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INNOVATION FOR TECHNOLOGY

CITIZEN EMPOWERMENT IN NEWLY BORN SMART CITIES IN MAURITIUS

Final Report

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Final Report

Citizen empowerment in newly born Smart Cities in Mauritius

Under the MAURITIUS RESEARCH COUNCIL

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Chapter 1: Introduction

1.1 Introduction

Smart Cities are becoming more of a reality every day, and smart cities are being set up around the world. Over the last decade, research into technologies needed to build and support Smart Cities have matured. Today, with the use of information and communications technologies (ICT), many solutions to manage the Smart City infrastructure such as energy monitoring, water management, transport management, traffic control and parking space management, have been proposed and is being implemented. However, such technological advances may not be enough for Smart Cities to be a successful reality. In the zeal for technological advancement, “who” Smart Cities are built for should not be neglected. Smart Cities should be created and deployed for humans first; then only will the Smart City be of real value and the engineering efforts used towards the enhancement of the human experience of the Smart City.

According to International Telecommunication Union (ITU)'s report "Measuring Information Society" published in 2015 [1], the ICT Development Index IDI (based on ICT Access, ICT Use and ICT Skills) for Europe is highest (average IDI value at 7.35). The high IDI values in Europe reflects on the access to high bandwidth connectivity, high adult literacy rate and the and better ICT use. This certainly explains why many of the smart cities today such as Barcelona, Copenhagen, Helsinki, and Vienna are found in Europe.

Africa has by far the lowest average IDI value at 2.53. In the African region, Mauritius is ranked first with an IDI value of 5.41, followed by Seychelles and South Africa. According to research by Frost & Sullivan in its report "The Telecommunications Market in Southern Africa" [2], a new techno park, a third submarine fibre optic cable as well as enhanced integration of ICT and business in the country is boosting competitiveness in the Information Technology sector in Mauritius. The Smart City Scheme of the government of Mauritius already aims at leveraging digitalization and new technologies for the development of Smart Cities and Techno-poles.

The disparity between Europe and Africa is obvious. However, according to a Deloitte report [3], Africa is ready to leapfrog the competition through smart cities technology but only with successful adoption and appropriate selection of technology. Smart City solutions that are successful in Europe may not be successful in Africa and Mauritius.

In [4], the author investigates the causes of E-Government failure in developing countries. Similarly, in [5], the author, argues that the high failure rate of E-government projects in Africa results in waste of financial resources, which African countries can't afford. Users and the information systems designed to support their needs and behaviours are becoming increasingly complex [6]. For Smart Cities to become a reality, it is important that citizens adopt and accept smart city technologies.

The technology acceptance model (TAM) [7] which consists of two major constructs: perceived ease of use (PEOU) and perceived usefulness (PU) is often used to study and determine the adoption of new solutions. In [8], the authors use TAM to assess and improve M-Learning. In [9], the authors use the Modified Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) model to study the factors that influenced the adoption of TV streaming by Internet users in Indonesia. A study [10] uses Unified Theory of Acceptance and Use of Technology (UTAUT) to investigate what impacts people to adopt mobile banking and why it is underused. Findings from such research are useful in providing guidance to developers for designing appropriate solutions.

To the best of our knowledge, apart from some research conducted in the area of e/m-learning, e-government, mobile payments and mobile banking, not much research has been conducted in Africa to evaluate the level of participation and adoption of smart cities solutions. No such research has been conducted in Mauritius. The acceptance and adoption of smart cities solutions is fundamental as the technological innovations alone are not sufficient. Variables and behaviours that influence acceptance and usage of such technologies, potential limitations and gaps have to be identified and analysed especially in this context where citizens may be called upon to participate heavily and provide information to the entire community.

For smart cities to become a reality in Mauritius, smart city applications and services should be citizen-centered and relevant for ordinary citizens in their everyday life. Institutions such as governments are the drivers of the Smart City. However, for the success of the smart city initiatives, it is important to get feedback from the citizens who would form an integral part of the smart city.

This research will look into the Mauritian society's readiness for acceptance of new solutions and smart

city technologies and give an insight into the needs and demand of the society, as well as the harmonization of individual and common demands. It also allows to perform analysis of the social and non-technological aspects of smart city adoption.

1.2 Research Aims and Objectives

Advances in technology are quickly paving the way for smart cities. A smart city is an urban centre that harnesses technologies, such as ICT, to improve the quality of life of residents, manage available resources such as roads and water in economically sustainable manner, and reduce environmental pollution. The Government of Mauritius has set up the Smart City Scheme to provide an enabling framework and a package of attractive fiscal and non-fiscal incentives to investors for the development of smart cities across the island. However, prior to the design and implementation of such technologies, it is important to predict the behavioural intention to use such technology so that smart city technologies effectively empower citizens and improve the quality of life of citizens. In this research work, it is proposed to use the TAM to effectively assess the perception and readiness and the perceived usefulness of certain smart city technologies such as for transportation as well as identifying key smart city applications for Mauritius.

The aim of this research project is to evaluate and assess the different factors and condition that can have an impact on the perceived ease of use (PEOU), perceived usefulness (PU), attitudes towards using (ATT), behavioural intention (BI) to use and actual use (AU) of smart city technologies. For smart cities to become a reality in Mauritius, smart city applications and services should be citizen-centered and relevant for ordinary citizens in their everyday life. This research work will allow to assess the readiness of Mauritian citizens for Smart city applications as well as identify applications which can empower citizen.

Chapter 2: Literature Review

2.1 Introduction to Technology Acceptance Model (TAM)

Technology Acceptance Model has been developed by Davis (1989) and is one of the most popular research models to predict use and acceptance of information systems and technology by individual users. TAM has been widely studied and verified by different studies that examine the individual technology acceptance behaviour in different information systems constructs. Davis's Technology Acceptance Model (TAM) provides a valid and reliable measure that predicts the acceptance or adoption of new technologies by end-users (Davis, 1989; Davis, Bagozzi, &Warshaw, 1989). It is also a commonly used model to measure technology acceptance (King & He, 2006).

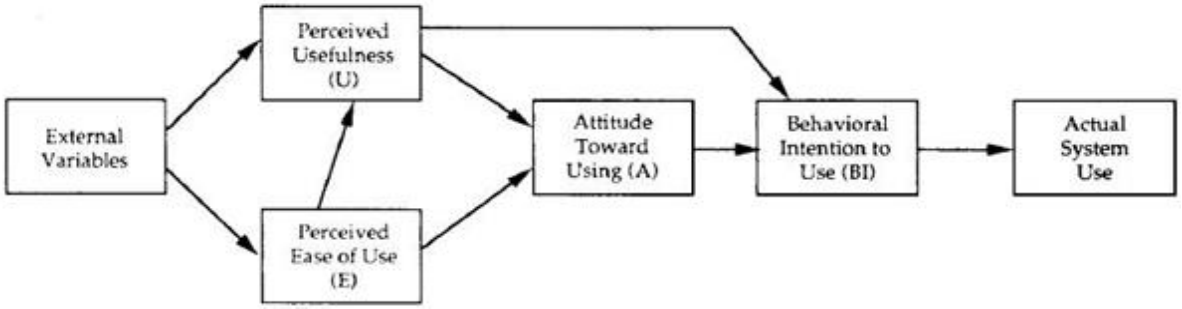
In contrast with the other entries of the Consumer Health Informatics Research Resource website (which cover psychosocial variables that contribute to cognitive, affective, and ultimately behavioural effects), this entry is about technology, or a channel of communication. Specifically, the technology acceptance model assesses end-user acceptance of a technology for a health communication purpose. The ultimate success of health communication interventions via web based and other communication technologies is dependent on the use of technology by the target audiences for intended purposes.

Davis's (1989) original TAM predicts acceptance based on the end-user's perceived usefulness (PU) and perceived ease of use (PEOU) of the technology for a specific purpose. Davis applied the model to work settings, and defined PU as "the degree to which a person believes that using a particular system would enhance his or her job performance." (Davis, 1989, p. 320). In non-work settings, the goal becomes personal objectives instead of enhancing job performance. For example, a PU goal or "job" of a health care consumer in selecting a physician (using web-based data) hypothetically is to identify a highly qualified medical practitioner. In this circumstance, web-based information is useful to the extent it helps achieve the latter goal. Davis (1989) defined PEOU as: "the degree to which a person believes that using a particular system would be free of effort" (p. 320). Here, PEOU's definition, unlike PU's, transcends work settings as well as goals or purposes.

According to theory of reasoned action the individual behaviour is motivated by behavioural objectives and these are a function of an individual's attitude toward the behaviour and subjective norms surrounding the performance of the behaviour. Technology acceptance mode (TAM) has been based on

theory of reasoned action (TRA) and has been used to explain individual's acceptance behaviour. TAM was first proposed by Davis (1989) in his Doctoral thesis. Theory of Planned Behaviour helps to recognize how the behaviour of people can be changed. TPB suggests that human action is guided by three factors which are behavioural, normative and control beliefs includes some factors that are part of TAM. However, TPB is not specific Information systems usage (IS). The perceived usefulness factor and perceived ease of use factors are major factors in computer use behaviours based on Technology acceptance model. TAM has been widely used to scrutinize individual technology acceptance behaviour in various types of information systems.

In TAM model, there are two factors perceived usefulness and perceived ease of use is relevant in computer use behaviours. Davis defines perceived usefulness as the prospective user's subjective probability that using a specific application system will enhance his or her job or life performance. Perceive ease of use (EOU) can be defined as the degree to which the prospective user expects the target system to be free of effort. According to TAM, ease of use and perceived usefulness are the most important determinants of actual system use. These two factors are influenced by external variables. The main external factors that are usually manifested are social factors, cultural factors and political factors. Social factors include language, skills and facilitating conditions. Political factors are mainly the impact of using technology in politics and political crisis. The attitude to use is concerned with the user's evaluation of the desirability of employing a particular information system application. Behavioural intention is the measure of the likelihood of a person employing the application.



Technology acceptance Model (TAM) Davis (1989)

2.2History & Beginning of the concept of Acceptance

Both practitioners and researchers have a strong interest in understanding why people accept information technology so that better methods for designing, evaluating, and predicting how users will respond to new technology can be developed. Although practically intertwined, design and evaluation are logically independent issues, as noted by DILLON, and it remains an open question in many instances how to translate usability evaluation results to specific interface design improvements. Acceptance theory seeks to extend the traditional model of user-centered design espoused in usability engineering approaches (e.g., NIELSEN) from questions of interface improvement towards predictions of likely usage.

Historically, developers and procurers of new technology may have been able to rely on authority to ensure that technology was used, at least in industrial/organizational contexts, though even the much-maligned scientific management of TAYLOR appealed to the motivational power of financial reward in encouraging workers to use the tools designed for them in the way in which they were told. However, current working practices, as well as the leisure and educational applications of information technology, render the search for predictive measures of acceptance more acute. As technological use spreads across society and organizations become more dependent on information technologies, the concern with designing information systems that will be used appropriately grows.

Researchers have studied a range of issues related to this topic, from individual user characteristics such as cognitive style (HUBER) to internal beliefs and their impact on usage behavior (e.g., DESANCTIS; FUERST CHENEY; GINZBERG; IVES ET AL; SRINIVASAN; SWANSON, 1987). Acceptance has been viewed as a function of user involvement in systems development (BARKI HARTWICK; FRANZ ROBEY; HARTWICK BARKI) or as a measure of the political climate in an organization (MARKUS). The type of system development process used (e.g., ALAVI) and the process by which technology is implemented and diffused (e.g., BRANCHEAU WETHERBE; FICHMAN; MOORE BENBASAT) have also been explored. None of these variables can account for sufficient variance in acceptance to enable a researcher, procurer, or designer to predict user acceptance reliably.

The search for a single-variable answer is unlikely to yield an explanation of the level of acceptance any information technology will receive among its intended users. However, there are distinct trends in the literature that suggest the issue is not intractable, and several clusters of determining variables have been proposed. This literature is diverse and emerging from distinct disciplines. Though THOMPSON

covered tangentially related work under the heading of "technology utilization" in Vol. 10, this is the first ARIST chapter on information technology acceptance. Thus, it is appropriate to tackle this topic in a manner that affords the reader some insight into the range of perspectives that converge on this problem as well as the precise empirical findings to date.

At the highest level, acceptance has been subsumed under the theoretical analysis of innovation diffusion, and it is appropriate to start coverage of the topic here. However, precise analysis of user acceptance has now become a central concern of disciplines studying information technology in particular rather than general technological innovations. This work concentrates more directly on the determinants and importance of user acceptance, rather than the broad issues of social diffusion, and is the major focus of the present chapter. More than one theoretical approach is necessary for our complete understanding of the issues involved, and, for clarity, approaches are treated independently at the outset.

Perhaps the principal theoretical perspective on technology acceptance is innovation diffusion theory, which has been applied at both individual (e.g., ROGERS) and organizational (e.g., ZALTMAN ET AL.,) levels of analysis. Its primary intention is to provide an account of the manner in which any technological innovation moves from the stage of invention to widespread use (or not). Though not concerned with information technology exclusively, diffusion theory offers a conceptual framework for discussing acceptance at a global level.

