03] Using the smart meter increases my productivity of accomplishing tasks | | .697 |
| [PE04] If I use the smart meter, I will increase my chances of saving the public resources | | .829 |
| **TP: Trust in Provider** | **KMO: 68.1%** | **Loading** |
| [TP01] I generally have faith in smart meters | | .523 |
| [TP02] I feel that the smart meter is generally reliable | | .640 |
| [TP03] I generally trust smart meters unless there is a reason not to | | .727 |
| [TP04] I trust smart meters to offer secure service | | .852 |
| [TP05] I find smart meters are secure in executing tasks | | .667 |

| | | |
|---|---|---|
| [TP06] I find smart meters safe for receiving consumption statements | | .648 |
| **US: User Satisfaction** | **KMO: 83.4%** | **Loading** |
| [US01] I am confident that the data generated from the smart meter will help me in the decision-making process regarding my electricity consumption | | .688 |
| [US02] Smart meters make my life easy | | .662 |
| [US03] I would truly enjoy using smart meters | | .707 |
| [US04] I am pleased that the smart meter meets my needs | | .819 |
| [US05] I am content that the smart meter is efficient | | .843 |
| [US06] I am happy with the effectiveness of the smart meter | | .746 |
| [US07] Overall, I am satisfied with the smart meter | | .780 |
| **CB: Change in User Behavior** | **KMO 58.3%** | **Loading** |
| [CB01] I would use smart meters instead of the traditional methods of conducting the services | | .816 |
| [CB02] I am very likely to provide needed information to the smart meter to better serve my needs | | .812 |
| [CB03] I use the smart meter to get energy information about my residence | | .583 |
| **NB: Net Benefits** | **KMO 83.0%** | **Loading** |
| [NB01] Using smart meters will help me do things quicker | | .680 |
| [NB02] The smart meter will help me improve the quality of life | | .647 |
| [NB03] I think the overall cost of using the smart meter is going to be reduced in the future once smart meters are fully utilized by all | | .801 |
| [NB04] The smart meter helps reduce my energy bills | | .874 |
| [NB05] The smart meter increases my understanding of my energy usage | | .880 |
| [NB06] The smart meter helps me make better decisions about energy usage | | .794 |

## 5.4 DESCRIPTIVE ANALYSIS

The descriptive analysis helped the researcher to interpret the responses given to each statement. A Likert scale was used for respondents to indicate their level of agreement or disagreement. A 7 point scale was used with the following meaning:

1 = Strongly Disagree
2 = Somewhat Disagree
3 = Disagree
4 = Neither Agree not Disagree
5 = Agree
6 = Somewhat Agree
7 = Strongly Agree

The ratings are totalled and the Mean score and Standard Deviations are calculated to evaluate responses to each statement.

### 5.4.1 Information Quality

With respect to Information Quality, the descriptive results shown in Table 6 indicate that respondents scored a 73% agreement with the variables. This indicated that respondents believed that the information provided by the smart meter is accurate and clear. It also indicates that the information is precise and provided on time and has a very time format. By taking a closer look at the individual statements, it is shown that statements IQ01 and IQ02 had a slightly higher level of disagreement than the remaining statements. It shows that one out of ten respondents did not have confidence in the security of information and its accuracy. In addition, it is found that the average mean value is 5.89 and the SD is 1.96. This shows that overall, respondents have scored above average for their perceptions of Information Quality.

Table 6: Descriptive results for Information Quality

| **Information Quality** | **Disagree** | **Neutral** | **Agree** | **Mean** | **SD** |
|---|---|---|---|---|---|
| [IQ01] The information that the smart meter generates is accurate | 13.0% | 14.3% | 72.7% | 5.79 | 2.126 |
| [IQ02] The information that is processed by the smart meter is secured | 12.3% | 18.0% | 69.7% | 5.72 | 2.106 |
| [IQ03] The Information available through the smart meter is relevant for me | 11.0% | 20.3% | 68.7% | 5.73 | 2.047 |
| [IQ04] The information presented by the smart meter is displayed in a useful format | 10.7% | 25.3% | 64.0% | 5.60 | 2.043 |
| [IQ05] The information that the smart meter generates is clear | 3.7% | 26.0% | 70.3% | 6.00 | 1.634 |
| [IQ06] The smart meter provides sufficient information to users | 6.0% | 18.7% | 75.3% | 6.08 | 1.733 |
| [IQ07] The smart meter provides up-to-date information to users | 12.0% | 7.3% | 80.7% | 6.06 | 2.027 |
| [IQ08] The information that the smart meter generates is produced in time | 9.7% | 15.0% | 75.3% | 5.97 | 1.945 |
| [IQ09] The information that the smart meter generates is precise | 11.7% | 7.0% | 81.3% | 6.09 | 2.004 |
| [IQ10] The information that the smart meter generates meets my needs | 9.7% | 18.3% | 72.0% | 5.87 | 1.966 |
| **Average** | 9.9% | 17.0% | 73.0% | 5.89 | 1.963 |

### 5.4.2 Service Quality

Table 7 displays the descriptive statistics of Service Quality. It shows a 61.7% level of agreement for all the statements. However, the third statement EQ03 had an agreement value that is lower than the remaining statements. Another interesting observation is that the level of agreement with statement five EQ05 has a 69% level of agreement. The high level of agreement for this item showed how confident the respondents felt that the call centre for the smart meters could provide a quality service to users. However, 19% of the respondents did not think that help was always available when needed. The overall mean value for this variable was 5.43 while the SD is 2.167.

Table 7: Descriptive results for Service Quality

| **Service Quality** | **Disagree** | **Neutral** | **Agree** | **Mean** | **SD** |
|---|---|---|---|---|---|
| [EQ01] The service quality of the smart meter is reliable to ensure that I get the service I need. | 10.7% | 31.0% | 58.3% | 5.43 | 2.044 |
| [EQ02] The support staff of the smart meter is competent to provide the needed support to me. | 13.3% | 26.7% | 60.0% | 5.40 | 2.158 |
| [EQ03] The call centre representatives of the smart meter always help me when I need support with the smart meter | 19.0% | 24.3% | 56.7% | 5.13 | 2.356 |
| [EQ04] The call centre representatives of the smart meter always pay personal attention when I experience problems with the smart meter | 16.7% | 19.0% | 64.3% | 5.43 | 2.294 |
| [EQ05] The call centre representatives of the smart meter have adequate knowledge to answer my queries related to smart meters | 9.7% | 21.3% | 69.0% | 5.78 | 1.981 |
| **Average** | 13.9% | 24.5% | 61.7% | 5.43 | 2.167 |

### 5.4.3 Performance Expectancy

In Table 8, the descriptive statistics for Performance Expectancy are provided. There is a high overall level of agreement with this variable (72.7%), with item 4 receiving the highest level of agreement (83%). This indicates that respondents believe that there will be higher savings from using the smart meters. In addition, it is observed that statement 3 had a slightly higher level of disagreement as compared to the remaining statements. For the mean value and SD, they are recorded as 5.90 and 1.90.

Table 8: Descriptive results for Performance Expectancy

| **Performance Expectancy** | **Disagree** | **Neutral** | **Agree** | **Mean** | **SD** |
|---|---|---|---|---|---|
| [PE01] I find smart meter useful in my daily life | 10.3% | 28.7% | 61.0% | 5.52 | 2.031 |
| [PE02] Using the smart meter enables me to accomplish related tasks more quickly | 8.7% | 9.7% | 81.7% | 6.19 | 1.829 |
| [PE03] Using the smart meter increases my productivity of accomplishing tasks | 12.3% | 22.7% | 65.0% | 5.58 | 2.116 |
| [PE04] If I use the smart meter, I will increase my chances of saving the public resources | 6.0% | 11.0% | 83.0% | 6.31 | 1.638 |
| **Average** | 9.3% | 18.0% | 72.7% | 5.90 | 1.904 |

### 5.4.4 Trust in Provider

In Table 9, the descriptive statistics for Trust in Provider are provided. Overall, there is a 68.4% level of agreement with this variable with item 6 receiving the highest level of agreement (75%). This indicates that respondents believe that it is safe to receive statements about smart meter consumptions. For the mean value and SD, they are recorded as 5.77 and 1.95.

Table 9: Descriptive results for Trust in Provider

| **Trust in Provider** | **Disagree** | **Neutral** | **Agree** | **Mean** | **SD** |
|---|---|---|---|---|---|
| [TP01] I generally have faith in smart meters | 10.7% | 22.0% | 67.3% | 5.70 | 2.036 |
| [TP02] I feel that smart meter s are generally reliable | 8.3% | 21.3% | 70.3% | 5.86 | 1.906 |
| [TP03] I generally trust smart meters unless there is a reason not to | 15.7% | 12.0% | 72.3% | 5.70 | 2.247 |
| [TP04] I trust smart meters to offer secure service | 9.3% | 25.7% | 65.0% | 5.67 | 1.978 |
| [TP05] I find smart meters are secure in executing tasks | 9.3% | 30.0% | 60.7% | 5.54 | 1.985 |
| [TP06] I find smart meters safe for receiving consumption statements | 3.7% | 21.3% | 75.0% | 6.14 | 1.584 |
| **Average** | 9.5% | 22.1% | 68.4% | 5.77 | 1.956 |

### 5.4.5 User Satisfaction

In Table 10, the descriptive statistics for User Satisfaction are shown. Overall, respondents had a very high level of agreement (80.5%). This indicates that respondents are pleased with it, knowing that the smart meters will make their lives easier. By taking a closer look, it was observed statements 1 and 2 had slightly higher levels of disagreement when compared to the remaining statements. This indicates that some respondents are not very confident about smart meters and it does not make their lives easier. The overall mean value was 6.23 and the SD was 1.64. This mean value is very high in comparison with the remaining values. In addition, the low SD value indicates that there is a level of assurance that the respondents have about the smart meters.

Table 10: Descriptive results for User Satisfaction

| User Satisfaction | Disagree | Neutral | Agree | Mean | SD |
|---|---|---|---|---|---|
| [US01] I am confident that the data generated from the smart meter will help me in the decision-making process regarding my electricity consumption | 13.0% | 12.7% | 74.3% | 5.84 | 2.119 |
| [US02] Smart meters make my life easy | 9.3% | 16.0% | 74.7% | 5.96 | 1.932 |
| [US03] I would truly enjoy using smart meters | 4.7% | 16.0% | 79.3% | 6.24 | 1.597 |
| [US04] I am pleased that the smart meter meets my needs | 2.7% | 14.0% | 83.3% | 6.42 | 1.375 |
| [US05] I am content that the smart meter is efficient | 3.7% | 12.0% | 84.3% | 6.42 | 1.439 |
| [US06] I am happy with the effectiveness of the smart meter | 2.3% | 14.3% | 83.3% | 6.43 | 1.346 |
| [US07] Overall, I am satisfied with the smart meter | 7.7% | 8.0% | 84.3% | 6.30 | 1.732 |
| **Average** | 6.2% | 13.3% | 80.5% | 6.23 | 1.649 |

### 5.4.6 Change in User Behaviour

Table 11 displays the descriptive results of Change in User Behaviour variable. As noticed, there is an 80.8% level of agreement, which implies the willingness of the respondents to change their behaviour towards smart meters. Another interesting observation is that the mean value was 6.26 with SD of 1.601. The first statement had a disagreement level of 9.7%, which is high compared to the remaining statements.

Table 11: Descriptive results for Change in User Behavior

| Change in User Behavior | Disagree | Neutral | Agree | Mean | SD |
|---|---|---|---|---|---|
| [CB01] I would use the smart meter instead of the traditional methods of conducting the services | 9.7% | 12.0% | 78.3% | 6.06 | 1.921 |
| [CB02] I am very likely to provide needed information to the smart meter to better serve my needs | 3.7% | 13.0% | 83.3% | 6.39 | 1.458 |
| [CB03] I use the smart meter to get energy information about my residence | 2.7% | 16.7% | 80.7% | 6.34 | 1.425 |
| **Average** | 5.4% | 13.9% | 80.8% | 6.26 | 1.601 |

### 5.4.7 Net Benefits

In relation to Net Benefits, the descriptive results shown in Table 12 indicate that respondents scored a 76.7% agreement with the variables. This indicated that respondents believe that using the smart meters helped them reduce their bill amount and can help them manage their monthly consumption. On closer examination, it can be seen that measure 1 received a higher value of disagreement than the remaining measures. This indicates that several respondents do not think that smart meters helped them perform related tasks quicker. Finally, the mean value is 5.98 and the SD is 1.952.

Table 12: Descriptive results for Net Benefits

| **Net Benefit** | **Disagree** | **Neutral** | **Agree** | **Mean** | **SD** |
|---|---|---|---|---|---|
| [NB01] Using the smart meter will help me do things quicker | 15.0% | 15.7% | 69.3% | 5.63 | 2.225 |
| [NB02] The smart meter will help me improve the quality of life | 13.7% | 25.0% | 61.3% | 5.43 | 2.173 |
| [NB03] I think the overall cost of using the smart meter is going to be reduced in the future once smart meters are fully utilized by all | 9.0% | 9.7% | 81.3% | 6.17 | 1.853 |
| [NB04] The smart meter helps reduce my energy bills | 8.0% | 12.0% | 80.0% | 6.16 | 1.807 |
| [NB05] The smart meter increases my understanding of my energy usage | 8.0% | 6.0% | 86.0% | 6.34 | 1.730 |
| [NB06] The smart meter helps me make better decisions about energy usage | 10.3% | 7.7% | 82.0% | 6.15 | 1.923 |
| **Average** | 10.7% | 12.7% | 76.7% | 5.98 | 1.952 |

## 5.5 MEASUREMENT MODEL

Before proceeding to test the constructs in the structural model, tests for validity and reliability are run called the measurement model. In the model, the constructs are known as latent variables, and the indicators used to measure the latent variables are referred to as the measured variables (Hair et al., 2016). So, the measurement model calculates the levels of association between the latent variables (constructs) and their indicators. Accordingly, the measurement model selects only those latent and measured variables that meet the criteria for validity and reliability.

### 5.5.1 Constructs of the Measurement Model and Evaluation

The constructs that were found in the conceptual model of this study were used in the measurement model. There were four independent variables, which were information quality, service quality, performance expectancy, and trust in the provider. The mediator was user satisfaction, the moderator was change in user behaviour, and the dependent variable was net benefits.

### 5.5.2 Measurement Model Evaluation

#### 5.5.2.1 Convergent Validity

Proceeding with the analysis, the first action which was taken was to check the measures which were used to establish whether they were discrete. The appropriate test for this is the convergent validity test which checks for close correlations which might reveal certain overlaps in the measures in relation to their constructs (Hair et al., 2016). It was expected that indicators of the same construct should correlate highly with each other since they were designed to measure the same item.

Convergent validity was measured using the Average Variance Extracted (AVE) test (Hair et al., 2016), which is discussed below.

- ***Average Variance Extracted (AVE)***

The AVE is calculated by adding the squared loadings of all the indicators and dividing by the number of indicators. This produces a measure which indicates how closely the indicators converge to their respective constructs. The minimum threshold for convergence is 0.5 (Hair et al., 2012), Table 13 presents the AVE values for our constructs. As can be seen, convergent validity is established since all the scores are >0.5.

Table 13: Average Variance Extracted for Constructs

| Construct | Average Variance Extracted (AVE) |
|---|---|
| Information Quality | 0.571 |
| Net Benefits | 0.646 |
| Performance Expectancy | 0.588 |
| Service Quality | 0.559 |
| Trust in Provider | 0.569 |
| User Change Behavior | 0.551 |
| User Satisfaction | 0.565 |

#### 5.5.2.2 Discriminant Validity

This test measures the extent to which a construct is discrete in comparison with other constructs. They should be reasonably discrete, otherwise there may be an overlap which would call into question the discriminant validity of the constructs (Hair et al., 2016). To conduct this test, cross-loading is applied as discussed in the next section.

- ***Cross loading***

Table 14 presents the cross-loadings of the indicators. The procedure to be adopted is to immediately eliminate any indicator with a score > 0.4 Values > 0.7 indicates that these indicators should be retained. Those indicators in the range 0.4 to 0.7 are only removed after checking whether their removal leads to a higher AVE score. Otherwise they are retained. Examining the results in Table 14, it can be observed that several indicators scored < 0.4 and were removed. There were a number of indicators with scores in the 0.4 to 0.7 and following a check on whether they improved the AVE, they were duly removed.

Table 14: Cross Loadings of the Indicators

| | **Information Quality** | **Net Benefits** | **Performance Expectancy** | **Service Quality** | **Trust in Provider** | **User Change Behavior** | **User Satisfaction** |
|---|---|---|---|---|---|---|---|
| **CB01** | | | | | | 0.790 | |
| **CB02** | | | | | | 0.762 | |
| **CB03** | | | | | | 0.669 | |
| **EQ01** | | | | 0.801 | | | |
| **EQ02** | | | | 0.701 | | | |
| **EQ03** | | | | 0.731 | | | |
| **EQ04** | | | | 0.696 | | | |
| **EQ05** | | | | 0.801 | | | |
| **IQ02** | 0.783 | | | | | | |
| **IQ03** | 0.614 | | | | | | |
| **IQ04** | 0.881 | | | | | | |
| **IQ05** | 0.603 | | | | | | |
| **IQ06** | 0.692 | | | | | | |
| **IQ07** | 0.870 | | | | | | |
| **IQ08** | 0.809 | | | | | | |
| **IQ09** | 0.730 | | | | | | |
| **IQ10** | 0.764 | | | | | | |
| **NB01** | | 0.610 | | | | | |
| **NB03** | | 0.745 | | | | | |
| **NB04** | | 0.873 | | | | | |
| **NB05** | | 0.919 | | | | | |
| **NB06** | | 0.836 | | | | | |
| **PE01** | | | 0.753 | | | | |
| **PE02** | | | 0.810 | | | | |
| **PE03** | | | 0.678 | | | | |
| **PE04** | | | 0.819 | | | | |
| **TP03** | | | | | 0.690 | | |
| **TP04** | | | | | 0.853 | | |
| **TP05** | | | | | 0.651 | | |

| | | |
|---|---|---|
| **TP06** | 0.805 | |
| **US01** | | 0.681 |
| **US02** | | 0.678 |
| **US03** | | 0.715 |
| **US04** | | 0.823 |
| **US05** | | 0.838 |
| **US06** | | 0.743 |
| **US07** | | 0.767 |

#### 5.5.2.3 Construct Reliability

In a scientific survey, as in this case, several measures are used to capture one variable. Most statements are quite similar with only slight variations in the syntax. If a respondent answers a certain question in a way which is inconsistent with the others, this could indicate that the question was poorly understood or that the respondent answered in a hurried fashion without really understanding the statement. But it could be the case that the statement in question does not reliably measure the underlying construct.

Cronbach's Alpha and Composite Reliability are the two tests available for this purpose in SmartPLS. Both measure the internal consistency of a set of indicators. According to Hair et al. (2012) the composite reliability test is the more accurate than Cronbach's alpha. This is because the starting point for composite reliability is an assumption that the indicators are not reliable, at least to the same extent. A composite reliability value of 0.60 in an exploratory research project is an adequate threshold for considering the constructs to be reliable. However, some authors hold that scores of at least 0.70 are preferable for any advanced research.

The first of these measures, the Cronbach's Alpha test, measures the internal consistency of the variables i.e. the test measures the extent to which items in a group are correlated. The test returns values between 0 and 1 and the agreed threshold for reliability is scores > 0.7 (idre.ucla.edu, 2017b).

SmartPLS also reports results for the composite reliability test. This is a useful feature of SmartPLS as it offers further confirmation of the strengths of the various correlations. Table 15 shows the results for both tests. While the scores on both tests do not greatly differ, the Cronbach's Alpha score for User Change Behaviour is only 0.602 and this result would have led to rejecting that construct as failing to meet the threshold for reliability. However, the comparable score for that construct on the

Composite Reliability test was 0.785 and, since this latter test is, as previously mentioned, more accurate in its calculation, all of the constructs have met the threshold criterion of 0.7 or higher (Hair et al., 2016).

Table 15: Reliability Results of the Research Constructs

| Construct | Cronbach's Alpha | Composite Reliability | Result |
|---|---|---|---|
| Information Quality | 0.904 | 0.922 | Strong |
| Net Benefits | 0.858 | 0.900 | Strong |
| Performance Expectancy | 0.765 | 0.850 | Strong |
| Service Quality | 0.803 | 0.863 | Strong |
| Trust in Provider | 0.746 | 0.839 | Strong |
| User Change Behavior | 0.602 | 0.785 | Strong |
| User Satisfaction | 0.870 | 0.900 | Strong |

### 5.5.3 Correlation

It is useful to check to check the strength of associations between variables before proceeding further to determine causal effects (Hair et al., 2016). Correlation analysis of the associations between pairs of variables in SmartPLS produces a correlation matrix as shown in Table 16.

Table 16: Correlation Analysis of the Research Constructs

| | Information Quality | Net Benefits | Performance Expectancy | Service quality | Trust in Provider | User Change Behavior | User Satisfaction |
|---|---|---|---|---|---|---|---|
| **Information Quality** | 1 | | | | | | |
| **Net Benefits** | 0.696 | 1 | | | | | |
| **Performance Expectancy** | 0.609 | 0.689 | 1 | | | | |
| **Service quality** | 0.687 | 0.583 | 0.738 | 1 | | | |
| **Trust in Provider** | 0.681 | 0.550 | 0.544 | 0.464 | 1 | | |
| **User Change Behavior** | 0.513 | 0.505 | 0.525 | 0.349 | 0.522 | 1 | |
| **User Satisfaction** | 0.732 | 0.852 | 0.732 | 0.605 | 0.692 | 0.654 | 1 |

Examining the Table, the values returned measure the strength of ‘r’ the correlation coefficient. Interpreting the results, it is first noted that all the values are positive indicating a direct relationship. A negative value would indicate an inverse relationship implying that an increase in one variable would be associated with a comparable decrease in the other variable in the pair being checked. Values < 0.3 are considered to be weak relationships, values between 0.3 and o.5 indicate a moderate association and values > 0.5 are regarded as strong. The strongest association is for User Satisfaction with Net Benefits (r=0.852). The implication is that the greater the degree of customer satisfaction with smart meters, the greater the extent of realisation of the benefits these meters offer and vice versa. Most of the other pairs of variables show strong associations, with the exception of User Change Behaviour and Trust in Provider with Service Quality where the associations are moderate. However, overall, the correlation matrix results do not raise any concerns and we can proceed to the Structural Model.

## 5.6 STRUCTURAL MODEL

Although the Correlation Analysis in the previous section showed the strength of associations between pairs of variables, no causal inferences can be drawn from those results. However, in order to test the hypotheses, it is necessary to evaluate the causal influences of the relevant variables, SmartPLS enables the research to test the conceptual model which was developed for this study, in order to test these hypotheses.

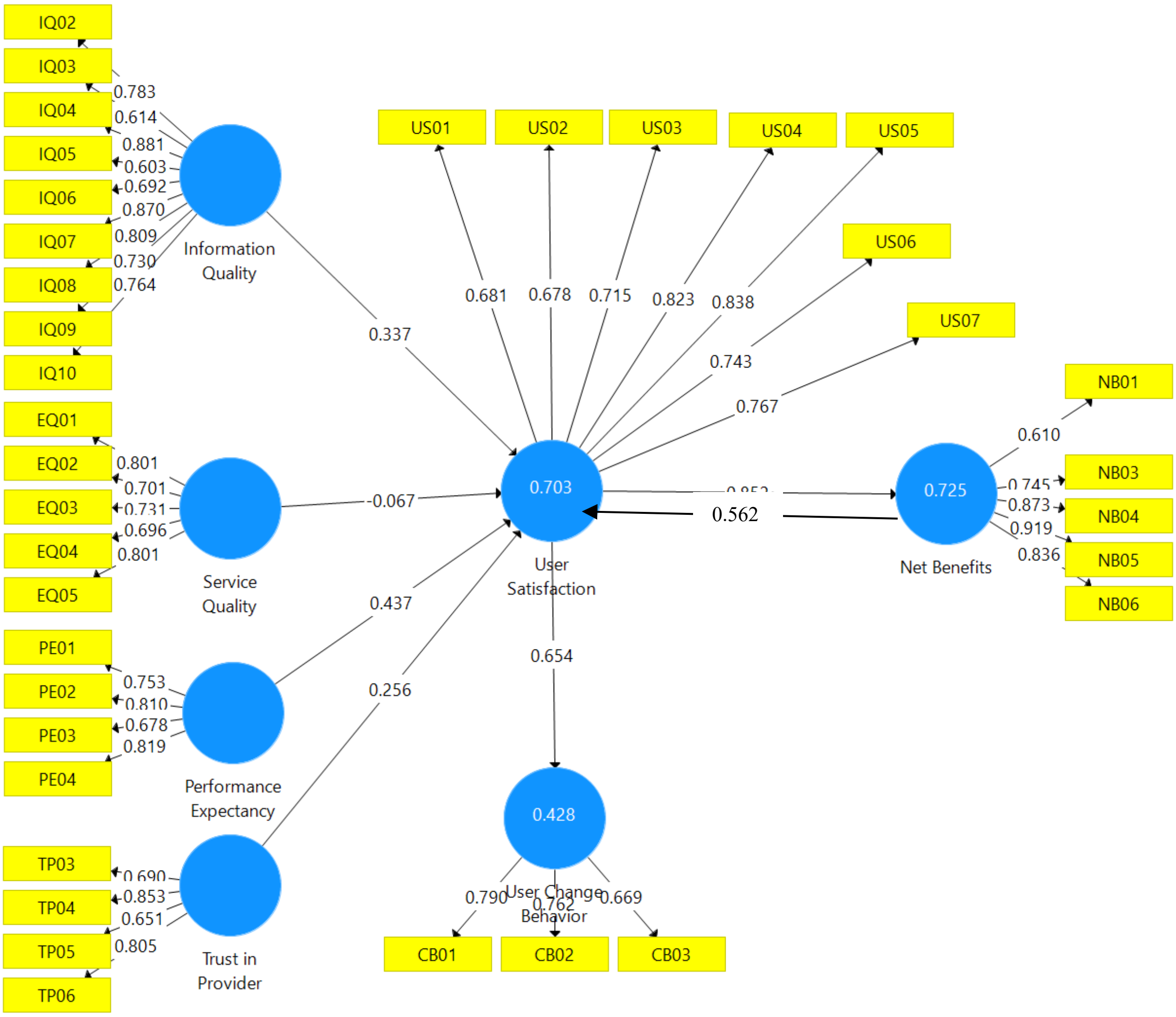
### 5.6.1 Analysis of the Research Model's Path Coefficients

SmartPLS v. 3.2.8 software was used in this study to investigate the various path weightings in the Research Model. The Path Weightings are the results of a very rigorous procedure with iterations beginning at 1 and with a maximum of 300, which is a very powerful instrument. The results of running the pathways test on the research model results in a pathway coefficient for each pathway and the $R^2$ score. However, the test does not directly yield a P score for significance. However, applying the bootstrapping procedure allows for P values to be calculated. Hair et al. (2012) point out that bootstrapping iterations should reach at least 5,000 for accuracy and with a default confidence level of 95%, which is suitable for social sciences research as in this current study.