Diffusion theory posits five characteristics of innovations that affect their diffusion: relative advantage (the extent to which a technology offers improvements over currently available tools), compatibility (its consistency with social practices and norms among its users), complexity (its ease of use or learning), trialability (the opportunity to try an innovation before committing to use it), and observability (the extent to which the technology's outputs and its gains are clear to see). Each of these characteristics on its own is insufficient to predict either the extent or the rate of diffusion, but diffusion studies have demonstrated that innovations affording advantages, compatibility with existing practices and beliefs, low complexity, potential trialability, and observability, will be more extensively and rapidly diffused than an innovation with the cluster of opposite characteristics (Rogers). An early meta-analysis of the innovation diffusion literature found that three of these characteristics had the greatest influence on adoption: compatibility and relative advantage were positively related to innovation adoption ($p < .05$),

while complexity was negatively related to adoption at marginally significant ($p < .062$) levels (Tornatzky Klein). However, the authors criticized the then current conceptualizations of these constructs. Relative advantage, in particular, was cited as especially ambiguous because the criteria used to judge what is "advantageous" is often not defined (e.g., an innovation could be advantageous because it costs less or is less complex).

In examining and extending these characteristics in a context specific to information technology (IT), MOORE BENBASAT report an extensive effort to develop an instrument which can be used to evaluate user perceptions of IT innovations. Their results suggest that the most important perceived characteristics of an IT innovation which affect decisions regarding use are: voluntariness of use, image ("the degree to which use of an innovation is perceived to enhance one's image or status in one's social system," p. 195), relative advantage, compatibility, ease of use, trialability, result demonstrability, and visibility. These results lend at least partial support to Roger's factors, but add an important emphasis on variables related to discretion and ease of use.

Innovation diffusion theory suggests that factors at the level of the individual user are also important. ROGERS divides technology or innovation adopters into five categories depending on their speed of uptake: innovators, early adopters, early majority, late majority, and laggards. Such distinctions could be seen as somewhat fuzzy, not least because any distribution over time could be so divided. However, Rogers plots these categories over a normal distribution where each major category (innovators and early adopters are combined into one for this purpose) represents a standard deviation of dispersion. Accordingly, the division between early and late majority is the mean, with laggards and late adopters constituting 50% of the population. On this basis, Rogers estimates that early adopters and innovators jointly make up only 16% of the total population. Early adopters have disproportionate influence over the adoption of any technology, and profiling studies of these categories have revealed a number of personality (e.g., risk-taking, adventure seeking) and socioeconomic (e.g., wealth, education) variables that supposedly distinguish their members.

This approach seems to have direct relevance to studies of IT acceptance in organizations. BRANCHEAU WETHERBE showed that the cumulative adoption distribution of spreadsheet use closely follows a sigmoidal, S-shaped curve, as predicted by innovation diffusion theory. Thus, organizations evaluating technology for use in the organization must be cognizant of the user base for which the tool is both

designed and purchased. For a tool that will be used throughout the organization, it is reasonable to expect that a protracted period of time may be required before all users are "up to speed" on how to use the tool effectively. Understanding users who are likely to be "laggards" is important; intervention strategies (i.e., extended training) can be designed with those users in mind.

Recent research has attempted to extend diffusion theory to more complex adoption scenarios. For example, managerial influence in the organization can encourage (or discourage) acceptance explicitly through expressed preferences and/or mandates (LEONARD-BARTON DESCHAMPS; MOORE BENBASAT) and through reward systems and incentives (LEONARD-BARTON). Thus, studies that examine acceptance at the level of the organization need to account for the potential importance of managerial influence. The innovation diffusion approach seems to have been useful in the area of end-user computing (EUC) within the IS literature, as many of the theoretically strong EUC studies (e.g., BRANCHEAU WETHERBE; MOORE BENBASAT at the individual level; BROWN BOSTROM at the organizational level) are based on theories of innovation diffusion. In fact, in their review and analysis of the EUC literature, BRANCHEAU BROWN suggests innovation diffusion as a promising basis for future EUC research.

While diffusion theory provides a context in which one may examine the uptake and impact of information technology over time, it provides little explicit treatment of user acceptance. Its most direct link would appear to be in the area of innovation characteristics that may drive individual adoption decisions (i.e., the perceived complexity, compatibility, etc. of a particular IT) and innovation positioning (the planned marketing of a technology to a specific group or organization) (ROGERS).

As researchers seek to identify the factors that determine user acceptance of any information technology and, in particular, factors that can be influenced by design, the question of acceptance has come to be tackled more directly by researchers working outside (or at least on the outskirts of) the classical innovation diffusion tradition. Most noticeably, researchers in the fields of human-computer interaction and management information systems (MIS) have drawn heavily on theoretical work in social and cognitive psychology, as well as sociology, in studying user acceptance. For purposes of clarity, a distinction is drawn here between those theoretical approaches seeking to understand the social and psychological determinants of user acceptance at an individual level and those seeking to understand user acceptance in terms of the design and implementation process of new technology.

2.3 TAM Model Explanation

Technology Acceptance Model is one of the most popular theories that is used widely to explain Information System usage. So many studies have been conducted which has led to the changes in the originally proposed model. A new model called combined TAM-TPB model which integrated the Technology Acceptance Model and Theory of Planned Behaviour was proposed by Taylor and Todd (1995). Venkatesh and Davis (2000) proposed a new version of TAM called TAM2 which added new variables to the existing model. Venkatesh et al. (2003) in a study published in MIS quarterly proposed the Unified Theory of Acceptance and Use of Technology (UTAUT) Model.

The various studies conducted by researchers have tried to modify the TAM by adding new variables to it. Agarwal and Prasad (1998a, 1998b) modified TAM by adding the construct of compatibility in the Technology Acceptance Model. Moon and Kim (2001) has added a new variable playfulness factors to study acceptance of the World Wide Web. Lim (2000) proposed to modify TAM by adding variables like experience, self-efficacy, perceived risk and social influence. Another study done by Agarwal and Karahanna added cognitive absorption, playfulness and self-efficacy to the TAM model. Chau (1996) in a study reviewed TAM by included two types of perceived usefulness: near-term and long-term. Vander Heijden (2000) after analysing the individual acceptance and usage of the website added two new constructs to TAM: perceived entertainment value and perceived presentation attractiveness.

Chau and Hu (2002) combined the factor of peer Influence with Technology Acceptance Model. According to study by Franco and Roldan (2005) the relationship between perceived usefulness and behavioural intention was strong among goal-directed users. Chau and Hu (2001) compared three models Technology Acceptance Model (TAM), the Theory of Planned Behaviour (TPB), and a decomposed TPB model that is potentially adequate in the targeted healthcare professional setting in Hong Kong. The results indicated that TAM was superior to TPB in explaining the physicians' intention to use telemedicine technology. The study conducted by Sun and Zhang (2003) found voluntariness can be factor in determining the behavioural intention to use.

For present purposes, user acceptance is defined as the demonstrable willingness within a user group to employ information technology for the tasks it is designed to support. Thus, the concept is not being applied to situations in which users claim they will employ it without providing evidence of use, or to the use of a technology for purposes unintended by the designers or procurers (e.g., using an Internet connection for personal entertainment in a work situation). Obviously there is a degree of fuzziness here since actual usage is always likely to deviate slightly from idealized, planned usage, but the essence of acceptance theory is that such deviations are not significant; that is, the process of user acceptance of any information technology for intended purposes can be modeled and predicted.

Lack of user acceptance is a significant impediment to the success of new information systems (Gould et al; Nickerson). In fact, users are often unwilling to use information systems which, if used, would result in impressive performance gains (e.g., Alavi Henderson; Swanson, 1988). Therefore, user acceptance has been viewed as the pivotal factor in determining the success or failure of any information system project (DAVIS, 1993).

Prior research has provided valuable insights into how and why employees make a decision about the adoption and use of information technologies (ITs) in the workplace. From an organizational point of view, however, the more important issue is how managers make informed decisions about interventions that can lead to greater acceptance and effective utilization of IT. There is limited research in the IT implementation literature that deals with the role of interventions to aid such managerial decision making. Particularly, there is a need to understand how various interventions can influence the known determinants of IT adoption and use. To address this gap in the literature, we draw from the vast body of research on the technology acceptance model (TAM), particularly the work on the determinants of perceived usefulness and perceived ease of use, and: (i) develop a comprehensive nomological network (integrated model) of the determinants of individual level (IT) adoption and use; (ii) empirically test the proposed integrated model; and (iii) present a research agenda focused on potential pre- and post-implementation interventions that can enhance employees' adoption and use of IT. Our findings and research agenda have important implications for managerial decision making on IT implementation in organizations.

While great progress has been made in understanding the determinants of employees' information technology (IT) adoption and use (Venkatesh, Morris, Davis, & Davis, 2003), trade press still suggests that low adoption and use of IT by employees are still major barriers to successful IT implementations in organizations (Overby, 2002; Gross, 2005). As ITs are becoming increasingly complex and central to organizational operations and managerial decision making (e.g., enterprise resource planning, supply chain management, customer relationship management systems), this issue has become even more severe. There are numerous examples of IT implementation failures in organizations leading to huge financial losses. Two high-profile examples of IT implementation failures are Hewlett-Packard's (HP) failure in 2004 that had a financial impact of $160 million (Koch, 2004a) and Nike's failure in 2000 that cost $100 million in sales and resulted in a 20% drop in stock price (Koch, 2004b). Low adoption and underutilization of ITs have been suggested to be key reasons for "productivity paradox"—that is, a contradictory relationship between IT investment and firm performance (Landauer, 1995; Sichel,1997; Devaraj & Kohli, 2003). This issue is particularly important given that recent reports suggest that worldwide investment in IT will increase at a rate of 7.7% a year from 2004 to 2008 compared to 5.1% from 2000 to 2004 (World Information Technology and Service Alliance, 2004). It has been suggested in both the academic and trade press that managers need to develop and implement effective interventions in order to maximize employees' IT adoption and use (Cohen, 2005;Jasperson, Carter, &Zmud, 2005). Therefore, identifying interventions that could influence adoption and use of new ITs can aid managerial decision making on successful IT implementation strategies (Jasperson et al., 2005).

2.4 Other Models: Theory of Reasoned Action (TRA) & Theory of Planned Behaviour (TPB)

2.4.1 The Theory of Reasoned Action and its derivatives in User Acceptance

Fishbein Ajzen's Theory of Reasoned Action (TRA) in the social psychology literature defines relationships between beliefs, attitudes, norms, intentions, and behavior. According to this theory, an individual's behavior (e.g., use or rejection of technology) is determined by one's intention to perform the behavior, and this intention is influenced jointly by the individual's attitude and subjective norm, defined as "the person's perception that most people who are important to him think he should or should not perform the behavior in question" (Fishbein Ajzen, p. 302).

According to TRA, attitude toward a behavior is determined by beliefs about the consequences of the behavior and the affective evaluation of those consequences. Beliefs are defined as the individual's subjective probability that performing a given behavior will result in a given consequence. Affective evaluation is "an implicit evaluative response" (FISHBEIN AJZEN, p. 29) to the consequence; thus the attitude construct in TRA is general in nature and is not anchored to any given belief set. This approach represents an information processing view of attitude formation and change which states that external stimuli influence attitudes only through changes in the person's belief structure (AJZEN FISHBEIN).

However, attitude alone does not solely determine behavioral intentions. Intentions are determined also by subjective norms, which, in turn, are determined by an individual's normative beliefs and motivation to comply with perceived norms. The end result is a generalized model for understanding the determinants of human behavior in situations where people may exert their choices. The model has been used to make accurate predictions of human choice in situations as diverse as voting in elections (BOWMAN FISHBEIN) and consumption of alcoholic beverages (SCHLEGEL ET AL.,). In their meta-analysis examining the application of TRA, SHEPPARD ET AL. found that the theory performed extremely well in the prediction of choice among alternatives. They concluded that the theory was exceptionally robust and offered strong predictive utility, even when used to investigate situations and activities falling outside the original boundary conditions of the theory (such as predicting non-voluntary behavior, or when intentions were assessed even before subjects had all the information necessary to form a completely confident intention).

While TRA is a general model applicable to many areas, a number of MIS specific models have been derived from TRA. Of these models, the most widely cited is DAVIS' (1989) Technology Acceptance Model (TAM) (see Figure 2). The goal of TAM is to predict information system acceptance and diagnose design problems before users have experience with a system. TAM predicts user acceptance of any technology is determined by two factors: perceived usefulness and perceived ease of use.