### 5.6.2 Results

The results of the SmartPLS analysis are presented in Figure 7 below. Path weightings ae shown as Beta coefficients for these relationships. To interpret what these Beta values imply, we take the example of Performance Expectancy path to User Satisfaction which is 0.437. This implies that for every 1 standard point deviation in Performance Expectancy, there is a corresponding 0.437 standard point deviation in User Satisfaction. Simply stated, the Beta values indicate the amount of influence that the independent variable have on the dependent variable. Figure 7 shows Information Quality, Service Quality, Performance Expectancy, and Trust in Provider as independent variables influencing User Satisfaction.

Figure 7: Path Analysis SEM




Results show that these independent variables can explain 70% of the variance in User Satisfaction and that User Satisfaction can explain 43% of the variance in User

Change Behaviour. In addition, the results also show that User Satisfaction is a strong predictor of Net Benefits and explains 72% of the variance in their interaction. The loadings on the internal factors for each variable represent the internal correlation between the statements that represent each variable.

### 5.6.3 Hypotheses Testing

In this section the results of the hypotheses tests are presented and discussed. The results are shown in Table 17.

Table 17: Path Coefficients results

| Construct Relationships | Path Coefficient | T Statistics | P Values | Result |
|---|---|---|---|---|
| Information Quality -> User Satisfaction | 0.337 | 5.660 | 0.000 | Supported |
| Service Quality -> User Satisfaction | -0.067 | 1.355 | 0.176 | Not Supported |
| Trust in Provider -> User Satisfaction | 0.256 | 5.472 | 0.000 | Supported |
| Performance Expectancy -> User Satisfaction | 0.437 | 8.462 | 0.000 | Supported |
| User Satisfaction -> Net Benefits | 0.852 | 40.459 | 0.000 | Supported |
| User Satisfaction -> User Change Behavior | 0.654 | 13.210 | 0.000 | Supported |
| Net Benefits -> User Satisfaction | 0.562 | 9.412 | 0.000 | Supported |

***Hypothesis $H_1$: Information quality of technology has a positive and significant impact on the user satisfaction with smart city technologies.***

Information Quality related to User Satisfaction had a Beta coefficient of 0.337 with T Statistic of 5.660. The calculated significance for this result was $P < 0.0005$ which is very highly significant. Thus there is sufficient evidence to support this hypothesis

***Hypothesis $H_2$: Service quality of technology has a positive and significant impact on the user satisfaction with smart city technologies.***

The table shows a negative result for this hypothesis (-0.067) and a significance value of $p = 0.176$ which is outside of the range for significance. Accordingly, there is insufficient evidence to support H2.

***Hypothesis $H_3$: Trust in the technology provider has a positive and significant impact on the user satisfaction with smart city technologies.***

The result of the path coefficient for this influence was 0.256. Although this influence, prima facie, appears to be small, it was, nevertheless a highly significant result with $p < 0.0005$. Hence, hypothesis H3 was supported.

***Hypothesis $H_4$: Performance expectancy of technology has a positive and significant impact on the user satisfaction with smart city technologies.***

The results of the path analysis indicated that Performance Expectancy positively influences User Satisfaction. The path coefficient of 0.437 and the value generated from it are, indicate that the more likely it is that the users are satisfied with the smart meters; leading to the enhanced use of smart meters. Hence, hypothesis H4 was supported.

***Hypothesis $H_5$: User satisfaction has a positive and significant impact on the net benefits of smart city technologies.***

User Satisfaction is the construct that exerted the highest amount of positive influence on Net Benefits. The test establishes that the influence of 0.852 is very highly significant ($p < 0.0005$. This implies that satisfied customers realized the benefits of using smart meters in their homes. Thus, there is sufficient evidence to support hypothesis H5.

***Hypothesis $H_6$: User satisfaction has a positive and significant impact on user change behavior toward smart city technologies.***

One of the main and interesting concepts examined in this study is User Change Behaviour. The results in Table 16 show that User Satisfaction had a strong influence on User Change Behaviour, with a path coefficient of 0.654. By running bootstrapping, it is evident that this influence was significant ($p<0.0005$). This indicates that satisfied users tend to change their behaviour towards dealing with their energy consumption by using the smart meters, which helps in keeping control of their electricity usage. Based on this argument and the results in the table, hypothesis H6 is supported.

***Hypothesis $H_7$: Net benefits have a positive and significant impact on user satisfaction with smart city technologies.***

The beta value of 0.652 and a significance value, following bootstrapping, of $p < 0.0005$ is very strong evidence to support H7. This means that higher benefits of using smart meters led to boosting residents' satisfaction with smart meters. Based on this discussion, hypothesis H7 is supported.

## 5.7 MEANS COMPARISON

Since the research contains hypotheses that are related to demographics, it is useful to perform means comparison tests to investigate whether there were significant differences based on demographical features. These tests helped in providing a result for the related hypotheses. ANOVA and T-Test were conducted in this section to achieve this purpose. T-Test compares the means of two categories (e.g., males vs. females). The test determines whether the difference in the mean is significant with respect to one of the main research constructs. ANOVA test is similar to T-Test in the sense that it measures the differences in means, and whether these differences are significant or simply due to natural variation in the data. ANOVA is used when there are more than two categories (e.g., Educational level). In the case that the ANOVA test is significant, a follow-up test is performed which is called the post hoc Tukey test. It helps the researcher to identify the differences in the categories of the variable (Montgomery, 2017).

- **Hypothesis$H_8$:** There is a statistically significant difference between gender, and Change in User Behaviour and Net Benefits of using the smart meters in Kuwait.

A t-test was conducted to find out any differences based on gender and the change in user behaviour and net benefits. The results show that there is a significant difference based on gender and change in user behaviour scale ($t = -2.745$, $p < 0.05$), with a mean score of 5.061 and SD = .848 for male, and a mean score of 5.348 and SD = .961 for female. Moreover, the results show that there is a significant difference based on gender and net benefits scale ($t = -2.038$, $p < 0.05$), with a mean score of 4.947 and SD = 1.072 for males, and a mean score of 5.221 and SD = 1.260 for females. Thus, hypotheses H8 is supported. The results are shown in Table 18.

Table 18: Differences in means between Gender, with change in user behavior and net benefits

| **Scales** | **Male** | | **Female** | | ***t(300)*** | **p** |
|---|---|---|---|---|---|---|
| | **M** | **SD** | **M** | **SD** | | |
| Change in User Behavior | 5.0617 | .84870 | 5.3486 | .96157 | -2.745 | 0.006 |
| Net Benefits | 4.9473 | 1.07225 | 5.2218 | 1.26022 | -2.038 | 0.042 |

*p < 0.05,**p < 0.01, ***p < 0.001, (2-tailed).

**Hypothesis$H_9$:** There is a statistically significant difference between Age, and Change in User Behavior and Net Benefits of using the smart meters in Kuwait.

A one way ANOVA test was conducted to find out the differences based on Age, and change in user behaviour and net benefits. With respect to change in user behaviour, the analysis of variance shows a statistically significant effect on age, $F(4,295) = 16.66$, $p < 0.0005$. With respect to net benefits, the analysis of variance shows a statistically significant effect for age, $F(4,295) = 7.42$, $p < 0.0005$. The results are shown in Table 19.

Table 19: ANOVA for differences in means of respondent age considering change in user behavior and net benefits

| **Age** | **18-24 years** | | **25-34 years** | | **35-44 years** | | **45-54 years** | | **55 years and above** | | ***F*(4, 295)** | **p** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **M** | **SD** | **M** | **SD** | **M** | **SD** | **M** | **SD** | **M** | **SD** | | |
| CB | 5.326 | 1.189 | 5.578 | .726 | 5.313 | .510 | 4.564 | 1.192 | 4.625 | .834 | 16.66 | .000 |
| NB | 4.788 | 2.018 | 5.449 | 1.105 | 5.217 | .326 | 4.583 | 1.580 | 4.565 | .754 | 7.42 | .000 |

CB= Change in User Behavior, NB= Net Benefits
*p < 0.05,**p < 0.01, ***p < 0.001, (2-tailed).

Table 20 presents the results of the Tukey test for Age. For change in user behaviour, it is noticed in the results that those who are between 18-24 years old have higher perceptions of change in user behaviour than those respondents between 45-54 years. Overall, the results show that the younger generation has higher perceptions than others, meaning that younger people are more willing to change their behaviour and start using smart meters technology. With respect to net benefits, it is also observed from the table that younger generations understand and appreciate the benefits of using smart meters more than the older generation. Based on this analysis, hypothesis H9 is supported.

Table 20: Tukey tests results with respect to Age

| Dependent Variable | (I) Age | (J) Age | Mean Difference (I-J) | Sig. |
|---|---|---|---|---|
| CB | 18-24 years | 25-34 years | -.25103 | .652 |
| | | 35-44 years | .01379 | 1.000 |
| | | **45-54 years** | **.76211*** | **.001** |
| | | 55 years and above | .70192* | .018 |
| | 25-34 years | 18-24 years | .25103 | .652 |
| | | 35-44 years | .26483 | .180 |
| | | **45-54 years** | **1.01314*** | **.000** |
| | | **55 years and above** | **.95296*** | **.000** |
| | 35-44 years | 18-24 years | -.01379 | 1.000 |
| | | 25-34 years | -.26483 | .180 |
| | | **45-54 years** | **.74832*** | **.000** |
| | | **55 years and above** | **.68813*** | **.001** |
| | 45-54 years | **18-24 years** | **-.76211*** | **.001** |
| | | **25-34 years** | **-1.01314*** | **.000** |
| | | **35-44 years** | **-.74832*** | **.000** |
| | | 55 years and above | -.06019 | .998 |
| | 55 years and above | **18-24 years** | **-.70192*** | **.018** |
| | | **25-34 years** | **-.95296*** | **.000** |
| | | **35-44 years** | **-.68813*** | **.001** |
| | | 45-54 years | .06019 | .998 |
| NB | 18-24 years | 25-34 years | -.66136 | .064 |
| | | 35-44 years | -.42871 | .416 |
| | | 45-54 years | .20513 | .940 |
| | | 55 years and above | .22299 | .950 |
| | 25-34 years | 18-24 years | .66136 | .064 |
| | | 35-44 years | .23265 | .606 |
| | | **45-54 years** | **.86649*** | **.000** |
| | | **55 years and above** | **.88434*** | **.003** |
| | 35-44 years | 18-24 years | .42871 | .416 |
| | | 25-34 years | -.23265 | .606 |
| | | **45-54 years** | **.63384*** | **.009** |
| | | 55 years and above | .65170 | .055 |
| | 45-54 years | 18-24 years | -.20513 | .940 |
| | | **25-34 years** | **-.86649*** | **.000** |
| | | **35-44 years** | **-.63384*** | **.009** |
| | | 55 years and above | .01786 | 1.000 |
| | 55 years and above | 18-24 years | -.22299 | .950 |
| | | **25-34 years** | **-.88434*** | **.003** |
| | | 35-44 years | -.65170 | .055 |
| | | 45-54 years | -.01786 | 1.000 |

**Hypothesis$H_{10}$:** There is a statistically significant difference between Educational level, and Change in User Behavior and Net Benefits of using the smart meters in Kuwait.

A one way ANOVA test was conducted to find the differences based on Educational level, and change in user behaviour and net benefits. With respect to change in user behaviour, the analysis of variance shows a statistically significant effect for age: F(4, 295) = 2.467, p = 0.045. For net benefits, the analysis of variance shows a statistically significant effect of educational level: F(4, 295) = 2.964, p = 0.020. The results are shown in Table 21.

Table 21: ANOVA for differences in means of respondent age considering change in user behavior and net benefits

| **Educational level** | **Less than High School** | | **high school** | | **Diploma** | | **Bachelor (BA)** | | **Masters/PhD** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **M** | **SD** | **M** | **SD** | **M** | **SD** | **M** | **SD** | **M** | **SD** | ***F*(4, 295)** | **p** |
| CB | 5.521 | .678 | 4.966 | 1.186 | 5.425 | .888 | 5.167 | .870 | 5.015 | 1.009 | 2.467 | .045 |
| NB | 5.609 | .701 | 4.638 | 1.816 | 5.077 | 1.263 | 5.046 | 1.091 | 5.070 | .997 | 2.964 | .020 |

CB= Change in User Behavior, NB= Net Benefits
*p < 0.05,**p < 0.01, ***p < 0.001, (2-tailed).

Table 22 presents the results of the Tukey test for the Educational level. It is noticed in the results that those who are at a lower educational level than high school have higher significant perceptions about net benefits than those that have a high school degree. This implies that having lower levels of education might lead to an individual being more convinced about the value and benefits of smart meters. Based on this analysis, hypothesis H10 is supported.

Table 22: Tukey tests results with respect to Educational level

| **Dependent Variable** | **(I) Educational Level** | **(J) Educational Level** | **Mean Difference (I-J)** | **Sig.** |
|---|---|---|---|---|
| Change in User Behavior | Less than High School | High School | .55476 | .102 |
| | | Diploma | .09643 | .993 |
| | | Bachelor (BA) | .35428 | .218 |
| | | Masters/PhD | .50628 | .146 |
| | High School | Less than High School | -.55476 | .102 |
| | | Diploma | -.45833 | .287 |
| | | Bachelor (BA) | -.20048 | .796 |
| | | Masters/PhD | -.04848 | 1.000 |
| | Diploma | Less than High School | -.09643 | .993 |

| | | | | |
|---|---|---|---|---|
| | | High School | .45833 | .287 |
| | | Bachelor (BA) | .25785 | .602 |
| | | Masters/PhD | .40985 | .378 |
| | Bachelor (BA) | Less than High School | -.35428 | .218 |
| | | High School | .20048 | .796 |
| | | Diploma | -.25785 | .602 |
| | | Masters/PhD | .15200 | .903 |
| | Masters/PhD | Less than High School | -.50628 | .146 |
| | | High School | .04848 | 1.000 |
| | | Diploma | -.40985 | .378 |
| | | Bachelor (BA) | -.15200 | .903 |
| Net Benefits | **Less than High School** | **High School** | **.97063*** | **.007** |
| | | Diploma | .53175 | .348 |
| | | Bachelor (BA) | .56301 | .068 |
| | | Masters/PhD | .53882 | .308 |
| | High School | Less than High School | -.97063* | .007 |
| | | Diploma | -.43889 | .583 |
| | | Bachelor (BA) | -.40762 | .386 |
| | | Masters/PhD | -.43182 | .576 |
| | Diploma | Less than High School | -.53175 | .348 |
| | | High School | .43889 | .583 |
| | | Bachelor (BA) | .03127 | 1.000 |
| | | Masters/PhD | .00707 | 1.000 |
| | Bachelor (BA) | Less than High School | -.56301 | .068 |
| | | High School | .40762 | .386 |
| | | Diploma | -.03127 | 1.000 |
| | | Masters/PhD | -.02420 | 1.000 |
| | Masters/PhD | Less than High School | -.53882 | .308 |
| | | High School | .43182 | .576 |
| | | Diploma | -.00707 | 1.000 |
| | | Bachelor (BA) | .02420 | 1.000 |

**Hypothesis$H_{11}$:** There is a statistically significant difference between marital status, and Change in User Behavior and Net Benefits of using the smart meters in Kuwait.

A one way ANOVA test was conducted to find out the differences based on marital status, and change in user behaviour and net benefits. With respect to change in user behaviour, the analysis of variance shows a statistically significant effect on marital status: F(3, 296) = 5.802, p = 0.001. For Net benefits, the analysis of variance shows a statistically non-significant effect on marital status, F(3, 296) = 1.876, p = 0.134. The results are shown in Table 23.

Table 23: ANOVA for differences in means of respondent marital status considering change in user behavior and net benefits

| Marital Status | Single | | Married | | Divorced | | Widowed | | *F*(3, 296) | p |
|---|---|---|---|---|---|---|---|---|---|---|
| | M | SD | M | SD | M | SD | M | SD | | |
| CB | 5.6037 | 1.109 | 5.055 | .904 | 5.434 | .667 | 5.431 | .252 | 5.802 | .001 |
| NB | 5.069 | 1.845 | 5.013 | 1.099 | 5.460 | .540 | 4.833 | .813 | 1.876 | .134 |

CB= Change in User Behavior, NB= Net Benefits
*p < 0.05,**p < 0.01, ***p < 0.001, (2-tailed).

Table 24 presents the results of the Tukey test for marital status. It is noticed in the results that single people had higher perceptions towards change in user behaviour than married people. This can probably be explained by the fact that married people are accustomed to certain ways of doing things and thus, it becomes more difficult for them to change their behaviour. Based on this analysis, hypothesis H11 is supported.

Table 24: Tukey tests results with respect to marital status

| Dependent Variable | (I) Marital Status | (J) Marital Status | Mean Difference (I-J) | Sig. |
|---|---|---|---|---|
| CB | Single | **Married** | **.54783*** | **.002** |
| | | Divorced | .16913 | .824 |
| | | Widowed | .17184 | .942 |
| | Married | **Single** | **-.54783*** | **.002** |
| | | Divorced | -.37870 | .061 |
| | | Widowed | -.37599 | .525 |
| | Divorced | Single | -.16913 | .824 |
| | | Married | .37870 | .061 |
| | | Widowed | .00271 | 1.000 |
| | Widowed | Single | -.17184 | .942 |
| | | Married | .37599 | .525 |
| | | Divorced | -.00271 | 1.000 |

**Hypothesis$H_{12}$:** There is a statistically significant difference between the Number of children, and Change in User Behavior and Net Benefits of using the smart meters in Kuwait.

A one way ANOVA test was conducted to find out the differences based on the Number of children in the family and change in user behaviour and net benefits. With respect to change in user behaviour, the analysis of variance shows a statistically significant effect for the Number of children: $F(4, 295) = 6.244$, $p < 0.0005$. For net benefits, the analysis of variance shows a statistically significant effect for the Number of children, $F(4, 295) = 3.105$, $p = 0.016$. The results are shown in Table 25.

Table 25: ANOVA for differences in means of respondent No. of children considering changes in user behavior and net benefits

| No. of Children | No Children | | 1-2 Child | | 3-5 Children | | 6-8 Children | | 9 or more | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **M** | **SD** | **M** | **SD** | **M** | **SD** | **M** | **SD** | **M** | **SD** | ***F*(4, 295)** | **p** |
| CB | 5.239 | .870 | 5.477 | .818 | 5.070 | .826 | 4.950 | 1.067 | 4.625 | .648 | 6.244 | .000 |
| NB | 5.166 | .855 | 5.201 | 1.337 | 5.270 | .677 | 4.758 | 1.339 | 4.500 | .691 | 3.105 | .016 |

CB= Change in User Behavior, NB= Net Benefits
*p < 0.05,**p < 0.01, ***p < 0.001, (2-tailed).

Table 26 presents the results of the Tukey test for the Number of children. It is noticed in these results that those people with 1-2 children had higher perceptions towards change in user behaviour than people with a greater number of children. This can plausibly be explained by the fact that a small family might be more willing to change its behaviour and adopt smart meters. With respect to net benefits, the results of the Tukey test were inconclusive as it does not show where the differences exist. Based on this analysis, hypothesis H12 is supported.

Table 26: Tukey tests results with respect to No. of children

| Dependent Variable | No of Children (I) | No of Children (J) | Mean Difference (I-J) | Sig. |
|---|---|---|---|---|
| Change in User Behavior | No Children | 1-2 Child | -.238 | .750 |
| | | 3-5 Children | .169 | .927 |
| | | 6-8 Children | .289 | .638 |
| | | 9 or more | .615 | .236 |
| | 1-2 Child | No Children | .238 | .750 |
| | | **3-5 Children** | **.40666*** | **.019** |
| | | **6-8 Children** | **.52638*** | **.001** |
| | | **9 or more** | **.85208*** | **.006** |
| | 3-5 Children | No Children | -.169 | .927 |
| | | 1-2 Child | -.40666* | .019 |
| | | 6-8 Children | .120 | .928 |
| | | 9 or more | .445 | .420 |
| | 6-8 Children | No Children | -.289 | .638 |
| | | 1-2 Child | -.52638* | .001 |
| | | 3-5 Children | -.120 | .928 |
| | | 9 or more | .326 | .715 |
| | 9 or more | No Children | -.615 | .236 |
| | | 1-2 Child | -.85208* | .006 |
| | | 3-5 Children | -.445 | .420 |
| | | 6-8 Children | -.326 | .715 |

| | | | | |
|---|---|---|---|---|
| Net Benefits | No Children | 1-2 Child | -.035 | 1.000 |
| | | 3-5 Children | -.103 | .996 |
| | | 6-8 Children | .408 | .565 |
| | | 9 or more | .667 | .425 |
| | 1-2 Child | No Children | .035 | 1.000 |
| | | 3-5 Children | -.069 | .995 |
| | | 6-8 Children | .443 | .080 |
| | | 9 or more | .701 | .202 |
| | 3-5 Children | No Children | .103 | .996 |
| | | 1-2 Child | .069 | .995 |
| | | 6-8 Children | .512 | .066 |
| | | 9 or more | .770 | .154 |
| | 6-8 Children | No Children | -.408 | .565 |
| | | 1-2 Child | -.443 | .080 |
| | | 3-5 Children | -.512 | .066 |
| | | 9 or more | .258 | .941 |
| | 9 or more | No Children | -.667 | .425 |
| | | 1-2 Child | -.701 | .202 |
| | | 3-5 Children | -.770 | .154 |
| | | 6-8 Children | -.258 | .941 |

**Hypothesis$H_{13}$:** There is a statistically significant difference between the Type of house, and Change in User Behavior and Net Benefits of using the smart meters in Kuwait.

A one way ANOVA test was conducted to find out the differences based on the type of house, and change in user behaviour and net benefits. With respect to change in user behaviour, the analysis of variance shows a statistically significant effect for the type of house: $F(2, 296) = 6.241$, $p = 0.002$. With respect to net benefits, the analysis of variance shows a statistically significant effect for the type of house, $F(2, 296) = 6.944$, $p = 0.001$. The results are shown in Table 27.

Table 27: ANOVA for differences in means of respondent type of house considering change in user behavior and net benefits

| Type of House | Apartment | | Low Income House | | Villa | | $F$(2, 296) | p |
|---|---|---|---|---|---|---|---|---|
| | M | SD | M | SD | M | SD | | |
| CB | 5.503 | .696 | 5.250 | .563 | 5.045 | 1.080 | 6.241 | .002 |
| NB | 5.186 | 1.094 | 5.442 | .267 | 4.859 | 1.397 | 6.944 | .001 |

CB= Change in User Behavior, NB= Net Benefits
*p < 0.05,**p < 0.01, ***p < 0.001, (2-tailed).

Table 28 presents the results of the Tukey test for type of house. With respect to change in user behaviour, it is noticed in the results that those people living in apartments had higher perceptions towards change in user behaviour than people living in Villas. This implies that people living in apartments may be more cautious about their spending, and may welcome the idea of using smart meters. With respect to net benefits, people living in low-income houses displayed higher perceptions towards net benefits than those living in a villa. The reason might be that people living in low-income houses tend to be more vigilant towards the benefits of using smart meters. Based on this analysis, hypothesis H13 is supported.

Table 28: Tukey tests results with respect to Type of house

| Dependent Variable | (I) Type of house | (J) Type of house | Mean Difference (I-J) | Sig. |
|---|---|---|---|---|
| CB | Apartment | Low Income House | .25379 | .217 |
| | | **Villa** | **.45819*** | **.002** |
| | Low Income House | Apartment | -.25379 | .217 |
| | | Villa | .20440 | .237 |
| | Villa | Apartment | -.45819* | .002 |
| | | Low Income House | -.20440 | .237 |
| NB | Apartment | Low Income House | -.25535 | .387 |
| | | Villa | .32733 | .128 |
| | Low Income House | Apartment | .25535 | .387 |
| | | **Villa** | **.58268*** | **.001** |
| | Villa | Apartment | -.32733 | .128 |
| | | Low Income House | -.58268* | .001 |

Table 29 presents a summary of the research hypotheses examined. It shows that all the research hypotheses were supported except for one, which is the influence of service quality. The table also demonstrates the expected influence of the relationships.