Within TAM, perceived usefulness (U) is defined as the degree to which a user believes that using the system will enhance his or her performance. Perceived ease of use (EOU) is defined as the degree to which the user believes that using the system will be free from effort. Both U and EOU are specific perceptions and are anchored to specific beliefs users hold about the system. According to TAM, U and

EOU have a significant impact on a user's attitude toward using the system (A), defined as feelings of favorableness or un-favorableness toward the system. (Thus, attitude is a general construct not tied to any specific beliefs about the technology.) Behavioral intentions to use the system (BI) are modeled as a function of A and U. BI then determines actual use. Research has consistently shown that BI is the strongest predictor of actual use (DAVIS ET AL., TAYLOR TODD).

There are several interesting differences between TAM and TRA. First, DAVIS ET AL explicitly drop subjective norms from the model, arguing that the subjective norm construct is context-driven. They explain that, while subjective norms may be important in some settings, in the empirical work validating TAM, it was not found to be an important predictor of intentions. Davis et al explain that, because the technology studied was of a personal and individual nature (i.e., use of the technology was not dependent on others' use of the same technology), system usage was not likely driven by social influences.

Another important difference is that TAM proposes a direct path from perceived usefulness to intention, violating TRA which shows attitude completely mediating the relationship between beliefs and intention. According to DAVIS ET AL, in the work environment, intentions to use IT may be based on its anticipated impact on job performance, regardless of the individual's overall attitude toward that system. In other words, even though an employee may dislike a system, that employee may still use the system if it is perceived to increase job performance (thus, it has high perceived usefulness).

A final note of interest regarding TAM's divergence from TRA is the direct effect of EOU on U. In other words, when faced with two systems offering identical functionality, a user should find the easier one to be more useful. DAVIS states that if a user becomes more productive via ease-of-use enhancements, then he or she should become more productive overall. The converse (that U influences EOU) does not hold, however. Thus, from a theoretical perspective, perceived ease of use influences perceived usefulness, but not vice versa.

In their work validating TAM, DAVIS ET AL. found a stronger relationship between perceived usefulness (U) and intentions to use than perceived ease of use (EOU) and intentions. The relationship between EOU and intentions was largely mediated by U. In comparing TAM and TRA, DAVIS (1989) found that

TAM was a better predictor (based on the amount of variance explained, R2) of intentions to use a particular software package, reporting an R2 of .47 for Time 1 (immediately after the introduction of the software) and an R2 of .51 for Time 2 (14 weeks later). These figures were compared with .32 and .26 for TRA at Time 1 and Time 2, respectively. DAVIS (1993) reports similar results in looking at different technology and removing behavioral intentions from the model. TAM has been found to be extremely robust and has been replicated using different tasks (ADAMS ET AL., MATHIESON). In a comparison of several models, Mathieson found that TAM predicted intention to use a spreadsheet package better than alternative models. In another comparison of theoretical models, TAYLOR TODD found that TAM provided a good fit to data on the use of a computing resource center, accounting for 34% of the variance in behavior, 52% of the variance in intention, and 73% of the variance in attitude.

In another study examining the efficacy of TAM, ADAMS ET AL. suggested that both U and EOU may change over time and that perceptions of EOU may develop only through prolonged usage. STRAUB ET AL. further supported the validity of the perceived usefulness and perceived ease of use constructs, finding that the TAM measures explained 48.7% of the variance in self-reported system usage. However, for computer-generated (objective) measures of use, the TAM variables explained only about 7% of the variance, suggesting that other factors may be significant predictors of system usage. While Straub et al. did not suggest any specific factors that may be important, some (e.g., Adams et al., Topi) have suggested a user's experience with the system may be one factor having substantial influence, while others have suggested self-efficacy (e.g., Hill et al., Wood Bandura) as an important antecedent of individual behavior. However, this area remains relatively unexplored.

2.4.2 The Theory of Planned Behaviour (TPB)

While the Theory of Reasoned Action (TRA) has been the most widely used theory for examining user acceptance, other theoretical perspectives have also been used. The Theory of Planned Behavior (TPB) (AJZEN, 1985, 1991) is a descendant of TRA and adds a third antecedent of intention, perceived behavioral control, to the TRA model. Perceived behavioral control is determined by the availability of skills, resources, and opportunities, as well as the perceived importance of those skills, resources, and opportunities to achieve outcomes. Perceived behavioral control has been viewed to be close to BANDURA's (1982) self-efficacy belief concept (Ajzen, 1991).TPB holds that attitudes, subjective norms,

and perceived behavioral control are direct determinants of intentions, which in turn influence behavior.

In attempting to apply TPB (which, like TRA, is a generalized model), a Decomposed Theory of Planned Behavior (TAYLOR TODD) has also been examined in the IS literature which attempts to identify and model the specific antecedents to attitude, subjective norm, and perceived behavioral control relevant to IT use. Taylor Todd suggest perceived usefulness, perceived ease of use, and compatibility as antecedents of attitude (largely consistent with TAM). In addition, they suggest that peer influence and superiors' influence are antecedents of subjective norm. Finally, they model self-efficacy, resource-facilitating conditions, and technology facilitating conditions as determinants of perceived behavioral control. While not as extensively studied as TAM, the literature provides several tests of TPB. However, the results have been somewhat mixed. MATHIESON tested both TAM and TPB and found that, while TPB was predictive of user intention, it did not provide as complete an explanation of intention as TAM. In addition, Mathieson noted that TAM was easier to apply.

Taylor Todd tested the decomposed version of TPB discussed above and found that TAM was a (slightly) better predictor of usage, but that the decomposed TPB model provided a more complete (albeit slight) understanding of the determinants of intention (R2 = .57 for TPB and .52 for TAM). The authors note that, in choosing between TAM and the decomposed TPB, the trade-off of moderate increases in explanatory power for intentions versus added complexity is a difficult one. The decomposed TPB adds seven more variables to increase the predictive power of behavior 2% over TAM. However, the decomposed TPB also helps researchers better understand the roles of subjective norms and perceived behavioral control, which are absent from TAM. Taylor Todd conclude that if the goal is to predict IT usage, TAM may be better; however, if the goal is to better understand specific determinants of intention, the decomposed TPB may offer additional explanatory power.

Thus, the Theory of Reasoned Action and its derivatives (specifically, the Technology Acceptance Model and the Theory of Planned Behavior) provide a useful and robust composite perspective on the issue of technology acceptance. These theoretical approaches have provided an important contribution to this MIS research stream, and additional studies have been attempting to build on the existing body of knowledge in this area. (VENKATESH DAVIS).

2.5 Uses of TAM Model

2.5.1 Consumer acceptance of online banking: an extension of the technology acceptance model

Since the mid-1990s, there has been a fundamental shift in banking delivery channels toward using self-service channels such as online banking services. During the past years online banking acceptance has been rapid and currently 55 percent of the private banking customers in Finland have an online banking contract with their bank (The Finnish Banker's Association, 2003; cf. Nordea Oyj, 2003). In general, Europe has been and still is the leader in online banking technology and usage (Schneider, 2001). By comparison, at the end of 2000 only roughly 20 percent of the US banks offered online banking services and only 20 percent of US private banking customers equipped with an internet connection used online banking services (Sheshunoff, 2000; Orr, 2001). By the end of 2002 about 120 largest US banks offered online banking services (Pyun et al., 2002). Although in recent years this number has grown rapidly, there is some evidence supporting the opposite fact that online banking acceptance is faced with problems. Robinson (2000) for instance found that half of the people that have tried online banking services will not become active users. An interesting and notable difference between US and European banks is that US banks are not allowed to have a vast bank branch network covering the whole country (Pyun et al., 2002). Thus online banking services as well as ATMs have fostered competition between banks in the USA.

Online banking acceptance has gained special attention in academic studies during the past five years as, for instance, banking journals have devoted special issues on the topic (e.g. Karjaluoto et al., 2002; Waite and Harrison, 2002; Bradley and Stewart, 2003; Gerrard and Cunningham, 2003; Mukherjee and Nath, 2003). We can find two fundamental reasons underlying online banking development and diffusion. First, banks get notable cost savings by offering online banking services. It has been proved that online banking channel is the cheapest delivery channel for banking products once established (Sathye, 1999; Robinson, 2000; Giglio, 2002). Second, banks have reduced their branch networks and downsized the number of service staff, which have paved the way to self-service channels as quite many customers felt that branch banking took too much time and effort (Karjaluoto et al., 2003). Therefore, time and cost savings and freedom from place have been found the main reasons underlying online banking acceptance (Polatoglu and Ekin, 2001; Black et al., 2002; Howcroft et al., 2002).

Several studies indicate that online bankers are the most profitable and wealthiest segment to banks (Mols, 1998; Robinson, 2000; Sheshunoff, 2000). On this basis, no bank today can underestimate the power of the online channel. Luxman (1999) for instance estimates that in the near future the online channel reinforces its importance especially in the countryside, where banks have closed many branches. However, there is no supporting evidence on this regional issue. Without the possibility of managing banking affairs directly from home or office, customers easily perceive troubles in managing their financial affairs such as paying bills.

Organizations invest in information systems for many reasons, for example cutting costs, producing more without increasing costs, improving the quality of services or products (Lederer et al., 1998). It has been noted that users' attitudes towards and acceptance of a new information system have a critical impact on successful information system adoption (Davis, 1989; Venkatesh and Davis, 1996; Succi and Walter, 1999). If users are not willing to accept the information system, it will not bring full benefits to the organisation (Davis, 1993; Davis and Venkatesh, 1996). The more accepting of a new information system the users are, the more willing they are to make changes in their practices and use their time and effort to actually start using the new information system (Succi and Walter, 1999).

A system that satisfies user's needs reinforces satisfaction with the system and is a perceptual or subjective measure of system success. Similarly, usage of a system can be an indicator of information system success and computer acceptance in some cases. Whether the system is regarded as good or bad depends on how the user feels about the system. Especially if the users do not rely on the system and its information their behaviour toward the system could be negative. Success is not necessarily dependent of the technical quality of the system (Ives et al., 1983). Using the system is connected with the effectiveness of the system – systems that users regard as useless cannot be effective. Therefore, it is important to find out the reasons why people decide to use or not to use information system (IS). This knowledge will help both systems designers and developers in their work (Mathieson, 1991).

From a theoretical standpoint, the results presented contributed to the existing literature in a number of ways. First, the article makes a contribution to electronic banking literature by providing insights on the factors that seem to affect online banking acceptance. The results hint that information about online banking services and its benefits is a critical factor influencing the acceptance. Moreover, security and

privacy were found to have a relatively weak relationship with the acceptance. This is in contrary to many banking studies conducted during the past years (Roboff and Charles, 1998; Sathye, 1999; Hamlet and Strube, 2000; Polatoglu and Ekin, 2001; Black et al., 2002; Giglio, 2002; Howcroft et al., 2002). Secondly, the article contributes to the technology acceptance literature by suggesting that PU as well as perceived enjoyment (PE) were found to have some effect on technology acceptance (cf. Davis, 1989; Davis et al., 1989; Teo et al., 1999). Furthermore, we found that PU was more influential than PEOU in explaining technology acceptance.

2.5.2 Predicting user acceptance of e-shopping on the Web

Electronic commerce generally refers to the sale and purchase of products and services on the Internet; consumer purchasing decisions mainly depend on individual evaluations of the value of products or services. Keeney [27] used a value proposition of e-commerce to represent customer evaluations, defining it as the net value of the benefits and costs associated with the transacted products or services in the processing of finding, ordering and receiving. With this, evaluations of outcomes about fundamental transaction objectives may influence buyers 'decisions. For B2C e-commerce, electronic-shopping (e-shopping) involves intensive communication of information, and thus is an interactive behaviour involving consumers and firms, conducted via the Internet or World Wide Web (WWW). Sellers can easily enter an e-market, reducing the costs of constructing and maintaining e-stores, especially of production, delivery, and storage of digital products or on-line services. From the perspective of consumers, an e-market is a trading centre that supports the main e-shopping processes—from searching and requesting target products/services, through evaluating and selecting candidate products or services, to ordering, delivery, and final payment. The new channel of e-shopping thus has changed the relationship between consumers and firms. Thus, e-shopping is treated as a voluntary behaviour in which consumers become more active and autonomous during a transaction.

Triandis stated that facilitating conditions determine individual behaviour. According to him, facilitating conditions represent the objective environmental factors that allow individuals to use an IS or IT. As verified in prior studies, organizational facilitating conditions affect individual use of PCs at work [38, 44], and technological facilitating conditions determine individual intentions to use the Internet. Moreover, organizational support not only influences PU and PEOU, but also affects the use of PCs [22, 24]. Briefly, technological and organizational support can determine IT behaviour. Based on the

belief–attitude–intention–behaviour relationship in the TRA, this study proposes a model extending TAM to predict consumer e-shopping behaviour. The model not only includes PEOU, PU, attitudes toward e-shopping and user acceptance, but also adopts the Web environmental factors as the facilitating conditions of e-shopping, and includes perceived quality with respect to the websites by following Davis's TAM involving system variables.