Table 29: Summary of the Research Hypotheses Post

| No. | Hypothesis | Results |
|---|---|---|
| **H1** | Information quality of technology has a positive and significant impact on user satisfaction with smart city technologies. | Supported |
| **H2** | Service quality of technology has a positive and significant impact on user satisfaction with smart city technologies. | Not Supported |
| **H3** | Trust in the technology provider has a positive and significant impact on user satisfaction with smart city technologies. | Supported |
| **H4** | Performance expectancy of technology has a positive and significant impact on user satisfaction with smart city technologies. | Supported |
| **H5** | User satisfaction has a positive and significant impact on the net benefits of smart city technologies. | Supported |
| **H6** | User satisfaction has a positive and significant impact on user change behavior toward smart city technologies. | Supported |
| **H7** | Net benefits have a positive and significant impact on user satisfaction with smart city technologies. | Supported |

| | | |
|---|---|---|
| **H8** | There is a statistically significant difference between gender, and Change in User Behaviour and Net Benefits of using the smart meters in Kuwait | Supported |
| **H9** | There is a statistically significant difference between Age, and Change in User Behaviour and Net Benefits of using the smart meters in Kuwait | Supported |
| **H10** | There is a statistically significant difference between Educational level, and Change in User Behaviour and Net Benefits of using the smart meters in Kuwait | Supported |
| **H11** | There is a statistically significant difference between Marital status, and Change in User Behaviour and Net Benefits of using the smart meters in Kuwait | Supported |
| **H12** | There is a statistically significant difference between Number of children, and Change in User Behaviour and Net Benefits of using the smart meters in Kuwait | Supported |
| **H13** | There is a statistically significant difference between Type of house, and Change in User Behaviour and Net Benefits of using the smart meters in Kuwait | Supported |

## 5.8 COMPARISON BETWEEN EDUCATED AND UNEDUCATED

Table 30 presents the results for comparison based on education type. For this analysis, the sample has been divided into two categories; those with sub-high school, high school and diploma, and those who have a university or Ph.D. degree. The purpose of this analysis is to see if the education type or background makes a difference to the perceptions of smart meters. The results show that information quality has a higher impact on user satisfaction for those with a sub-high school/high school/diploma, as compared to the other group. The path weight for high school/diploma holders is 0.457 while it is 0.299 for university/Ph.D. holders. This might indicate a higher reliance on information from those with lower levels of education. Another interesting observation is that the impact of service quality on user satisfaction was not significant for both groups. Another finding shows that university/Ph.D. holders displayed a higher impact from trust in provider on user satisfaction. This implies that residents that have higher levels of education may tend to trust the smart meter's providers more than the others.

Table 30: comparison based on education type

| Relationship | Less than high school/High School/Diploma | | | University/PhD | | |
|---|---|---|---|---|---|---|
| | Path Weight | T Statistics | P Values | Path Weight | T Statistics | P Values |
| Information Quality -> User Satisfaction | 0.457 | 7.575 | 0.000 | 0.299 | 3.676 | 0.000 |
| Performance Expectancy -> User Satisfaction | 0.478 | 4.941 | 0.000 | 0.415 | 6.764 | 0.000 |
| Service Quality -> User Satisfaction | -0.147 | 1.594 | 0.111 | -0.044 | 0.709 | 0.479 |
| Trust in Provider -> User Satisfaction | 0.188 | 2.706 | 0.007 | 0.290 | 5.240 | 0.000 |
| User Satisfaction -> Net Benefits | 0.857 | 26.935 | 0.000 | 0.869 | 27.434 | 0.000 |
| User Satisfaction -> User Change Behavior | 0.650 | 11.290 | 0.000 | 0.723 | 14.985 | 0.000 |

## 5.9 CHAPTER SUMMARY

This chapter provided details of the analysis of the collected data using SmartPLS. A descriptive analysis of the responses was produced showing percentages of responses to the various items in the questionnaire with columns showing mean response rates and standard deviations for each item. A correlation matrix displayed levels of association between measured variables for each latent variable. Tests established the validity and reliability of the conceptual model and the links between the constructs were examined by Structural Equation Modelling; the stated hypotheses of the study were then tested.

The findings of this chapter are discussed with reference to the literature in the next chapter.

# CHAPTER 6: DISCUSSION

## 6.1 INTRODUCTION

This study has examined the impact of technology acceptance factors on User Satisfaction and User Change Behaviour in ‘technology push’ scenario within a smart city context. This study aimed to assess the relationships and the predictive impact subsisting among dependable and independent variables. The dependent variable is Net Benefits, while the predictive independent variables consisted of Information Quality, Service Quality, Performance Expectancy, and Trust in Provider. The mediator is User Satisfaction and the moderator is User Change Behaviour. The type of study used in this thesis was a cross-sectional study of smart meter users in Kuwait.

To do so, this study developed a conceptual model mainly based on Technology Acceptance Model (TAM). Following this, various tests for validating the conceptual model were conducted using data collected by means of a survey of 300 homeowners who used smart meters. Following data analysis, the findings of the study were presented and the stated hypotheses were tested. In this chapter, the key findings are discussed and the supported hypotheses are critically evaluated in the light of the relevant literature.

## 6.2 INSTRUMENT VALIDATION

The measured variables were examined by convergent and discriminant validity tests to ascertain that they converged to the latent variables that they represented. They also meticulously measured what they purported to measure and that these measured variables were discrete. Tests of factor analysis and composite reliability were run and a high level of convergent validity of the variables was established (Hair et al., 2010). Average variance extracted (AVE), established discriminant validity of all the latent variables.

Cronbach’s alpha **(α)** established the internal reliability of the measured variables. Thus, in this study, it was found that the criteria for validity and internal reliability were adequately met.

## 6.3 HYPOTHESES TESTING

In this section, the results of the hypotheses tests are displayed as in Table 31. With the exception of H2, sufficient evidence was found to support the remaining hypotheses. The findings related to each hypothesis are presented and discussed in the following sections.

Table 31: Summary of the research hypotheses post

| No. | Hypothesis | Results |
|---|---|---|
| **H1** | Information quality of technology has a positive and significant impact on the user satisfaction with smart city technologies. | Supported |
| **H2** | Service quality of technology has a positive and significant impact on the user satisfaction with smart city technologies. | Not Supported |
| **H3** | Trust in the technology provider has a positive and significant impact on the user satisfaction with smart city technologies. | Supported |
| **H4** | Performance expectancy of technology has a positive and significant impact on the user satisfaction with smart city technologies. | Supported |
| **H5** | User satisfaction has a positive and significant impact on the net benefits of smart city technologies. | Supported |
| **H6** | User satisfaction has a positive and significant impact on user change behavior toward smart city technologies. | Supported |
| **H7** | Net benefits have a positive and significant impact on user satisfaction with smart city technologies. | Supported |
| **H8** | There is a statistically significant difference between gender, and Change in User Behavior and Net Benefits of using the smart meters in Kuwait? | Supported |
| **H9** | There is a statistically significant difference between Age, and Change in User Behavior and Net Benefits of using the smart meters in Kuwait | Supported |
| **H10** | There is a statistically significant difference between Educational level, and Change in User Behavior and Net Benefits of using the smart meters in Kuwait | Supported |
| **H11** | There is a statistically significant difference between Marital status, and Change in User Behavior and Net Benefits of using the smart meters in Kuwait | Supported |
| **H12** | There is a statistically significant difference between the Number of children, and Change in User Behavior and Net Benefits of using the smart meters in Kuwait | Supported |
| **H13** | There is a statistically significant difference between the Type of house, and Change in User Behavior and Net Benefits of using the smart meters in Kuwait | Supported |

### 6.3.1 Independent Factors

This section examines the impact of the independent variables on the mediator, which is User Satisfaction. A link is established to the literature review established in chapter two.

- **Information Quality**

The first hypothesis postulated that Information Quality would have a positive influence on User Satisfaction with smart meters in Kuwait.

The SEM output shows that Information Quality has a pathway weighting of 0.337 and a T-value of 5.660. The significance was calculated through bootstrapping and returned a highly significant result ($p < 0.0005$). Accordingly, there is very strong evidence to support H1 (Information quality of technology has a positive and significant impact on the user satisfaction with smart city technologies). It is plausible to suppose that information is crucially important for residents despite the fact that there was push from the authorities to adopt their use so that they can make informed decisions. It is likely that local authorities would provide adequate information also to facilitate the adoption of the smart meters by the homeowners. This finding supports the earlier results of a survey by Mora, Gilart-Iglesias, Pérez-del Hoyo and Andújar-Montoya (2017) which emphasised the importance of paying attention to delivering high quality information about smart meters. The importance of the methods for using them in order that residents would become familiar with them, and to motivate them to increase their usage and thus, their satisfaction with them were also emphasised.

- **Service Quality**

The second hypothesis stated that Service Quality had a positive impact on User Satisfaction with smart meters in Kuwait (H2).

The SEM results indicate a pathway weighting value of -0.067 and a T-value of 1.355. However, the calculated significance of $p = 0.176$ is $> 0.05$ thus there is insufficient evidence to support H2. Service Quality, in this study, was not significantly influencing User Satisfaction. An interesting point to add is that the influence seen in the analysis was negative. This outcome is supports the findings of Huang et al. (2018), who also did not find any significant relationship between Service Quality and User Satisfaction. However, a case survey undertaken by (Hollands, 2015) indicated that providing quality service to users about smart technologies and smart cities helped in enhancing their satisfaction. A plausible explanation is that, in the context of Kuwait, service quality was not an important consideration for users of smart meters because they are more likely to prefer a hands-on demonstration of using the smart meters in order to assess their level of satisfaction. Providing an excellent service does not necessarily mean that users of smart meters would be satisfied. In contrast to the previous studies in the literature, the findings of this study are different from previous research (Hollands 2015).

- **Trust in Provider**

The third hypothesis posited a positive influence for Trust in Provider User Satisfaction with smart meters in Kuwait (H3).

The SEM results showed a pathway weighting of 0.256 and a T-value of 5.472. The calculated significance was $p < 0.0005$. Accordingly, there is sufficient evidence to support H3. Thus, Trust in Provider was found to have a positive influence on User Satisfaction since trust encourages residents to use smart meters. This outcome is consistent with a the results of a survey undertaken by McLean and DeLone (2003) which found that trusting the smart technology provider increased satisfaction with smart city technologies.

- **Performance Expectancy**

The fourth hypothesis proposed that Performance Expectancy had a positive impact on User Satisfaction with smart meters (H4).

The SEM results were very highly significant ($p <0.0005$) and a T-value of 8.462. Thus, there is sufficient evidence to support H4. This outcome is consonant with the findings of studies undertaken by Leong et al. (2013), Sun et al. (2016), and Zolotov et al. (2018). Based on the findings and the literature, we can conclude that Performance Expectancy leads to higher User Satisfaction.

- **User Satisfaction**

User Satisfaction was postulated as influencing both Net Benefits and User Change Behaviour, as stated in hypotheses H5 and H6. The results have shown that User Satisfaction has a significant influence on Net Benefits, which supports H5. Higher levels of satisfaction allowed residents of smart cities to appreciate the value extracted from smart meters and thus, higher perceptions of the Net Benefits gained. This is consistent with the findings of Belanche-Gracia et al. (2015), which determined the presence of a significant positive relationship. Similarly, User Satisfaction has a positive significant relationship with User Change Behaviour, supporting H6. This indicates that becoming satisfied with the smart meters helps residents to change their Behaviour and start using them for tracking their consumption and usage. - This confirms the findings of Baron & Kuźnik (2017) and Lyons (2018), which showed that there is a positive significant relationship between User Satisfaction and User Change Behaviour.

- **Net Benefits**

H7 was tested for the influence of Net Benefits.

The SEM results indicate a p-value of <0.0005 and t-value of 9.412, thus, indicating that Net Benefits had a significant positive influence on User Satisfaction. Therefore, hypothesis H7 is supported. The outcome of this finding is consistent with studies undertaken by Mohanty, Choppali and Kougianos (2016), where a positive influence of Net Benefits was found to exist on User Satisfaction. This means that experiencing the benefits of using smart meters first hand led to acknowledging its value, and thus higher levels of User Satisfaction.

On the other hand, the findings of studies in Delone and McLean (2003) indicate that when the benefits are low and not very beneficial in realizing value, the residents in smart cities will be satisfied. For this study, a thorough literature review was presented about smart cities, its benefits, uses, applications and also their factors, along with some of the important technologies that might contribute to smart cities. Based on these studies seen in literature review, a conceptual model has been proposed, which links all the research variables, and presents the research hypotheses derived from the literature. The methodological approach was examined and chosen for this study in preparation for data collection and analysis. The analysis has presented us with a number of findings, which were used to provide recommendations to policy makers. The study has also determined and answered the research questions relating to the factors that influence user change behavior when smart cities are pushed to citizens. In addition, the minor research questions were also answered by determining the individual impact of all the research variables on user satisfaction with smart cities.

## 6.4 SUMMARY OF CHAPTER SIX

This chapter discussed the findings of the research based on the results of the research hypotheses presented in chapter 5 and with reference to the relevant literature. Initially, it discussed the instrument validity of the measurements used in the survey to collect data from smart homeowners in Kuwait. Thereafter, it discussed each research hypothesis and supported the results of each with previous literature. The discussion of the results has highlighted a very important contribution to public sector officials. In summary, the findings of this study have shown that most antecedents of User Satisfaction (Information Quality, Performance Expectancy, Trust in Provider) have a positive influence on User Satisfaction. Moreover, it did not support the relationship between Service Quality and User Satisfaction. User Satisfaction had a positive and significant influence on User Change Behaviour. Finally, Net Benefits had both a positive and negative influence on User Satisfaction.

The next chapter further discusses the practical and theoretical contributions of this study.

# CHAPTER 7: CONCLUSIONS RECOMMENDATIONS AND REFLECTIONS

## 7.1 INTRODUCTION

Research on the determinants of user satisfaction with smart cities and its impact on change in user behaviour and net benefits was triggered by the increasing intention and direction in Kuwait to build smart cities over the last few years. The scope of this research is to explore the determinants of user satisfaction in smart cities, examine how it impacts the change in user behaviour towards smart cities and how it could influence the net benefits of smart cities. Kuwait is a developing country which is in the early stages of the development of smart cities and is yet to reap the benefits and unleash the full potential of smart cities.

This study evaluated the behavioural aspect of individuals towards smart cities, which was based on the unified theory of user acceptance of technology. It examined how information quality, service quality, performance expectancy and trust in providers can influence user satisfaction with smart cities. A survey of the literature revealed different theoretical perspectives; a theoretical framework was developed consisting of four independent factors, user satisfaction as a mediator, change in user behaviour and net benefits of smart cities. The development of this theoretical framework also necessitated the formulation of a set of hypotheses which were tested.

A positivist research approach was adopted, and the data collection method was by means of a survey of 300 homeowners who had smart meters installed. The hypotheses were tested using SmartPLS v 2.3.9 software.

In this chapter, the contributions of the study are presented. The contributions to theory are by means of addressing identified research gaps. This is followed by presenting some practical implications of the findings of this study which may be of use to managers and local authorities. Pointers towards possibilities for future research are also presented.

## 7.2 RESEARCH IMPLICATIONS

### 7.2.1 Theoretical Implications

The first implication to theory provided by this study is the development and testing of a conceptual framework incorporating information quality, service quality, performance expectancy, trust in provider, user satisfaction, change in user behaviour and net benefits. This study was conducted in Kuwait, where it was proposed that information quality, service quality, performance expectancy and trust in provider have an influential impact on user satisfaction. In the framework, the direct impact of user satisfaction on change in user behaviour was investigated. Moreover, the direct relationship between user satisfaction and change in user behaviour on net benefits was examined. The variables were gleaned from a survey of previous literature in this field.

Developing this comprehensive theoretical framework is the first time, to our knowledge, that such a theoretical framework has been tested empirically and theoretically. This study is novel based on the technology push and its impact on accepting smart cities in Kuwait. The research incorporates a number of factors such as service quality, information quality, trust in provider and performance expectancy. The literature was examined prior to conducting this study and there were a limited number of studies that examined technology push but from a broader perspective and not from a smart city perspective. Smart cities are made of a number of innovative technologies that some people might not be accustomed to yet. Hence, the technology is more likely to be pushed to people. Scholars did not examine technology push and its impact on use and acceptance of smart cities (Hou 2012; Trutnev & Vidiasova 2019), which leaves us with a gap in the literature that needs to be covered.

Secondly, there is a paucity of research into the determinants of user satisfaction with smart cities in countries with different cultural values from those of previous studies (Paskaleva 2009). For example, most of the studies concerning the use of smart cities have been concentrated in countries such as the UK, China and the US. Very little research has been focused on smart cities in developing countries. Indeed, there is a need for studies focusing on smart cities in Kuwait; such studies in Kuwait as have been undertaken have been mostly from a human resource management perspective (Namazi, 2003; Simiar, 1983). Very few studies focused on the impact of trust in provider in the context of smart cities. Kuwait has a very unique structure in terms of culture, norms and religion. In light of the findings, we believe that culture might have an impact on the acceptance of use of technology in Kuwait. The people in Kuwait are used to having houses with certain features such as the building material, the size and the structure. It might be hard to convince some people of change, which is imminent. This study explored the user behaviour change towards technology, which was found to be an important element for satisfaction and use of smart cities. People are socially well connected to each other and hence, some might use and accept smart cities when the society is accepting it.

Thirdly, Seppanen et al. (2007) report the need for further research into the nature of the association between trust and commitment. Wilson and Brennan (2008), regard trust and commitment as the social fabric of the relationship. They identify the need for studies to be conducted into the influence of both trust and commitment on user satisfaction especially in the context of smart cities (Wilson and Brennan, 2008). Therefore, more empirical investigations of trust provider and commitment in smart cities were required. In this research, trust in provider was examined and not the general notion of trust. People might trust the technology or the government but they might not trust the provider of this technology. Hence, this study has filled in the gap in the literature by talking about the trust in the provider of the technology, which was overlooked in the previous studies.

Fourthly, despite it still being a fairly neglected area, there is a growing interest in the debate as to whether user change behaviour is an important factor in developing countries. (Crosno and Dahlstrom, 2008; Hawkins et al., 2009). Moreover, the impact of performance expectancy on user satisfaction was chosen for this study (Lytras & Visvizi 2018). The impact of performance expectancy might be influential in the case of Kuwait, since the country has access to developed technology. . .

In summary, there are a limited number of studies that concentrate on information quality, service quality, performance expectancy and trust in provider, which are assumed to be very important in a high context country such as Kuwait. In particular, there are a limited number of studies that examined the technology push concept. The technology push concept was mainly examined and explored in the private sector but rarely in the public sector. By adding technology push as a general framework for this study, we were able to examine use and acceptance of smart cities when the technology is enforced. The findings of this thesis have provided a novel contribution to the subject of user satisfaction within smart cities in developing countries such as Kuwait, and several theoretical contributions emerge from this research. Smart cities as digital drivers for economic growth, smart cities as an open platform for digital socio-political innovation, and smart cities as an open platform for digital economy (Sancino & Hudson 2020). More than ever, digital government projects, such as smart cities, have to meet high levels of social expectations in public value creation while facing increased levels of complexity and integration challenges. From the findings of this study, it is clear that the aim of the government is to increase satisfaction with technology. The findings also show us that people are interested in knowing the real value of the use of smart cities, where one of them is the economic return and saving. The findings are one of the contributions of the government effort to implement digital government projects where a number of government services would be offered through smart cities.

### 7.2.2 Practical Implications

The findings of this research provide meaningful and practical implications for government officials in the state of Kuwait regarding the success of the smart cities experiment, represented by the use of smart meters in two new residential areas in Kuwait. At a general level, the government officials should realize that smart cities can help in the reduction of the resources needed to operate the cities, and help in enhancing the quality of the services provided. Understanding how smart cities can enhance the quality of life rather than just relying on the best practices from other developed countries can increase the momentum of the government towards shifting completely to smart cities and its development. Moreover, the findings provide a guideline for the correct implementation of smart cities in Kuwait. It is very important for the government of Kuwait to understand user behavior and how smart cities can benefit them in the long run. Additionally, the government of Kuwait should also consider that resource optimization is a vital structural condition regarding the establishment of smart cities in the country.

The findings show that females are more perceptive of the net benefits of smart cities, and are willing to change their behavior than males. The results show that the younger generation has higher perceptions than others, meaning that younger people are willing to change their behavior and start using smart meters technology. With respect to net benefits, it is also observed from the table that younger generations understand and appreciate the benefits of using smart meters more than the older generation. The results show that those who are at an educational level lower than high school have higher significant perceptions about net benefits than those who have a high school degree. This implies that not having an education might lead to an individual being convinced about the value and benefits of smart meters. Single people had higher perceptions towards change in user behavior than married people. This can be explained by the fact that married people are accustomed to certain ways of doing things and thus, might make it difficult for them to change their behavior. People with 1-2 children had higher perceptions towards change in user behaviour than people with a greater number of children. This can be explained by the fact that a small family might be willing to change its behaviour and adopt smart meters. People living in apartments had higher perceptions towards change in user behavior than people living in a Villa. This implies that people living in apartments are more cautious about their spending and they welcome the idea of using smart meters. With respect to net benefits, people living in low-income houses displayed higher perceptions towards net benefits than those living in a villa. The reason is that people living in low-income houses are vigilant towards the benefits of using smart meters.

The findings also provide important guidance for the importance of trust in provider in order for smart cities to be successful. On this point, the government of Kuwait should realize that the selection of the optimal partner to provide the smart cities services can go a long way towards solidifying the trust and enhancement of user satisfaction. Regarding this, the government of Kuwait should understand that employing previous experiences with partners can help them avoid partners that had difficulties in the past, and shortlist a number of partners that are capable of carrying out and managing such huge projects like smart cities. There is a great experience to be learned from American or Korean firms in this area, which have shown an amazing track record of successful smart cities launch over the last decade. As there is a possibility of conflict between partners in smart cities, it is improbable that trust can go in line with the structural solidity of the partners and their size and magnitude. This could help them in the establishment of such projects. Moreover, based on this research, the satisfaction with smart cities should not be based on just trust but reliance on experience in smart cities. Partners that are assigned the task of running and managing smart cities should exhibit higher levels of transparency, which can be evident in clear and direct communication with the client (the government of Kuwait). This can help in enhancing the role of the government of Kuwait in smart cities, and keep them aligned with all the development and issues that may rise.

The change in user behavior was also a crucial factor in smart cities deployment. When implementing smart cities as the alternative to traditional cities, it is imperative that the provider and the government of Kuwait monitor the development of this new model. Thus, a close monitor of user behavior and how they interact with smart cities is needed.

Also, in order to have a successful implementation of smart cities, each partner should make a commitment to uphold the standards of best practices and deliver top notch quality to users. This can help in the establishment of a long term relationship with the customer, which could mean that users will come to rely on this partner. Trust in not something that is earned instantly but will grow gradually over a period of time. Thus, the stability in the partners implementing smart cities will help in accumulating experience on how to deal with residents and can therefore be an instrumental factor in the success of smart cities.

One of the main implications of the research can be the adoption of the notion of smart cities. In Kuwait, the idea is still strange to some citizens. However, with the advancement in the technology and the fast rhythm of life these days, it is eminent now that people start accepting smart cities. Probably the wide spread of COVID 19 all over the world and the lockdowns and curfews that took place in Kuwait has made people more aware and cautious of the social distancing guidelines from the government. A lot of public offices were closed. Thus, an urgent need for the development of smart cities is becoming more intense. The smart cities will provide citizens with all the services that they need and allow them to complete all their public transactions from home. This study has shown that there is acceptance of the idea from some citizens. Thus, this research paves the way for the start of a new era in Kuwait where the focus is shifted towards smart cities.

### 7.2.3 Methodological Implications

This study makes a number of important methodological implications to the field of consumer behaviour research. Firstly, there is a paucity of studies which investigate the impact of trust in provider as one of the predictor variables for smart cities. This is very important, especially in Middle Eastern countries such as Kuwait. Kaur, Akre & Arif (2019) have emphasised the importance of trust in developed countries or western cultural work settings. This study addresses this gap in global investigations by examining predictor variables in cross-cultural settings, which may be useful for generalising these predictors. Testing the predictor variables in Kuwait could provide an additional insight into the extant literature because Kuwaiti people and their cultural backgrounds are substantially different from those of western countries (Chatterjee & Kar 2018). The findings of the study recommend that trust in provider is important.

Moreover, this study confirms existing relevant measurement scales in a country which is culturally different from other settings. For example, trust in provider, and performance expectancy were tested in smart cities in western countries (Hou et al. 2020). Ullah & Sepasgozar (2019) examined the impact of information quality and service quality on user satisfaction in other countries such as India and Colombia. An important addition of this study is that it introduced change in user behavior, as behavior is a crucial steering mechanism that guides individuals on how they react and interact with the environment.