When a consumer asks for product or service information, places an order, or pays over the Internet/ WWW, he or she will have perceptions of the target products or services, and will perform the transaction after evaluating its value in terms of benefits and costs. Perceptions of value assessments in e-shopping aretermed user acceptance of e-shopping here. Based on the postulate of TRA, this study adopts user acceptance to represent individual behavioural intent towards e-shopping. Consequently, user acceptance is used as a surrogate for predicting actual consumer e-shopping behaviour. Given the diversity of product types and delivery modes on the Internet/WWW [35], products and services were classified into physical products, such as PCs or mobile phones, digital products, such as software, and on-line services, such as hotel registration. From the perspective of e-shopping flow, this suggests that ordering, requesting post-purchase service, taking delivery, and paying on-line are the four main phases of a transaction between consumers and firms in e-shopping. Thus, user acceptance is split into user acceptance of products/services and user acceptance of on-line offerings. According to the relationship between behavioural intention and behaviour in the TRA, greater user acceptance implies increased willingness to e-shop.

Previous studies have indicated that user information satisfaction affects the effectiveness of IS, system usage, as well as, directly or indirectly, affecting IS performance through IS usage. Although Davis did not include user information satisfaction in his TAM, we revised it based on prior studies and define it as user satisfaction with the Internet/WWW. Regarding e-shopping, this study expected to derive the new relations among US, PU and PEOU. As consumers usually access the Internet/WWW to search for information before making purchases, this study infers that US directly and indirectly affects user acceptance of e-shopping.

Consumers usually expect websites to support their shopping on the Web. For example, they may require accurate or available information on target products or services, a reliable website for accessing

products or services, and good service. According to an expectancy-value approach, those perceptions of e-shopping are termed: perceived quality of information, system, and service. Moreover, these three constructs are the determinants of the success of websites. Thus, this study postulates that perceived quality of information, system, and service can positively or negatively affect e-shopping behaviour.

Previous studies frequently used information quality to measure IS performance. Information quality is included in an assessment of the effect of Web use, especially on searching products/services in e-shopping. During e-shopping transactions, both consumers and firms communicate and coordinate by exchanging and sharing information via the Internet. Thus, perceived information quality is assessed using consumer perceptions of the quality of information on the Web. Perceived information quality is assumed to affect PEOUT, PU, attitudes toward e-shopping and user acceptance of e-shopping.

This study suggests that user acceptance is a better indicator of e-shopping intentions than user satisfaction. In testing the extended model, we found that individual attitudes toward e-shopping significantly and positively affect user acceptance, confirming the theoretical postulation of TAM. Briefly, consumer attitudes toward e-shopping strongly determine their willingness to use the Internet/WWW to shop for physical or digital products or on-line services, or to place an order, request post-purchase service, take delivery and make a payment. We also confirmed that both PU and PEOUT determine consumer attitudes toward e-shopping. The results reveal that consumer perceptions of the ease and effectiveness of e-shopping may indirectly lead to consumer acceptance of e-shopping via their attitudes.

2.5.3 Elucidating user behaviour of mobile learning: A perspective of the extended technology acceptance model

The third generation (3G) mobile services can be used as an efficient learning tool. Mobile learning (M-learning) is an activity in which people carry out learning activities using a mobile device like a cell phone or a personal digital assistant (PDA). M-learning allows users to access learning material anytime and anywhere (Clyde, 2004; Gay et al., 2001; Hill and Roldan, 2005; Liu et al., 2003). This new M-learning technology encourages users to attend a variety of learning activities, including to search for knowledge, participate in discussion groups and access informational contents online(Chang et al., 2003; Roschelle, 2003). M-learning compliments electronic learning (E-learning) by creating an additional access channel

for mobile users with mobile devices. Because of the potential widespread use of 3G mobile devices, M-learning is likely going to be the next wave of any learning environment, such as museums (Goh and Kinshuk, 2004; Hsu et al., 2006). The 3G networks are not yet commonly available, and M-learning is still in its infancy, with many aspects of mobile learning yet to be explored (Taylor, 2003). Previous studies have extensively addressed M-learning from technical perspectives (Chang et al., 2003; Chen et al., 2003; Liu et al., 2003), but few empirical works are available on M-learning from a customer's standpoint. As a result, M-learning suppliers can provide quality M-learning to customers only by studying the customers carefully.

Behaviour prediction has been one of the major purposes of psychological theories. Some of the more useful theories include the theory of reasoned action (TRA) (Ajzen and Fishbein, 1980; Fishbein and Ajzen, 1975), the social cognitive theory (SCT) (Compeau and Higgins, 1995; Hill et al., 1987) and TAM (Davis, 1989, 1993). TAM, originally presented by Davis (1989), is derived from TRA (Ajzen and Fishbein, 1980; Fishbein and Ajzen, 1975). TAM is a behavioural model that describes the antecedents of the adoption of information technology (IT), and is considered a robust tool for measuring the adoption of new technology by users (Agarwal and Prasad, 1999; Davis, 1989; Doll et al., 1998; Segars and Grover, 1993). Over the years TAM has been validated by various applications and extensions, including web-based information (van der Heijden, 2003; Yi and Hwang, 2003), internet banking (Wang et al., 2003) and electronic commerce (Henderson and Divett, 2003; van Dolen and de Ruyter, 2002). The M-learning technology is novel, and is therefore appropriate to be examined using the TAM model.

This work proposes and verifies that TAM can be employed to explain and predict the acceptance of M-learning. The findings of this study have several implications for M-learning providers and researchers interested in M-learning. First, this study found that perceived usefulness (PU) and perceived ease of use (PEOU) are key determinants of user perception of M-learning. However, PU affects individual's attitudes more than PEOU does. Although customers need a simple way to use M-learning, perceived usefulness is critical. In addition to designing a straightforward way to utilize the M-learning technology, providers should also endeavour to maximize the usefulness of m-learning. Second, this study has shown the importance of perceived mobility value (PMV) to an individual's acceptance of M-learning. The most significant feature of mobile technology is mobility, which enables customers to access learning information at anytime and anywhere. Mobility allows M-learning to become an important channel for obtaining learning material. Therefore, advantages of mobility are crucial to users. Third, individuals who perceive the M-learning technology as being pleasant will also find that using

M-learning is simple to use, and they also have a positive attitude toward M-learning. The fact that it is enjoyable is significant to attract users. Fourth, in order to predict user acceptance of M-learning, this study adds two external constructs, perceived enjoyment and perceived mobility value. The predictive power of these two added constructs shows that the new variables are imperative. As other new technologies become available for digital libraries and museums, TAM can be employed to predict and to explain the acceptance of the new technologies.

2.5.4 Determinants of Iranian agricultural consultants' intentions toward precision agriculture: Integrating innovativeness to the technology acceptance model

Environmental crises and global concerns toward the consequences and side impacts of conventional agricultural systems and agricultural activities on environment resulted in the viewpoint of the necessity of changing mental patterns regarding sustainable farming systems. Different agricultural methods such as precision agriculture have been presented to respond to environmental problems in recent years. There are three steps in technology development, and three strategies for precision agriculture (PA). Step one is based on conventional farming technology, with intensive mechanization to reduce the labour input. Step two involves the development of mapping techniques, variable-rate technology machines, and introductory decision support system on the basis of information technology. Step three implies the maturity of wisdom-oriented technologies. Scenario 1 is based on a ''high-input and high-output" conventional strategy. Scenario 2 has a strategy for ''low-input but constant output", and scenario 3 aims at ''optimized input–output" as the goal of precision farming (Shibusawa, 2002). Through the advent of environmental crises and global concerns toward the consequences and side impacts of some agricultural activities on environment most of the researches and experts brought up a huge global challenge, i.e. a motion toward environmentally friendly agriculture due to observing an agriculture profoundly as a national independence focus and an effective basis on the environmental balance. Taking action to an environmentally friendly agriculture requires that sustainability and sustainable agriculture as successful management of agricultural resources to satisfy changing human needs along with the environmental conservation and biologic resources increase would be taken into consideration (Chikwendu and Arokoyo, 1997). Sustainable agriculture is conceptually a system for successful management in taking advantage of resources for providing human foods as well as increasing the environmental quality conservation and natural resources. In a general concept the

sustainable agriculture is an insight which depends on human goals and his recognition of the effects of agricultural activities on the environment. In fact, the sustainable agriculture emphasizes that not only nature should be regarded but also agricultural products should be developed along with environment. Thus, production process will last in the future. There is a general consensus among agricultural development practitioners in Iran that the goals of sustainable agriculture should include increasing production (for an ever-increasing population), preventing soil erosion, reducing pesticide and fertilizers contamination, protecting biodiversity, preserving natural resources and improving well-being (Rezaei-Moghaddam et al., 2005).

In recent studies the formal reports of Iran's natural resources and environment are frustrating. It should be noted that after Australia, Iran has the second global rank in erosion and destruction of fertilized lands and natural resources. This is to say that 33 tons of soil has been destructed and eroded in each hectare. One of the major reasons is the excessive consumption of fertilizers and chemical pesticides in agricultural sector. In addition, the reports show that pesticides and chemical fertilizers (nearly 3 tons in each hectare) are used too much in Iran. Developing and modernizing agriculture in Iran has resulted in primary costs including water pollution by pesticides and transfer to the soil and live stocks, foodstuff and feedstuff contaminations, air pollution and excessive use of natural resources. Tendency toward modernizing agriculture has led to remove livestock and plant traditional procedures, hygiene risks and loss of job (Kashani, 2001). Also Iran is located in an arid and semi-arid region. Having an average annual precipitation of 250 mm, Iran receives less than one third of global average precipitation (750 mm). Bearing in mind such a climatic condition, many severe or mild droughts are inevitable. In recent years, Iran has experienced several droughts. The current severe, prolonged and extensive drought in Iran has not only affected agricultural productivity but also threatened water resource sustainability (Keshavarz et al., 2010). This crisis in agricultural development of Iran has demonstrated that conventional development strategies are fundamentally limited in their ability to promote sustainable agricultural development. Therefore, it emphasizes on forming a new agricultural model for achieving sustainable agricultural development (Rezaei-Moghaddam et al., 2005). Hence, it seems that the conceptual pattern dominating conventional agricultural systems should be changed and we should move toward the design of sustainable farming systems.

In recent years' different agricultural methods have been presented in response to environmental problems and reach to sustainable agricultural development such as precision agriculture. The concept of precision agriculture, based on information technology, is becoming an attractive idea for managing

natural resources and realizing modern sustainable agricultural development (Maohua, 2001). Precision agriculture is a management strategy that uses information technology to bring data from multiple sources to bear on decisions associated with crop production (National research Council, 1997). PA is conceptualized by a system approach to re-organize the total system of agriculture toward a low-input, high-efficiency sustainable agriculture. PA provides an ideal tool for agricultural risk assessment and rational farm-work scheduling (Zhang et al., 2002). In fact, precision agriculture is a management concept which combines information and communication technologies for management of temporal and spatial variability in agriculture (Fountas et al., 2005). The basic goal of PA to optimize yield with minimum input and reduced environmental pollution is highly required for developing countries to face the challenge of sustainability (Mondal and Basu, 2009). Precision agriculture techniques are enforceable in all aspects of production cycle of farming products, from pre-cultivation operation to harvest.

Different researches were carried out based on technology acceptance model for predicting individual behaviours, intentions, and attitudes toward information technology acceptance. The results of Davis et al. (1989) study indicated that perceived usefulness affected on information technologies acceptance while perceived ease of use had less effect on making decision to use those kinds of technologies. Different researches confirmed TAM needs to be given additional variables to provide an even stronger model. Adrian et al. (2005) noted that there was a significant relationship between attitude of confidence, perceived net benefit, and farm size and education level with behavioural intention. Moreover, there was a significant relationship between perceived usefulness and perceived net benefit; also there was a significant relationship between attitude of confidence and perceived ease of use and attitude of confidence and perceived usefulness. Lee et al. (2007) investigated the relationship between perceived usefulness, perceived ease of use, attitude to use and intention to use of information technology (IT). Yi et al. (2006) discovered that there was a significant and positive relationship between personal innovativeness (PI) and perceived ease of use, result demonstrability, perceived behavioural control and subjective norm.

Previous studies mostly confirmed innovativeness variable because of its important role in innovations acceptance (Agarwal and Prasad, 1998). They showed that PI could affect the decision whether or not to adopt a certain technology in the domain of IT. Agarwal and Prasad (1998) have proposed a new construct that illuminates the relationships in technology acceptance models, i.e., personal innovativeness in the domain of information technology. They defined PI as the ‘‘willingness of an

individual to try out any new information technology". A person is characterized as innovative, if he or she is early to adopt an innovation and individual with higher levels of PI is expected to have more positive intentions to use of new IT (Jeong et al., 2009). In general innovation diffusion research, it has long been recognized that highly innovative individuals are active information seekers about new ideas. They are able to cope with high levels of uncertainty and develop more positive intention toward acceptance. Individuals with higher personal innovativeness are expected to develop more positive beliefs about the target technology (Lu et al., 2005). Several authors agree that the PI influences their cognitive and decision-making processes (San Martin and Herrero, 2012).