According to the findings, broadly speaking, all scales appear valid in their general content but the number of purified items is not the same as found in the original scales. For example, after testing information quality, which consisted of ten items, this was purified to nine items and found to be highly reliable. Similarly, in trust, net benefits and change in user behavior, some items were not loaded completely and were therefore purified. However, several scales such as service quality, performance expectancy and user satisfaction were purified on their basic items. Future cross-national research could benefit from further investigation about the essential conditions in which the comparability of scales across countries is affected.

## 7.3 RECOMMENDATIONS TO POLICY MAKERS

The findings of this study were valuable as it allowed us to determine the factors that have an impact on user satisfaction and user change behavior when the technology is pushed to people. Hence, recommendations can be made to policy makers in Kuwait in order to maximize the value of smart cities and encourage more people to use it.

**Regulatory framework:** currently, there are no concrete set of rules that govern the establishment of smart cities. One of the ways to ensure higher levels of acceptance when smart cities are pushed to citizens is to ensure that the user experience is well defined and consistent. The regulations might have an impact on the enabling factors and barriers with regards to successful implementations of smart cities projects. A regulatory environment is normally understood as the laws, rules, and regulations put in place by the government entities and civilian organizations to control the behaviour and actions of business activities. There are no policies on smart cities, whether public or private. Also, the infrastructure is not in place and ready to accommodate this new concept of smart cities. Hence, the government is encouraged to develop a set of rules and guidelines for the smart cities and to clearly define all the roles and responsibilities of people as well as the benefits gained from smart cities. These rules and guidelines will also assist individuals in turning their own homes into smart homes, thus, enhancing the value and the benefits of smart cities to citizens.

**Citizen involvement:** one of the things that the government might try is to encourage citizens' involvement in the development of smart cities. This will help in showing the citizens the quality of life that can be gained from using and adopting smart cities and thus will help reduce the impact of technology push on people. Adoption of smart cities is one thing, but full engagement is a different level. Individuals can have a greater impact on the success of smart cities. They can also help in the development of rules and regulations with own ideas. One of the positive actions by the Supreme Council of Planning and Development in Kuwait was the establishment of a portal for citizens to upload their ideas and vision for the Development plan. This will contain useful ideas that the government would take and incorporate. In the same manner, policy makers can establish a portal that allows individuals to become more engaged with the rules and regulations and probably share some of their innovative ideas to help in the development of smart cities or just its regulations and guidelines.

**Political and Social parties:** Another recommendation for the government is the involvement of the political and social parties in promoting the smart cities. People are members of political and social parties, and the involvement of these parties will advocate for smart cities and its benefits. The involvement of the political parties will help in ensuring that the government work is shared and discussed with the other parties, which might be an indication of a healthy line of communications. The discussions with the political and social parties can bring numerous benefits such as the support and confidence of these parties, as well as the utilization of the resources that they have in order to take a viable and solid role in the development of smart cities. These parties might contain academics that have done research in similar areas and can help in enriching the discussions and brining a different perspective to the table. It is recommended that policy makers conduct a series of workshops and seminars with the political and social parties in order to evaluate and assess the smart homes experience. Also, policy makers can create joint committees with experts from these parties in order to utilize the experience that they have. They will also help in the development of smart cities' models that are acceptable for people and thus will not face higher resistance from people.

## *7.4* CONTRIBUTION OF THE RESEARCH

One of the most important contribution of the research is that it sets the stage for further development of smart cities in Kuwait and in the Gulf Corporation Council (GCC) Countries. GCC countries share similar traditions and culture and have close ties through religion and beliefs. Most of the GCC countries got their independence in the 60s or 70s thus making them fairly new in terms of development of a solid foundation for a developing country. Indeed, the explosion in the dot.com worldwide has brought with it numerous technologies and innovations. However, GCC countries were lagging behind in terms of technology and innovation. After the start of the new millennia, GCC countries started to explore automation of its services, which allowed for the countries to move to a new level. With respect to smart cities, GCC countries were and still behind on this notion, where Dubai was the first city to build a smart city in the GCC countries. The shyness of the GCC countries towards smart cities stems most probably from lack of trust and a solid infrastructure. In this respect, this study is useful not only to the State of Kuwait but also to all other GCC countries, which will help in understanding what makes people ecstatic about smart cities. Also, the study lends itself to providing recommendations to policy makers, which can also implemented in other GCC countries due to the similarities of the political arena and the similarity in the mindsets.

Another important contribution of this research is that it allowed to push the envelope towards smart cities in Kuwait as there was little focus in the studies on this topic. The government of Kuwait has announced that it will start building smart cities, which is already underway but taking small steps at a time. A crucial consideration of the importance of smart cities is that the world is changing and the financial situation of Kuwait was not good in 2020 as there was a huge deficit that was announced by the government. Thus, the government should really accelerate its plan to develop smart cities, as it would help in sustaining the resources that it has and help in providing better solution for all people. Thus, this research contributes to the development of plans and guidelines on developing smart cities and the important factors to consider to ensure success.

## 7.5 RESEARCH LIMITATIONS

### 7.5.1 Theoretical Limitations

There are some limitations to the research that should be noted and could be addressed in future research. Testing the use and acceptance of smart meters for newly developed areas in Kuwait may limit generalisability. There is a possibility that the predictor variables would be different when applied to other smart components of smart cities. Therefore, these predictor variables of the theoretical framework should be examined in other components of smart cities, which may present confounding effects on these other components. Therefore, more tests are necessary to strengthen the theoretical framework’s generalisability.

The other limitation of this research is that the present research did not consider the impact of past experience (previous history with providers of standard meters service) of citizens on the level of trust. In future research, researchers could examine the impact of past experience on trust level in the case of smart cities.

### 7.5.2 Methodological Limitations

There are a number of methodological limitations to the research design of this study. Firstly, the cross-sectional design of the study is presented. As the data was collected at a single point in time, it was not possible to create a cause-and-effect relationship over a longer period of time between the variables of interest. Future research could expand this to a longitudinal design in order to collect predictor and criterion variables before and after the change, which would strengthen the findings of the current study. It is suggested that longitudinal studies may be especially useful to understand the impact of the antecedents of user satisfaction within smart cities, and the impact on change in user behaviour and net benefits.

Secondly, the research analyses were based on smart cities in Kuwait, hence limiting the generalisability of the research findings (Cole et al., 2006). It is unclear at this stage whether the same pattern would occur in smart cities in other cultures, and whether the results obtained from this sample apply to other populations due to the cultural differences. Future research could conduct a cross-cultural study on the topic to determine to what extent these results are country-specific or can be extrapolated to other countries.

The third limitation of this study relates to the use of the questionnaire method, which implies that common method bias might have taken place as has been the case in other research using the same method (Blau, 1985). There may be problems relating to data obtained from a single source for causal prediction based on the survey, since the measures were taken on one occasion only. Therefore, multiple methods may be helpful to further clarify the plan of this research. This limitation proposes that in-depth interviews with employees along with quantitative data would be more useful.

The fourth limitation is that the global pandemic of COVID 19 that exploded worldwide in 2020 and has led many governments to enforce lockdown prevented the researcher from collecting responses from users by going door to door. Instead, the researcher had to rely on disseminating the questionnaire using social media and email after obtaining the contact list from the Ministry of Electricity and Water. A face to face would have allowed the researcher to interact with the users and explain the purpose of the study, which may have led to better results.

Finally, as the questionnaires were self-reported by the respondents, there may be reliability and validity issues with the information gained. According to Park and Kim (2009), self-survey data may produce high correlations among measures, because the data shares common method variance and therefore, the errors in measurement are correlated with each other.

These limitations do not reduce the significance of the results or findings in this study. The above points are mentioned in order to direct future research by identifying and supporting further improvement in this area. Next, the implications for future research are discussed.

## 7.6 FUTURE RESEARCH AVENUE

There are many avenues for future research. This study examined the direct relationships between the independent variables, such as information quality, service quality, performance expectancy, trust in provider, and the dependent variables, such as user satisfaction and net benefits. It also examined the impact of user satisfaction on the change in user behavior. One of the key issues for future researchers is to examine more sophisticated relationships between the antecedents' measure and user satisfaction. Regarding this, future research could further develop a theoretical model concerning user satisfaction for different types of predictor relationships. This study investigated the direct relationships between user satisfaction and a variety of antecedent factors. However, it is logical to suggest that a variety of more complicated relationships may exist.

Moreover, the conceptual framework developed for this study should be tested in other types of smart cities components rather than just in smart meters which may support its generalisability. There is a possibility that people who use other smart cities' components react differently; these predictor variables should be examined in smart cities components, which may present confounding effects. Therefore, more tests are required to reinforce its generalisability. In addition, longitudinal studies may help determine if the relationships studied here differ depending on the stage of the satisfaction development process under evaluation.

For future research, this study also recommends using in-depth interviews along with a survey questionnaire, which may infer more about the antecedents of user satisfaction. Therefore, further studies are required to better understand the antecedents of user satisfaction and the impact of user satisfaction on the net benefits of smart cities.

## 7.7 STATEMENT OF THE RESEARCH NOVELTY

The different components of this research were the basis for each individual element of the contributions produced in this thesis. Thus, Chapters 1, 2 and 3 have considered related information and proposed a conceptual model for the research methodology which was presented in Chapter 4; while the development and demonstration of the survey as a data collection method were presented in this Chapter as well. The practical data analysis and the redevelopment of the conceptual model was presented in Chapter 5. The findings of this thesis have produced a novel contribution to the subject of user satisfaction in smart cities, and so expanded the knowledge of the subject in terms of the following:

- The comprehensive novel model for the development of user satisfaction and net benefits in smart cities presented in Figure 7 is the main contribution of this thesis. This model is presented to address the lack of theoretical models explaining the relationship between information quality, service quality, performance expectancy and trust in provider in user satisfaction. It also presents the change in user behavior and net benefits as reported in Chapters 1 and 2. This model was developed as a conceptual model in Chapter 3 and empirically investigated in Chapter 5. The results of this investigation were the basis for the evidence and model modifications in Chapter 6.
- There are two levels of original contribution in this model. Firstly, the proposed model takes account of previous studies on smart cities and the user satisfaction, and this supports the conceptual level of this contribution. The researcher involved these studies and extended them to merge the factors recognised in the normative literature. In addition, the factors from empirical work have also been combined in the proposed model, thus, developing a consistent model for the adoption and use of smart cities. Secondly, the concept and process of the proposed model can be applied as a map for the evaluation process of trust in provider on user satisfaction and how it could impact change in user behavior and net benefits.

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# APPENDICES

## Appendix 1 Questionnaire in English

# Investigating the factors affecting the net benefits and change in user behaviour in technology push scenarios in Smart cities.

SURVEY

### I: DEMOGRAPHICS

| | | |
|---|---|---|
| **[GEN] Gender** | Male | Female |

| | | | |
|---|---|---|---|
| **[AGE] Age** | 18-24 years old | 25-34 years old | 35-44 years old |
| | 45-54 years old | 55 or above | |

| | | | |
|---|---|---|---|
| **[EDU] Education** | Less than High School | High School | Diploma |
| | Masters | Ph.D. | |

| | | | |
|---|---|---|---|
| **[MAR] Marital Status** | Single | Married | Divorced |
| | Widow | | |

| | | | |
|---|---|---|---|
| **[NCH] Number of Children in the House** | No Children | 1-2 children | 3-5 children |
| | 6-8 children | 9 or more | |

| | | | |
|---|---|---|---|
| **[TOH] Type of House** | Apartment | Low-income house | Villa |
| | | | |

## II: 7-POINT LIKERT SCALE

You are requested to answer each of the statements based on the below 7-point scale.

| IQ | Strongly Disagree | Somewhat Disagree | Disagree | Neither Agree Nor Disagree | Agree | Somewhat Agree | Strongly Agree |
|---|---|---|---|---|---|---|---|
| [IQ01] The information that the smart meter generates is accurate | | | | | | | |
| [IQ02] The information that is processed by the smart meter is secured | | | | | | | |
| [IQ03] The Information available through the smart meter is relevant for me | | | | | | | |
| [IQ04] The information presented by the smart meter is displayed in a useful format | | | | | | | |
| [IQ05] The information that the smart meter generates is clear | | | | | | | |
| [IQ06] The smart meter provides sufficient information to users | | | | | | | |
| [IQ07] The smart meter provides up-to-date information to users | | | | | | | |
| [IQ08] The information that the smart meter generates is produced in time | | | | | | | |
| [IQ09] The information that the smart meter generates is precise | | | | | | | |
| [IQ10] The information that the smart meter generates meets my needs | | | | | | | |

| EQ | Strongly Disagree | Somewhat Disagree | Disagree | Neither Agree Nor Disagree | Agree | Somewhat Agree | Strongly Agree |
|---|---|---|---|---|---|---|---|
| [EQ01] The service quality of the smart meter is reliable to ensure that I get the service I need. | | | | | | | |
| [EQ02] The support staff of the smart meter is competent to provide the needed support to me. | | | | | | | |
| [EQ03] The call center representatives of smart meter always help me when I need support with the smart meter | | | | | | | |
| [EQ04] The call center representatives of smart meter always pay personal attention when I experience problems with the smart meter | | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| [EQ05] The call center representatives of smart meter have adequate knowledge to answer my queries related to smart meter | | | | | | | |

| PE | Strongly Disagree | Somewhat Disagree | Disagree | Neither Agree Nor Disagree | Agree | Somewhat Agree | Strongly Agree |
|---|---|---|---|---|---|---|---|
| [PE01] I find smart meter useful in my daily life | | | | | | | |
| [PE02] Using the smart meter enables me to accomplish related tasks more quickly | | | | | | | |
| [PE03] Using the smart meter increases my productivity of accomplishing tasks | | | | | | | |
| [PE04] If I use the smart meter, I will increase my chances of saving the public resources | | | | | | | |

| TP | Strongly Disagree | Somewhat Disagree | Disagree | Neither Agree Nor Disagree | Agree | Somewhat Agree | Strongly Agree |
|---|---|---|---|---|---|---|---|
| [TP01] I generally have faith in smart meter | | | | | | | |
| [TP02] I feel that smart meter is generally reliable | | | | | | | |
| [TP03] I generally trust smart meter unless there is a reason not to | | | | | | | |
| [TP04] I trust smart meter to offer secure service | | | | | | | |
| [TP05] I find smart meter is secure in executing tasks | | | | | | | |
| [TP06] I find smart meter safe for receiving consumption statements | | | | | | | |

| US | Strongly Disagree | Somewhat Disagree | Disagree | Neither Agree Nor Disagree | Agree | Somewhat Agree | Strongly Agree |
|---|---|---|---|---|---|---|---|
| [US01] I am confident that the data generated from the smart meter will help me in the decision making process regarding my electricity consumption | | | | | | | |
| [US02] Smart meter makes my life easy | | | | | | | |
| [US03] I would truly enjoy using smart meter | | | | | | | |
| [US04] I am pleased that the smart meter meets my needs | | | | | | | |
| [US05] I am content that the smart meter is efficient | | | | | | | |
| [US06] I am happy with the effectiveness of the smart meter | | | | | | | |
| [US07] Overall, I am satisfied with the smart meter | | | | | | | |

| CB | Strongly Disagree | Somewhat Disagree | Disagree | Neither Agree Nor Disagree | Agree | Somewhat Agree | Strongly Agree |
|---|---|---|---|---|---|---|---|
| [CB01] I would use smart meter instead of the traditional methods of conducting the services | | | | | | | |
| [CB02] I am very likely to provide needed information to the smart meter in order to better serve my needs | | | | | | | |
| [CB03] I use the smart meter to get energy information about my residence | | | | | | | |
| [CB04] I use the smart meter to better understand what the energy terms mean | | | | | | | |

| NB | Strongly Disagree | Somewhat Disagree | Disagree | Neither Agree Nor Disagree | Agree | Somewhat Agree | Strongly Agree |
|---|---|---|---|---|---|---|---|
| [NB01] Using smart meter will help me do things quicker | | | | | | | |
| [NB02] The smart meter will help me improve the quality of life | | | | | | | |
| [NB03] I think the overall cost of using the smart meter is going to be reduced in the future once smart meters are fully utilized by all | | | | | | | |
| [NB04] The smart meter helps reduce my energy bills | | | | | | | |
| [NB05] The smart meter increases my understanding of my energy usage | | | | | | | |
| [NB06] The smart meter helps me make better decisions about energy usage | | | | | | | |

## Appendix 3: Consent Form

**Consent Form**

**Study title: Investigating the factors affecting the net benefits and change in user behaviour in technology push scenarios in Smart cities**

Thank you very much for agreeing to take part in my research. The purpose of this form is to make sure that you are happy to take part in the research and that you know what is involved.

| | |
|---|---|
| Have you had the opportunity to ask questions and discuss the study? | YES/NO |
| If you have asked questions have you had satisfactory answers to your questions? | YES/NO/NA |
| Do you understand that you are free to withdraw at any time? | YES/NO |
| Do you understand that you are free to choose not to answer a question without having to give a reason why? | YES/NO |
| Do you agree to take part in this study? | YES/NO |
| Do you grant permission for extracts from the survey to be used in reports of the research on the understanding that your anonymity will be maintained? | YES/NO |
| Do you grant permission for an extended, but anonymised, extract from the Survey to be included as an appendix in the final report? | YES/NO |

All Survey data will be treated in confidence and all transcripts and any writing will ensure anonymity for participants. If you wish to withdraw from the study, then you are required to send an official email/letter stating your intent to withdraw. A response will be sent within a week. The time frame for withdrawing from the study is 6 months from the data collection.

SIGNED.................................................................................................…………………………

NAME IN BLOCK LETTERS..............................................…………………………...

DATE...........................

**Appendix 2: Questionnaire in Arabic**

# التحقيق في العوامل التي تؤثر على الفائدة والتغيير في سلوك المستخدم في سيناريوهات فرض التكنولوجيا في المدن الذكية

استبيان

## القسم الأول: البيانات الشخصية

| | | |
|---|---|---|
| **[GEN]** الجنس | ذكر | أنثى |

| | | | |
|---|---|---|---|
| **[AGE]** العمر | 24-18 سنة | 34-25 سنة | 44-35 سنة |
| | 54-45 سنة | 55 سنة فما فوق | |

| | | | |
|---|---|---|---|
| **[EDU]** التعليم | أقل من ثانوية عامة | ثانوية عامة | دبلوم |
| | ماجستير | دكتوراة | |

| | | | |
|---|---|---|---|
| **[MAR]** الوضع الاجتماعي | أعزب | متزوج | مطلق |
| | أرمل | | |

| | | | |
|---|---|---|---|
| **[NCH]** عدد الأطفال في المنزل | لا يوجد أطفال | 1-2 طفل | 3-5 أطفال |
| | 6-8 أطفال | 9 أطفال فما فوق | |

| | | | |
|---|---|---|---|
| **[TOH]** نوع المنزل | شقة | منزل دخل محدود | فيلا |
| | | | |

## القسم الثاني: أسئلة الاستبيان على مقياس ليكرت 7

نطلب منك الإجابة على كل عبارة من العبارات بناءً على مقياس ليكرت مكون من 5 نقاط أدناه.

| جودة المعلومات | أعارض بشدة | أعارض لحد ما | أعارض | غير معارض أو موافق | موافق | موافق إلى حد ما | موافق بشدة |
|---|---|---|---|---|---|---|---|
| IQ[01] المعلومات التي يولدها العداد الذكي دقيقة | | | | | | | |
| IQ[02] يتم تأمين المعلومات التي تتم معالجتها بواسطة العداد الذكي | | | | | | | |
| IQ[03] المعلومات المتاحة من خلال العداد الذكي مناسبة لي | | | | | | | |
| IQ[04] يتم عرض المعلومات المقدمة بواسطة العداد الذكي بتنسيق جيد | | | | | | | |
| IQ[05] المعلومات التي يولدها العداد الذكي واضحة | | | | | | | |
| IQ[06] يوفر العداد الذكي معلومات كافية للمستخدمين | | | | | | | |
| IQ[07] يوفر العداد الذكي معلومات محدثة للمستخدمين | | | | | | | |
| IQ[08] يتم عرض المعلومات التي يولدها العداد الذكي في الوقت المناسب | | | | | | | |
| IQ[09] المعلومات التي يولدها العداد الذكي صحيحة | | | | | | | |
| IQ[10] المعلومات التي يولدها العداد الذكي تلبي احتياجاتي | | | | | | | |

| جودة الخدمة | أعارض بشدة | أعارض لحد ما | أعارض | غير معارض أو موافق | موافق | موافق إلى حد ما | موافق بشدة |
|---|---|---|---|---|---|---|---|
| EQ[01] جودة خدمة العدادات الذكية موثوقة لضمان حصولي على الخدمة التي أحتاج إليها. | | | | | | | |
| EQ[02] موظفو دعم العدادات الذكية مؤهلون لتقديم الدعم اللازم لي. | | | | | | | |
| EQ[03] دائمًا ما يساعدني موظفوا مركز الاتصال للعداد الذكي عندما أحتاج إلى الدعم | | | | | | | |
| EQ[04] دائمًا ما يولي موظفوا مركز الاتصال للعداد الذكي اهتمامًا شخصيًا عندما أواجه مشكلات | | | | | | | |
| EQ[05] يتمتع موظفوا مركز الاتصال للعداد الذكي بمعرفة كافية للرد على استفساراتي المتعلقة بالعداد الذكي | | | | | | | |

| توقعات الأداء | أعارض بشدة | أعارض لحد ما | أعارض | غير معارض أو موافق | موافق | موافق إلى حد ما | موافق بشدة |
|---|---|---|---|---|---|---|---|
| [PE01] أجد العداد الذكي مفيدًا في حياتي اليومية | | | | | | | |
| [PE02] يتيح لي استخدام العداد الذكي إنجاز المهام ذات الصلة بسرعة أكبر | | | | | | | |
| [PE03] استخدام العداد الذكي يزيد من إنتاجيتي لإنجاز المهام | | | | | | | |
| [PE04] إذا استخدمت العداد الذكي ، فسوف أزيد من قدرتي على توفير الموارد العامة | | | | | | | |

| الوثوق في مزود الخدمة | أعارض بشدة | أعارض لحد ما | أعارض | غير معارض أو موافق | موافق | موافق إلى حد ما | موافق بشدة |
|---|---|---|---|---|---|---|---|
| [TP01] أنا أؤمن بالعداد الذكي عمومًا | | | | | | | |
| [TP02] أشعر أن العداد الذكي موثوق بشكل عام | | | | | | | |
| [TP03] أثق في العداد الذكي عمومًا ما لم يكن هناك سبب | | | | | | | |
| [TP04] أثق في العداد الذكي لتقديم خدمة آمنة | | | | | | | |
| [TP05] أجد العداد الذكي آمنًا في تنفيذ المهام | | | | | | | |
| [TP06] أجد العداد الذكي آمنًا لتلقي بيانات الاستهلاك | | | | | | | |

| رضا المستخدم | أعارض بشدة | أعارض لحد ما | أعارض | غير معارض أو موافق | موافق | موافق إلى حد ما | موافق بشدة |
|---|---|---|---|---|---|---|---|
| [US01] أنا واثق من أن البيانات الناتجة من العداد الذكي ستساعدني في اتخاذ القرار فيما يتعلق باستهلاكي للكهرباء | | | | | | | |
| [US02] سيجعل العداد الذكي حياتي سهلة | | | | | | | |
| [US03] سأستمتع باستخدام عداد ذكي | | | | | | | |
| [US04] يسرني أن العداد الذكي يلبي احتياجاتي | | | | | | | |
| [US05] أنا راض عن فعالية العداد الذكي | | | | | | | |
| [US06] أنا سعيد بفعالية العداد الذكي | | | | | | | |
| [US07] بشكل عام، أنا راضٍ عن أداء العداد الذكي | | | | | | | |

| التغيير في السلوك | أعارض بشدة | أعارض لحد ما | أعارض | غير معارض أو موافق | موافق | موافق إلى حد ما | موافق بشدة |
|---|---|---|---|---|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| [CB01] أفضل استخدام العداد الذكي بدلاً من الطرق التقليدية للاستفادة من الخدمات | | | | | | | |
| [CB02] من المحتمل جدًا أن أوفر المعلومات المطلوبة للعداد الذكي من أجل تلبية احتياجاتي بشكل أفضل | | | | | | | |
| [CB03] أستخدم العداد الذكي للحصول على معلومات حول استهلاك الطاقة حول سكني | | | | | | | |
| [CB04] أستخدم العداد الذكي لفهم معنى مصطلحات الطاقة بشكل أفضل | | | | | | | |

| الفائدة الصافية | أعارض بشدة | أعارض لحد ما | أعارض | غير موافق أو معارض | موافق | موافق إلى حد ما | موافق بشدة |
|---|---|---|---|---|---|---|---|
| [NB01] سيساعدني استخدام العداد الذكي على أداء المهام بشكل أسرع | | | | | | | |
| [NB02] سيساعدني العداد الذكي على تحسين نوعية الحياة | | | | | | | |
| [NB03] أعتقد أن التكلفة الإجمالية لاستخدام العداد الذكي ستنخفض في المستقبل بمجرد استخدام العدادات الذكية بالكامل من قبل الجميع | | | | | | | |
| [NB04] يساعد العداد الذكي على تقليل فواتير الطاقة | | | | | | | |
| [NB05] يزيد العداد الذكي من فهمي لاستخدامي للطاقة | | | | | | | |
| [NB06] يساعدني العداد الذكي على اتخاذ قرارات أفضل بشأن استخدام الطاقة | | | | | | | |
| [NB07] يساعدني العداد الذكي في مقارنة استهلاك الطاقة الخاص مع الجيران. | | | | | | | |