Karahanna et al. (1999) state that perceived usefulness, visibility, result demonstrability and trialability had direct, positive and significant effect on behavioural attitude, and behavioural attitude had direct, positive and significant effect on individual intention to use information technology. Hubona and Buton-Jones (2002), Wu and Wang (2005) and Liu et al. (2005) revealed that there were positive relationships between belief about ease of use and belief about usefulness. Phillips et al. (1994), Malhotra and Galletta (1999), Liu et al. (2005) and Rezaei-Moghaddam and Salehi (2010) cited that there was a positive and significant relationship between attitude to use and intention to use and perceived ease of use and attitude to use. Phillips et al. (1994), Malhotra and Galletta (1999), Hubona and Buton-Jones (2002), Liu et al. (2005) and Rezaei-Moghaddam and Salehi (2010) showed that there was a positive and significant relationship between perceived usefulness and attitude to use. The results of Malhotra and Galletta (1999), Wu and Wang (2005) and Liu et al. (2005) showed that there were positive and significant relationships between perceived usefulness and behavioural intention. The results of Rezaei-Moghaddam and Salehi (2010) demonstrated that attitude of confidence had direct and significant effect on attitude to use of experts.

It is required that Iran moves toward precision agriculture technologies seriously due to potential capacities and it cannot be actualized unless different agricultural operators involve in. Due to the key role of agricultural experts in innovation adoption by farmers this study considers proper strategies for adoption of these technologies through investigating agricultural experts and consultants' attitude and intention as water and soil connectors, farm managers and different products supervisors regarding precision agriculture technologies application. According to excessive use of chemical fertilizers and pesticides by farmers and the water crisis in Iran, among precision agriculture technologies the experts' attitude and intention toward the variable-rate technology of fertilizing, irrigating, and spraying were

measured that these technologies are more tangible for them.

Modernization of agriculture in Iran has led to the negative impacts, such as air pollution, contamination of water resources by pesticides and its transfer to soil and animals, contamination of food and animal forage, and unsustainable use of natural resources. The agricultural policy makers need to change their thinking regarding agricultural system in Iran. The application of precision agriculture technologies is an alternative to sustainable agriculture. This is one of the fastest growing alternative agricultural systems in the world. This study was conducted to identify the behavioural attitude and intention toward the precision agriculture technologies among the agricultural personnel and consultants in Fars Province, Iran. Then, it tries to test intention of Iranian experts based on the technology acceptance model. According to the results, the suggested model could determine the experts' behavioural intention strongly. Behavioural attitude was the most effective variable on behavioural intention. The role of attitude to increase behavioural intention has been emphasized. So improvement of positive attitude toward the precision agriculture technologies increases behavioural intention. This finding has policy implications for agricultural development policy makers so that it can help extension agents, agricultural educators and agricultural administrators to present suitable training and services to change attitude of clients. Establishing national workshops are useful for increasing capacity and perception of experts.

2.5.5 Identifying and prioritizing barriers to implementation of smart energy city projects in Europe: An empirical approach

Global energy challenges and climate change have urged governments and institutions at local, regional, national, and supra-national levels to optimize urban energy systems. In response, numerous European SEC1 projects have been initiated and developed, aiming at optimizing urban energy systems and improving quality of life for citizens (Vanolo, 2014; Washburn et al., 2010). A universally accepted, unambiguous definition of a SEC project appears to be missing. The existing related definitions are very technical and do not focus on the urban perspective but are more concentrated on technical elements, considering smart energy systems (e.g., Lund, 2014) or smart energy networks (e.g., Chai et al., 2013). Here we follow the definition of Mosannenzadeh, p 151) (2016) who (based on Mosannenzadeh et al., 2017) defines a SEC project as one that aims at sustainability of energy systems and services through optimized integration of increased energy conservation, energy efficiency and use of local renewable energy sources. SEC projects have a specific period; they apply smart energy solutions to integrate multiple energy domains, and enforce collaboration of multiple stakeholders, while evaluating sustainability of their measurements (Mosannenzadeh, 2016). These projects have become popular

during the last two decades, specifically due to considerable support by both the European Union –under the EU sixth Framework Programme (FP6) and seventh Framework Programme (FP7), and more recently Horizon 2020– and the private sector (e.g. IBM).

SEC projects have faced the challenge of meeting their goals due to various financial, administrative, technical, and social barriers –i.e. difficulties that hinder project activities– especially in the crucial implementation stage (Di Nucci et al., 2010). Overcoming these barriers is necessary in order to facilitate and accelerate the successful accomplishment of SEC projects. Therefore, it is important to not only identify but also prioritize these barriers in order to efficiently allocate efforts and resources to abate the key obstacles hindering effective action (Nagesha and Balachandra, 2006). This research aims at supporting decision makers to better understand and prioritize implementation barriers in order to develop effective action and policy interventions towards implementation of smart energy city projects. Due to the novelty of SEC projects, the specific barriers to implementation of these projects have not been yet treated in the academic literature in a systematic way. The discussion, to our knowledge, has focused mostly on specific technologies such as smart grid (e.g. Luthra et al., 2014; McMorran et al., 2012) and combined heat and power (Wright et al., 2014). However, gray literature, including deliverables and reports of CONCERTO and SEC projects examined the specific barriers to design and implement such projects (Di Nucci et al., 2010; Di Nucci and Spitzbart, 2010; Pezzutto et al., 2015). As a result, there is still a need for a systematic identification and analysis of barriers to the implementation of SEC projects.

Sizhen et al. (2005) prioritized barriers to promotion of clean technology in China through an analytic hierarchy process based on the importance given by stakeholders. Nagesha and Balachandra (2006) used similar method to prioritize barriers to energy efficiency in India considering barrier intensity, required effort for barrier removal and the expected positive impact of barrier removal on energy efficiency and economic performance. Ren et al. (2015), improved this methodology to prioritize barriers to sustainable shale gas revolution in China by considering importance and interaction among barriers through the application of an analytic network process. Mathiyazhagan et al. (2013) performed an Interpretive Structural Modeling (ISM) qualitative analysis based on stakeholder opinion to identify the most dominant (important) barrier to adoption of green supply chain management in India. To our knowledge, a systematic and quantitative barrier prioritization by a simultaneous consideration of all these three aspects has not been yet investigated.

The specific objectives of this paper are (i) to identify barriers to implementation of urban scale SEC

projects in Europe; and (ii) to provide a systematic, dual-approach (i.e. quantitative and qualitative), and multi-dimensional prioritization of barriers by considering barrier importance, level of effort required to tackle a barrier and interaction among them. It is fundamental that barriers to the implementation of SEC projects are especially project-specific, meaning that their occurrence depends on numerous internal and external characteristics of the project (Di Nucci et al., 2010; Painuly, 2001). The examples of these characteristics include project design, the planned implementation process, the existing driving forces as well as numerous influential social, economic, environmental, and legal conditions (Cagno et al., 2013; Di Nucci et al., 2010). However, before defining the relationship between project characteristics and barriers, it is necessary to first identify the common barriers that occur in SEC projects due to their major aspects.

The CONCERTO initiative supported local communities towards sustainability of energy systems through local innovative energy efficiency interventions and by integrating local renewable energy sources in both new and existing urban districts (CONCERTO, 2015a). The CONCERTO Communities demonstrated the feasibility and integration of innovative technologies such as renewable-based cogeneration, sometimes smart grids, district heating/cooling systems and energy management systems in districts (CONCERTO, 2015a; Di Nucci et al., 2010). A number of these activities, especially those with a focus on refurbishment, were accompanied by socio economic research activities, specifically targeted to involve the relevant stakeholders or residents and increase the level of acceptance of the implemented measures. Moreover, the CONCERTO cities and communities are various in size and environmental, socio-economic, and political aspects, offering a rich source of information. The first batch of CONCERTO projects started in 2005 under EU FP6 (CONCERTO, 2015b). Until now, CONCERTO projects are all completed and information on the projects, including barriers to implementation of each case, can be found within the supporting platforms “Concerto Plus” and then “Concerto Premium”.

This research makes five main contributions to the scientific discussion of barriers to SEC development. First, 35 barriers have been identified to the implementation of SEC projects through an empirical approach, gathering information on 43 communities of the CONCERTO Initiative and validating it through literature review. These barriers have been categorised into nine groups: policy, administrative, legal, financial, market, environmental, technical, social, and information and awareness. Second, a novel multidimensional approach has been suggested and applied to prioritize barriers to SEC projects, combining the frequency, level of impact, causal relationships, scale, and origin of barriers. It is possible

to consider each of these aspects independently, but prioritization is most effective if all aspects are simultaneously considered together. Third, we borrowed the concept of “criticality”, applied in risk-analysis, for evaluating the importance of a barrier. Criticality of a barrier is a function of its frequency and impact. Fourth, we investigated and applied interaction among barriers instead of treating barriers in an isolated and piecemeal way. Fifth, we introduced a new indicator for the level of action required for tackling a barrier, namely inevitability. Inevitability is derived from combining barrier origin and scale. It shows if a barrier is more likely to be influenced at the project level, or policy level, or both.

It was showed how administrative, legal, financial and social barriers are strongly correlated with the projects’ and communities’ specific features. While policies and initiatives to promote SEC are essential at the macro level, implementation and uptake depend on key local actors such as investors and developers and local authorities. Thus, commitment of local administrations, choice of accompanying activities such as dissemination of information, use of appropriate communication tools, awareness raising, active involvement of relevant decision makers, user groups and market actors are crucial success factors (Di Nucci and Pol, 2009). To conclude, this research provided a multi-dimensional classification of barriers to the implementation of SEC projects. The outcomes of this research may help project coordinators and policy makers to better understand, predict and prioritize implementation barriers facing them and to develop proper action and policy interventions to ensure successful implementation of SEC projects.

2.6 The effects of successful ICT-based smart city services: From citizens' perspectives

According to Caragliu et al. (2011), a city is designated as smart if it balances economic, social, and environmental development, and if it links up to democratic processes through a participatory government. Cities, but also less urbanized regions and the countryside can all benefit from Smart City (SC) services that actively engage citizens in smarter, participatory governance of their regions (Kickbusch and Gleicher, 2014). Nowadays, city governments worldwide make their economic development policies with the aim of building advanced infrastructure and implementing SC initiatives, and this has become a priority on the list of their municipal goals.

There is emerging agreement that the adoption of technology in a country contributes to greater

national GDP and higher wages, compared to workers with similar skills in other countries (Beaudry and Green, 2002; Comin and Hobijn, 2004; Foster and Rosenzweig, 2010). A country's adoption of a new technology leverages its national wealth because technology expedites the production of goods and services, eventually facilitating economic growth and improving the perceived standard of living (Comin and Hobijn, 2008). Foster and Rosenzweig (2010) argued that a shortcut for poorer countries with slow-growing economies to catch up with the richer ones is through the use of advanced technologies. As a concept, SC is described in various ways, but a general definition involves the implementation and deployment of information and communication technology (ICT) infrastructures to support social and urban growth through improving the economy, citizens' involvement and government efficiency. Based on the new digital layer of SC services, the cities are not only smarter, but they also serve the mobile citizen in a better way. As stated by Neirotti et al. (2014), cities equipped with ICT implementations may not necessarily be labelled as better cities, but that these implementations can result in intermediate outputs that reflect their SC initiatives by providing their citizens with an improved and smarter way of living.

The SC literature agrees that very smart services, identified by Giffinger et al. (2007) as the “smartness footprint” in cities are meant to improve the living environment and the overall quality of life of citizens (e.g., Lee et al., 2014; Piro et al. 2014; Yigitcanlar and Lee, 2014). More specifically, smart cities strive to create the foundations for human centric and sustainable socio-economic wellbeing and quality of life (Kulkki, 2014), for example, ICT applications for the management of intelligent transportation systems, natural resources, energy, water monitoring, building, agglomeration and sprawl management, as well as online education and ICT applications for health care and city safety, e-service delivery, e-democracy and participation in the public sectors. Hence, the development of urban management to meet citizens' current needs and demands, and fostering actual and fluent interrelation among citizens to improve their quality of life through ICT-based SC services can be considered to be a successful implementation.

SC services provide wider coverage than e-government operations. According to an ISO report regarding smart cities in 2014, as a prerequisite for the development of SCs, adopting ICT applications in e-government enables citizens to communicate with all levels of government, improving and enhancing the efficiency and effectiveness of their involvement in the governance of the public sectors. With horizontal and vertical integration across various e-government initiatives, such as the development of transactional authentication systems and data collection/sharing of citizens and businesses, cities will

increasingly improve the contribution of more stakeholders to a broad range of public and private SC services. This study investigated the factors of the ICT-based SC services of government applications that lead to the improvement in its citizens' quality of life, particularly from the perspective of the citizens.

SC services act as knowledge and innovation networks and may have a major impact on the future quality of life and the environment (Caragliu et al. 2011). Over the past decade, many countries have considered and made plans to invest in their innovation capabilities and to create an environment that encourages and supports new, innovative services that are beneficial to the public and private sectors. The ultimate goal for such investment is to add to the region's quality of life. The quality of life associated with living and working in a civic environment can have a positive impact on competitiveness because it attracts entrepreneurial newcomers who energize businesses, as well as the political and cultural life of the citizens, leading to positive developmental changes (Annibal et al., 2013). Kinder (2000) mentioned that “technological advances are a major influence upon increasing longevity and of improving, in a sustainable manner, the quality of life enjoyed by an aging population.”

Diffusion of Innovation (DOI) theory (Rogers, 1962) provides one model of social and technological factors that influence the acceptance of innovative Information Technology (IT). This theory is widely used in a variety of technologies and serves as a tool to compare the scenarios of initial adoption and continued use (Agarwal and Prasad, 1997). Innovation Diffusion Theory (IDT) (Moore and Benbasat, 1991), an expansion of DOI, also includes a moderating factor termed “personal innovativeness” in the acceptance and adoption of ICT. This term represents an individual's inclination to innovate (Agarwal and Prasad, 1998). If users are more novelty seeking, they may be more accepting innovative technologies.

ICT has moved from being associated with peripheral innovations and developments and now addresses all of the economic, social and environmental aspects of wellbeing (Dameri and Garelli, 2014), as well as being tightly linked to the wide range of our knowledge economy (Katz and Rice, 2002). It empowers people to effectively interact and share knowledge, experiences, and mutual interests (Ishida, 2002). An SC is not only made by ICT because there are other core aspects of SC — “information city”, “knowledge city”, and “learning city” are concepts that target the crucial underlying data, information, and knowledge, improving the quality of life in city areas (OECD, 2010). Therefore, ICT based SC services are collections of technologies and social constructs that interact and shape each other in the course of

implementation, innovation, and diffusion. A large number of studies agree that ICT is exerting an increasing effect on different facets of people's overall quality of life (e.g., Khankhoje, 2004; Deakin, 2014; Makee et al., 2014; Veeckman and van der Graaf, 2015). In particular, an SC uses knowledge to become intelligent, that is, to provide the basis for developing a high capability for learning and innovation, and thus, delivering a better quality of life for its citizens (Komninos, 2006). More frequent use of city services relates closely to good service performance, more satisfaction with urban management, and a better quality of life in the city (James, 2009; Zenker and Rutter, 2014).

2.7 Discussion and implications

Taiwan's national broadband infrastructure is in a mature stage and the fourth generation (4G) of mobile phone communication is already in service, providing citizens with good communication in all of Taiwan's cities. The public traffic networks – from city bikes, shuttle buses, metro rapid transits, and the High-Speed Rail System – with are well connected for commuting and travelling as well as providing online ticket purchase and arrival time updating. Trucks collecting garbage, recycling articles, and kitchen waste are regularly bustling around in all of the cities, and some city dwellers are able to check the trucks' arrival times via Smartphone apps. University e-learning programs are accessible to students and community residents. The policing service apps are programmed with crime reporting, cab-calling, instant traffic broadcasting, big money bodyguard services and more, providing a channel to protect the safety of citizens' lives, property, and travel. Many ICT-based SC services are delivered through Smartphone apps in Taiwan and > 76% of the Taiwanese own smartphones. Moreover, after a few severe tragedies that occurred recently in Taiwan, such as earthquakes, a natural gas explosion, and food safety problems, the Taiwan Agricultural Products Production Traceability System by checking online or scanning a QR code on the product package and citizens can receive messages on their mobile phones about air pollution broadcasts and evacuation warnings for typhoons and torrential rain based on their residency and current location.

While investigating individual intention to accept and use technologies, studies have usually adopted the Technology Acceptance Model (TAM) (Davis, 1989), DOI/IDT, and UTAUT. Although TAM reveals the existence of external variables that can affect an individual's acceptance and use of a technology, it mainly focuses on the merits of the technologies. In addition to the factors that impact the adoption of a technology, DOI/IDT and UTAUT identify other factors as social impacts on an individual's attitude and behaviour toward technologies. That is, although the adoption of a technology is an individual

procedure that one undertakes after first hearing about an object to finally using it; diffusion stresses a group phenomenon, which suggests how an innovation spreads and how a technology with innovation spreads. These concepts would be diffused and widely adopted over time among users in a social system (Greenhalgh et al., 2004). The eight factors specified within the IDT (see Table 1) clearly explain the characteristics that affect the adoption of innovations and their diffusion (Meyer and Goes, 1988; Dobbins et al., 2001; Aubert and Hamel, 2001; Denis et al., 2002). The framework of this study is in line with IDT and incorporates the allegations in UTAUT that users with different demographic characteristics would act differently regarding the acceptance and usage of technology. In this study, the ICT-based SC services have been determined to have innovative traits that affect their likelihood to be adopted by some citizens as well as by potential adopters who are motivated by others in their social networks and likely to make the adjustments needed to adopt them (Greenhalgh et al., 2004). This motivation, which was measured by users' social image, the tangible and demonstrable results of their communicability, and the visibility of other users in this study, can be impacted by the SC services with technological and symbolic values that encourage the acceptance and use. As stated by Venkatesh et al. (2012), the belief is that citizens tend to turn to their social networks to reduce any doubts due to their uncertainty in the use of a new technology.

One result of this study is that Taiwanese citizens who have higher personal innovativeness, in terms of easily adapting to innovations, accept and use ICT-based SC services comparatively earlier than those who have a lower level of innovativeness. The former, identified as innovators and early adopters by Rogers (1962), motivate and encourage people in their social circles to use the services. In addition, differences in Taiwanese citizens' attitudes and behaviours toward ICT based SC services are not reflected in this study by their demographic characteristics in terms of age, gender, and education. This result is consistent with the past research that investigated the impact of demographics on the use of city facilities (Belanche et al., 2016). In studies on the adoption of technologies and applications in different countries, the impact of users' demographics varied(Venkatesh & Morris, 2000; Venkatesh et al., 2000; Venkatesh et al., 2003; Lin et al., 2004; Al-Gahtani et al., 2007; Dahlberg and Oorni, 2007; Cheng et al., 2011; Venkatesh et al. 2012; Khechine et al., 2014). An explanation of the lack of significance of the demographics in this study is that SC services have been introduced in the surveyed cities since 2004, or even earlier. Thus, with the time-longitude and service latitude, the ICT-based SC services in Taiwan have reached a certain level of diffusion. Since the services have been in everyday use

for some time, their acceptance tends to be more widespread across many demographic groups. In addition, in the contemporary social networking environment, e.g. by Facebook and Mobile01, the top social media majoring on the introduction and discussion of ICT products and services in Taiwan, and with the perspective of society enhancement through ICT applications, a successful diffusion of ICT-based SC services has not only occurred in certain offline clusters but has also impacted a wider group of citizens.

Literature review is still ongoing.

2.8 Conclusion

In this research work, thus it is aimed to study the user acceptance of smart city applications. In view of assessing user acceptance of smart city applications, a smart city app prototype has been developed. This app is used as a showcase for people to familiarise with smart city applications and thereafter their views are gathered. In the next chapter, the smart city app which has been developed is presented.

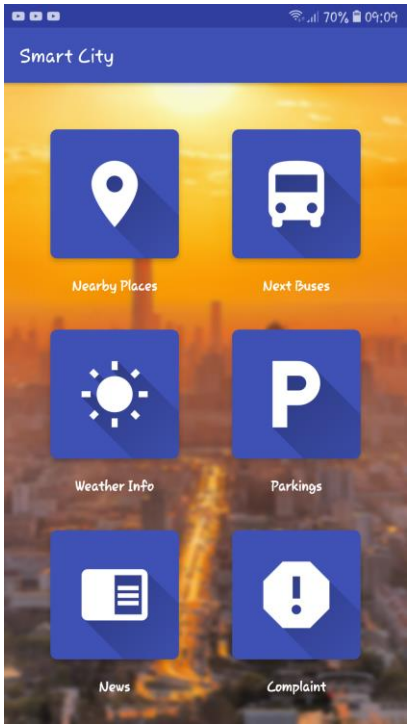
Chapter 3: Prototype SmartCity App for Mauritius

3.1 Introduction

The Smart City App is a collection of six different applications. These apps are:

1. The Nearby Places app
2. The Next Buses app
3. The Weather Info app
4. The Parking app
5. The News app
6. The Complaint app

Each of these apps operate independently of each other. So, to access them a menu is used. When the Smart City app is opened this menu will be shown. In the figure below is a screenshot of the menu:



Smart City app menu

Each of the apps can be accessed by simply clicking their respective icons.

3.2 Nearby Places App

Goal: The main goal of this app is to help users to find 'nearby places' (gas stations, pharmacies, restaurants and shopping centres) around the island.

Features: The Nearby Places App gives the user the location of nearby places on a map and allows the user to get the nearest place from his/her location. The route directions to a particular place can also be found.

There is a search feature which can be used to search for regions, towns or villages and get the nearby places around the searched region.

The user can also change the travel mode (car/walking) and the radius of search for the settings menu.

For each place there is a list of information available including:

1. Name of the place
2. Distance to the place from the user's location
3. Estimate of the duration for the journey from the user's location to the place
4. The address of the place
5. Contact information
6. Opening/closing time
7. Website.

Technologies used to implement the app are described as follows:

1. Google Maps API

This API allow the integration of google maps in the android app. It allows a map to be displayed in a google map activity and also allows the user to interact with the map. An API key is required and can be obtained for free by creating a google account and requesting the key. The key has to be inserted

in the app else the google map will not appear in the activity.

2. Google Places API

This API provides data about places (gas stations, pharmacies and so on). Using the data from the API, the places are shown on the google map. To receive data from the API, a request has to be made by means of a URL. The API will search for the places and respond by returning the data to the application. In the URL a few parameters have to be specified namely:

1. The type of the place (gas station, pharmacy and so on)
2. A centre location around which the API will search for the places (The search is in a circle)
3. The radius of the search circle.
4. and also the API key

Once the data has been downloaded from the API, it is processed by the app and then displayed on the map and into other elements of the activity.

The data that the API can provide are:

- Name of the place
- The vicinity of the place
- The location of the place
- And whether the place is open or close at the time of the request.

The other data is stored on the firebase database.

3. Google Maps Direction API

The google maps direction API is used to find the route direction and the distance and duration data from the user's location to a particular place. To receive data from the API, a request has to be made by means of a URL. In the URL a few parameters have to be specified namely:

1. The origin location
2. The Destination location

3. The travel mode
4. and, the API key

Once the data has been downloaded from the API, it is processed by the app and then displayed.

4. GPS Location of the user's smartphone

All smartphones nowadays are equipped with GPS technology. The GPS Location of the user's phone is used to locate the user and to give information such as directions, distances and durations to a particular place. This process happens dynamically (at the application's runtime) and no GPS information is stored or used in any other way within the app.

5. And Firebase database.

Firebase is hosted by Google. It is being used for other parts of the Smart City app. Firebase's services are based on a freemium model. The package being used here is the free one. It has a limit of about 100 simultaneous connections that can be made to it. The amount of data that is allowed to be stored on the database is also limiting. So, to cater for many users a paid membership would be required. Firebase offers several services such as Hosting, Storage, Database, etc.…

The one being used here is the Database service. The database is a NoSQL database and data is stored in JSON format. The connection between the database and the android app is seamless (no need to do it through code).

For this app the necessary data was inserted directly into the database. It is retrieved by the app when necessary and then, processed and displayed to the user.

The following data are stored and used for this app:

- The addresses
- The contact information
- The opening/closing times
- And, the websites of places.

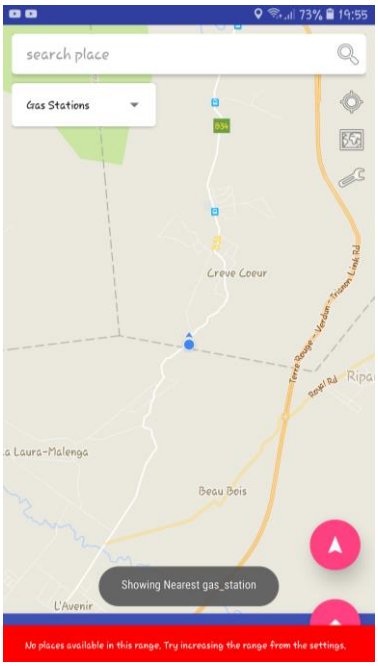


Figure 1 Message indicating no nearby places

When the user enters the app the places surrounding his location will be displayed on a map. If no places are available like in this case, message will appear to indicate the user that no places are available in the area and to increase the search range.

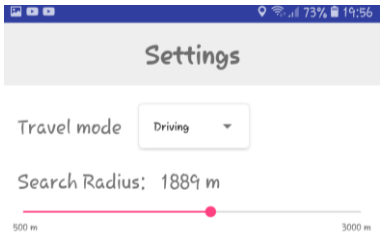


Figure 2 Settings menu

By pressing the settings icon the user gets access to the settings menu where the search radius can be changed. From here the travel mode can also be changed.

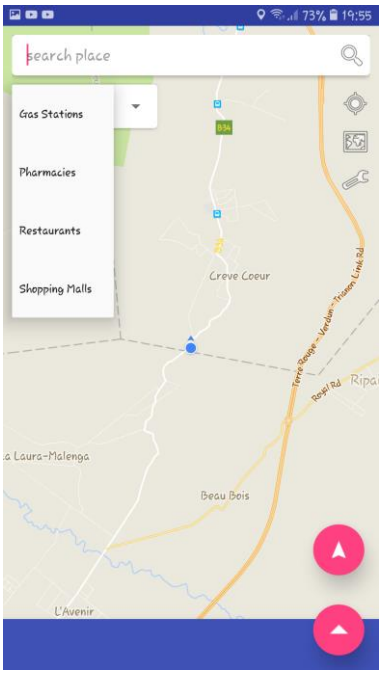


Figure 3 Changing place type

The type of place can be changed by selecting from

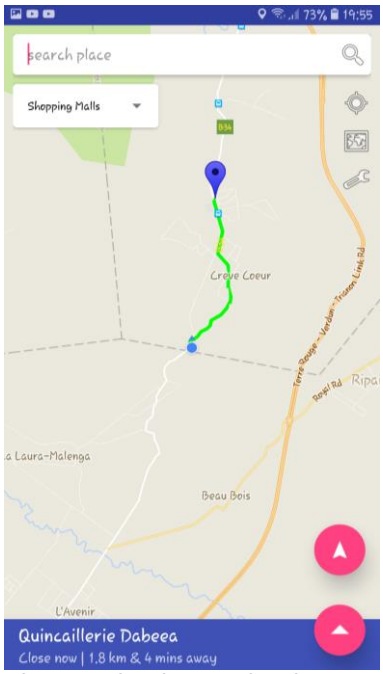


Figure 4 Showing nearby places

And now the app displays the nearby shopping

the list.	**centres for the selected search radius. It also gives directions, distance and duration information for the nearest place.**

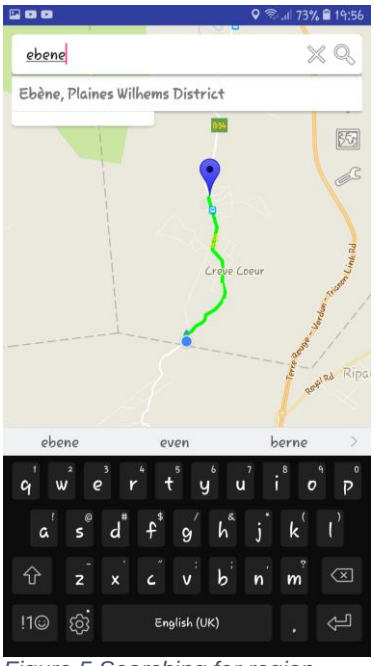


Figure 5 Searching for region

A region/town/village can be typed in the search bar. The app will suggest places' names and a suggestion can be chosen.

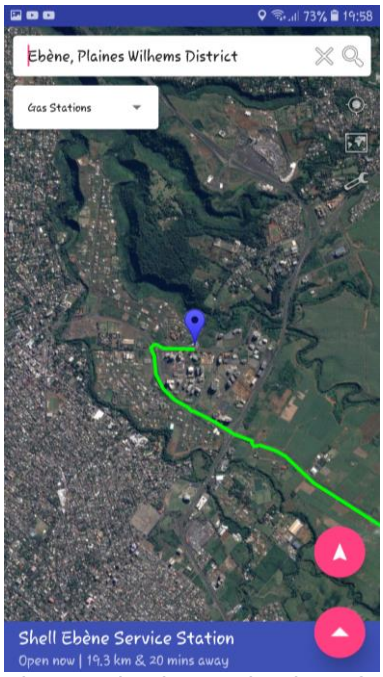


Figure 6 Showing nearby places for searched region

The app will then return the location of the nearby places for the searched region. The mode if the map can be changed by pressing the map icon on the top right. By pressing the floating button located on top of the bottom toolbar…

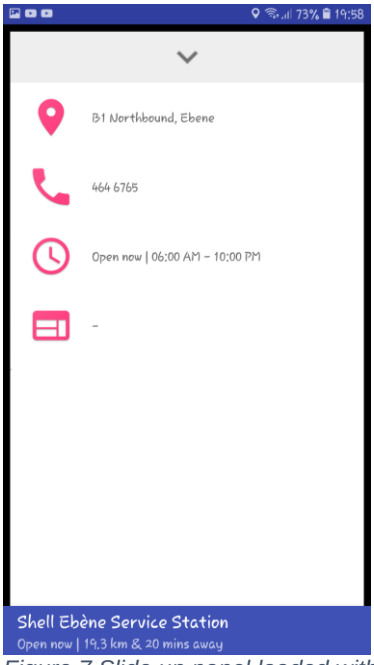


Figure 7 Slide up panel loaded with data

…a panel will slide up. This panel contains the information about a selected place from the map.

3.3 Next Buses App

Goal: The goal of this app is to provide an estimated time at which the next buses would arrive at a particular bus stop. This will help users know how much time they have to wait to catch a bus and also to plan their journey.

Features: The app provides an estimated time at which the next buses will arrive and a countdown till the bus arrives. The information is made available based on a chosen origin and destination bus stop.

The app can also automatically choose the nearest origin bus stop to the user based on a chosen destination bus stop and the GPS of the device. (This feature does not always work properly).

For prototype, only part of one bus route's data is present in the database. So, the app will be able to provide information only for that part of that route.

Technologies used to implement the app

1. Firebase database

   Firebase is hosted by Google. It is being used for other parts of the Smart City app.

   Firebase's services are based on a freemium model. The package being used here is the free one. It has a limit of about 100 simultaneous connections that can be made to it. The amount of data that is allowed to be stored on the database is also limiting. So, to cater for many users a paid membership would be required.

   Firebase offers several services such as Hosting, Storage, Database, etc.…The one being used here is the Database service. The database is a NoSQL database and data is stored in JSON format. The connection between the database and the android app is seamless (no need to do it through code). For this app the necessary data was inserted directly into the database. It is retrieved by the app when necessary and then, processed and displayed to the user.

2. GPS Location of the user's smartphone.

   All smartphones nowadays are equipped with GPS technology. The GPS Location of the user's phone is used to locate the user and to give the user the nearest bus stop based on his/her location. This process happens dynamically (at the application's runtime) and no GPS information is stored or used in any other way within the app.

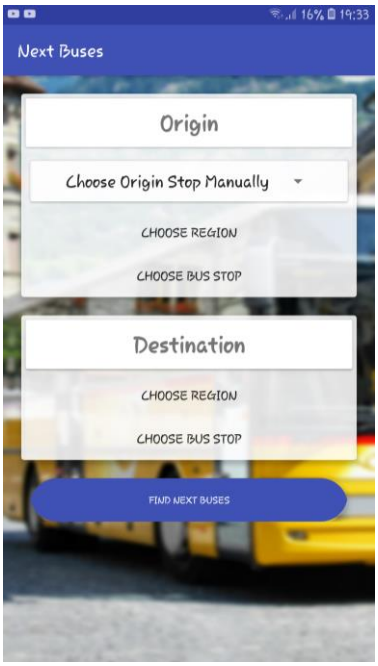


Figure 8 Next Buses app

When the user enters the Next Buses App he is presented with a screen where he has to choose his/her origin region and bus stop and his destination region and bus stop.

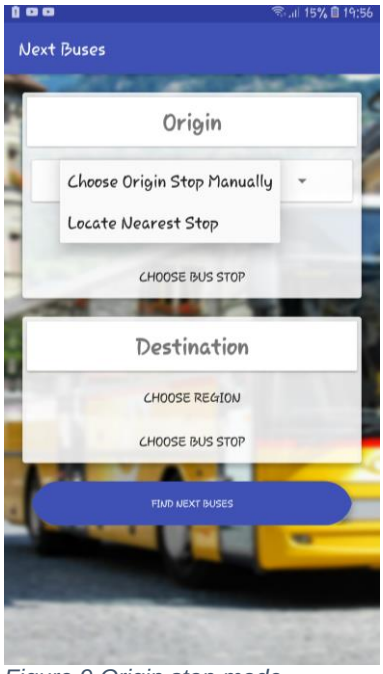


Figure 9 Origin stop mode

For the origin region and bus stop there is the option to either choose manually or allow the app to find the nearest one using GPS of the device.

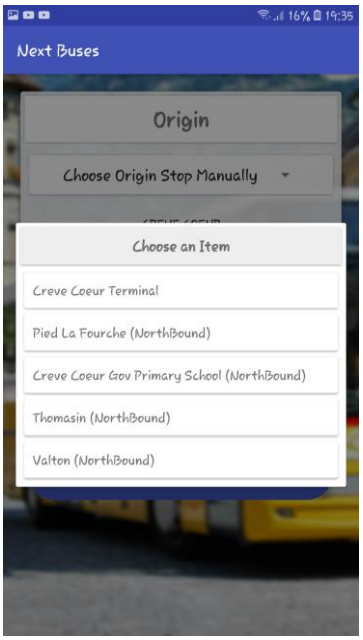


Figure 10 Choose origin stop manually

If the user chooses to enter the information manually he will then have to choose the region and bus stop from a list.

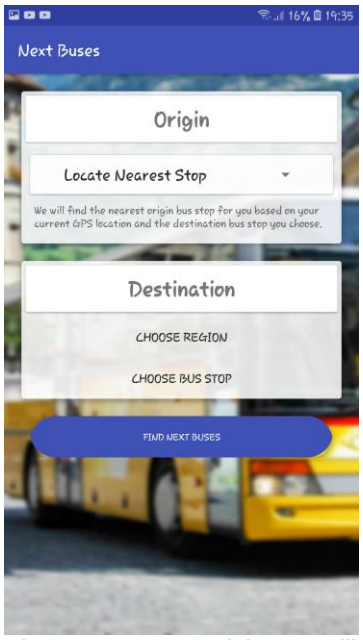


Figure 11 Nearest origin stop will be found automatically

If the user chooses to allow the app to find the region and bus stop he will only have to enter information for his destination.

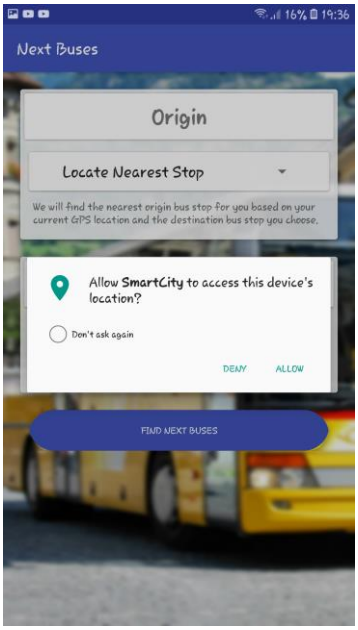


Figure 12 Permission request

If the user has not yet given his/her consent to use GPS Location, the app will ask for the permission before proceeding.

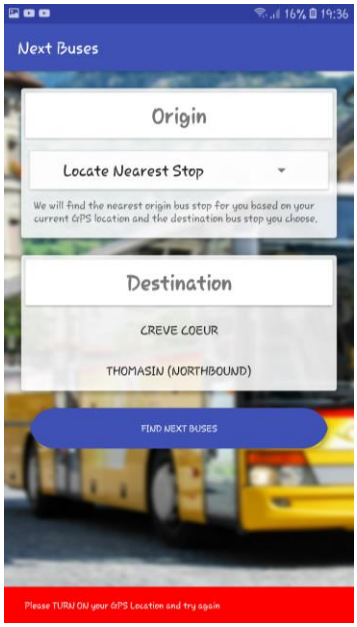


Figure 13 Message to enable GPS

Now, if the phone's GPS is disabled a message will appear to inform the user that the latter needs to enable it.

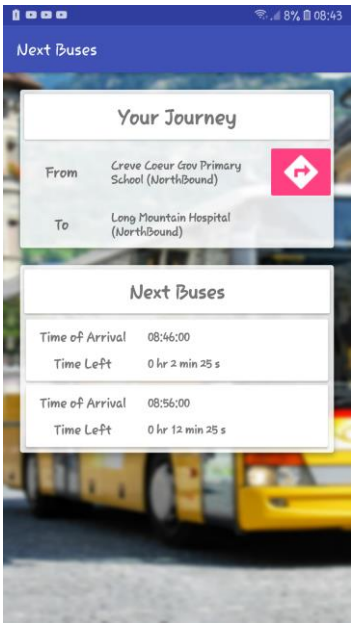


Figure 14 View next buses information

Then, another activity appears with the information about the next two buses. There is also a button next to the origin bus stops name which when pressed will open the google maps app and give turn-by-turn navigation from your current location to the bus stop.

3.4 Weather Info App

Goal: Normally, to get updated weather information we would have to wait no less than 4 hours for the meteorological station to release a new bulletin. The main goal of this app is to provide updated weather information to the users at all times. The API used in this app constantly updates the weather information based on live changes in the weather. So, there is no need to wait for weather bulletins to be released to get updated weather information.

Features: The Weather Info App provides current weather information and also gives a brief 10-day hourly weather forecast to the user.

Information provided:

1. Brief description of weather.
2. Temperature.
3. Atmospheric Pressure.
4. Air Humidity.
5. Wind information.
6. Precipitation.

Weather information is made available based on a chosen region. Most major towns and villages around Mauritius are covered. For areas which are not available to choose, the GPS location of the user's phone can be used to find the nearest covered region.

Technologies used to implement the app

Wunderground API (Weather Underground API)

This API was chosen over a few other APIs because it provides weather coverage for most of the towns and villages on the Island and also the weather information has the most disparity for different regions. The API is based on a freemium model. There are several packages available at different price points and the one that is being used here is the Developer package which allows for no more than 500 requests per day and 10 requests per minute and is free. So, to cater for many users a paid membership would be required. Data from the API is downloaded onto the user's phone in JSON format. It is then processed locally and displayed to

the user.

There is a few information which needs to be provided when requesting data from the API namely:

1. The format in which the data is to be received.
2. An API key, which is acquired when an account is created on the Wunderground website.
3. The latitude of the place for which data is being requested.
4. And, the longitude of the place for which data is being requested.

2. GPS Location of the user's smartphone.

All smartphones nowadays are equipped with GPS technology. The GPS Location of the user's phone is used to locate the user and to give weather information based on the location. This process happens dynamically (at the application's runtime) and no GPS information is stored or used in any other way within the app.

Figure 15 Current weather information

When the user enters the Weather App he is presented with a screen with a toolbar at the top and weather information below it. There is a spinner (drop-down list) in the toolbar and the spinner has "Ebene" as the chosen item by default. So, the information that is displayed by default is for Ebene.

Figure 16 Forecast information

The user can scroll down to view more information.

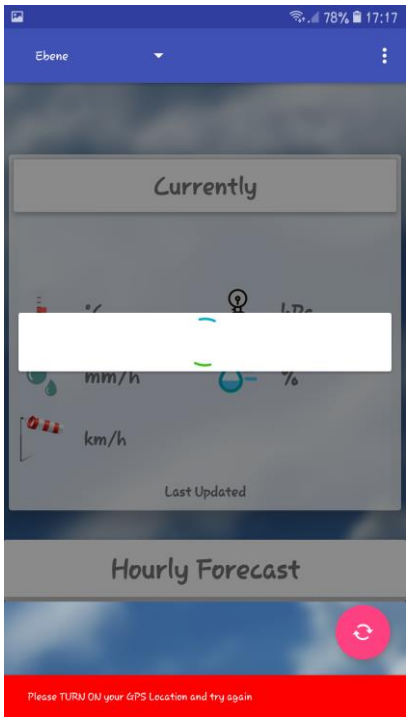


Figure 17 Choose location

The user can get weather information for a different region by tapping on the spinner and choosing a different region/town/village. In the spinner the second item is "Local". When this item is chosen the app will use the GPS location of the phone to get the weather info at the user's location.

Figure 18 Message to turn on GPS

Now, if the phone's GPS is disabled a message will appear to inform the user that the latter needs to enable it.

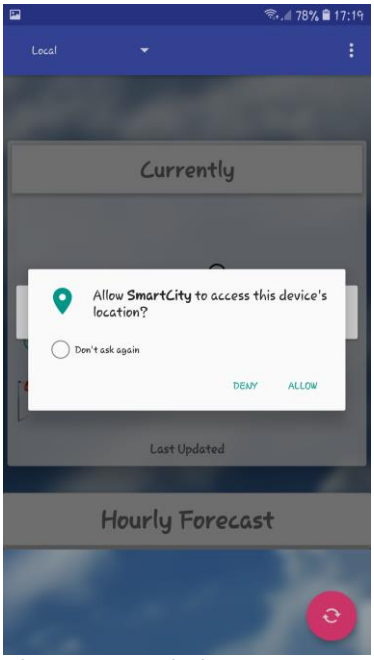


Figure 19 Permission request

If the user has not yet given his/her consent to use GPS Location, the app will ask for the permission before proceeding.

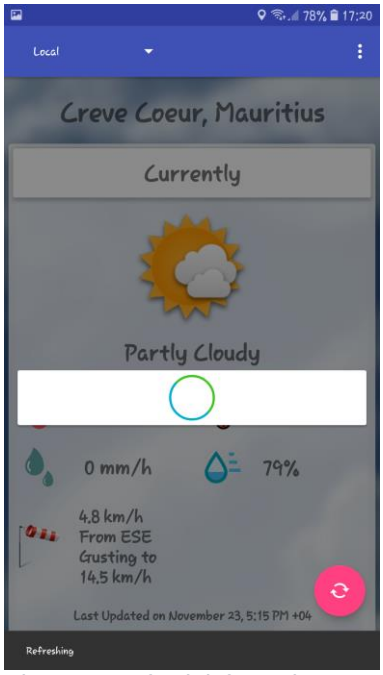


Figure 20 Refresh information

There is also a floating button at the bottom right corner of the screen. When clicked it just updates the weather information on the screen.

3.5 News App

Goal: Normally, to get updated News information we should visit the website of the local newspaper or buy a newspaper everyday which is not eco-friendly. The main goal of this app is to delivers breaking news, analysis and market data occurring in the smart city. It allows the user to be up to date with information. So, there is no need for the user to remember the URL of the website or buy a newspaper paper every day.

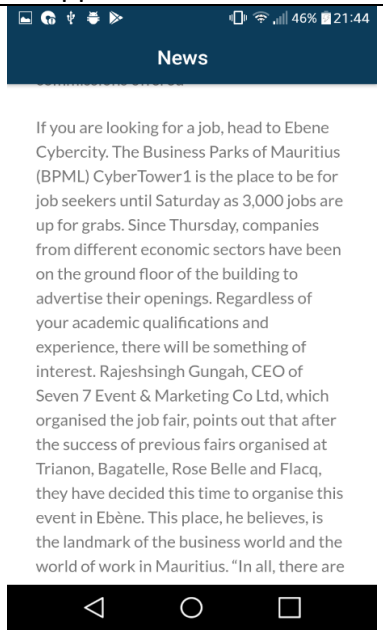
Technologies used to implement the app

1. WordPress

WordPress is a fast, lightweight and easy to use. WordPress is written in PHP and uses MySQL database. It allows to create a free website to be able to share experience, write articles.

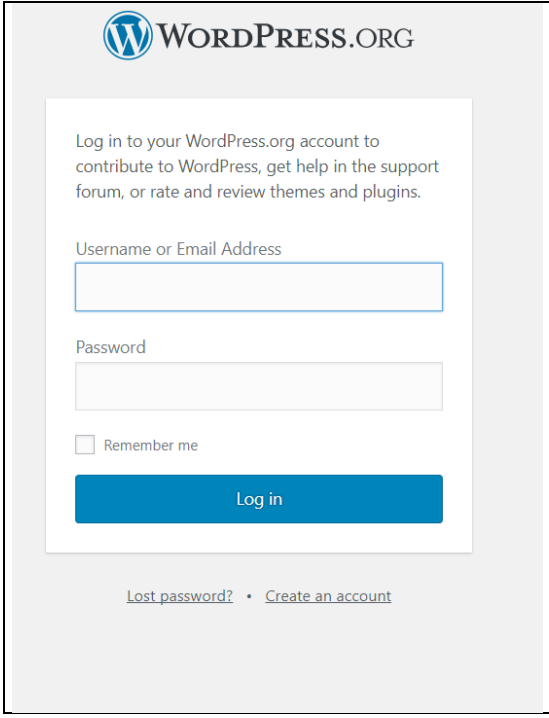
How to use the app?

The following figures show the client side of the app.



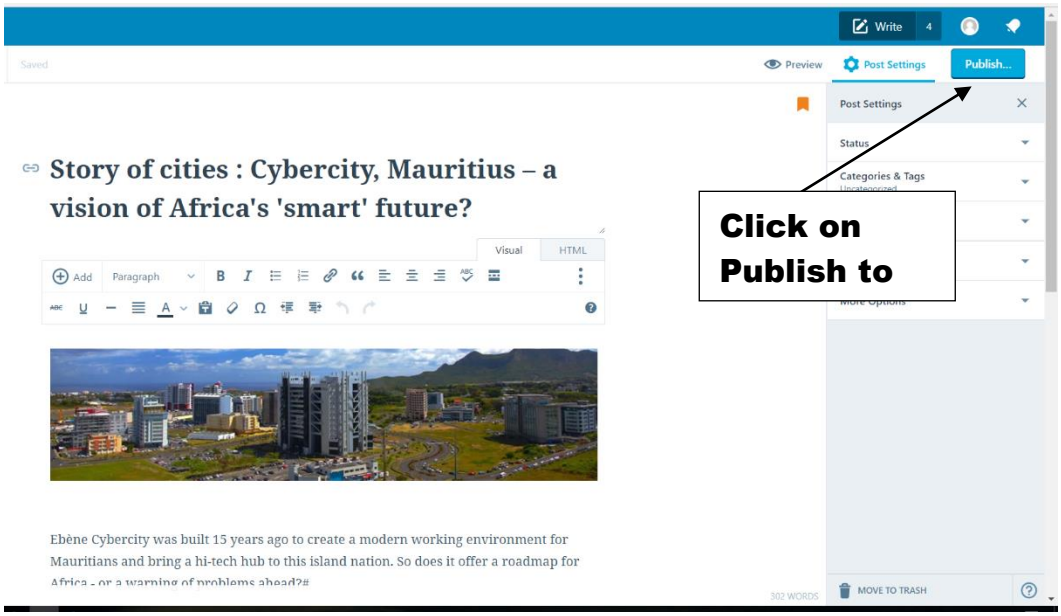
User can read articles.

The following figure shows the client side of the app.



Admin will login from the WordPress website:

"*https://login.wordpress.org/*"



Write news articles and click on publish. It will automatically publish the news articles.

3.6 Complaint App

Goal: The main purpose of this app is to allow user to post any complaint against a company or an authority, an accident. Also allow to view complaints which has been posted. Complaint Admin will take into consideration of the complaint you make and will deliver your complaints to the companies or authority concerned. Complaint Admin will also post status if it has been completed or still pending.

Features: The Complaint App Features are:

1. Able to post any complaint from anywhere anonymously.
2. Able to view all complaint.
3. Able to view all completed and pending complaints in a different page.

Technologies used to implement the app: Firebase

Firebase is a platform for mobile and web apps. It provides the tool to developed high quality apps. Firebase is a NoSQL database that make use of sockets, which allow clients to receive information live -without having to make GET requests to the Server and data are stored in JSON.

There are three main services for Firebase:

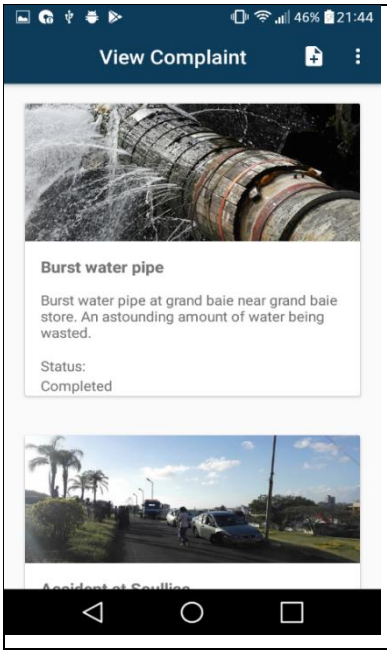
1. Real Time Database
2. Authentication
3. Static Hosting

Real Time Firebase

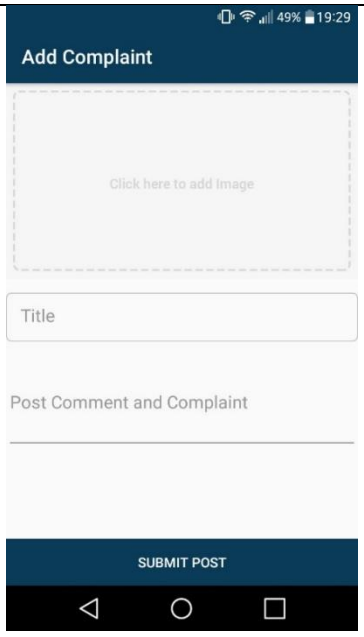
The Firebase Real time database is a cloud-hosted NoSQL database that allow you to store and sync data between users in Real-time. Real-time syncing simplify user to access their data from any device: web or mobile, no need for an application server and it helps your users collaborate with each other.

When users are offline, the Real-time Database SDKs use local cache on the device to serve and store changes. When the device connectivity is re-established, automatically synchronized local data with the current server state. It can be accessed. Firebase Real-time Database Security Rules provide security and data validation: expression-based rules that are accomplished when data is read or written.

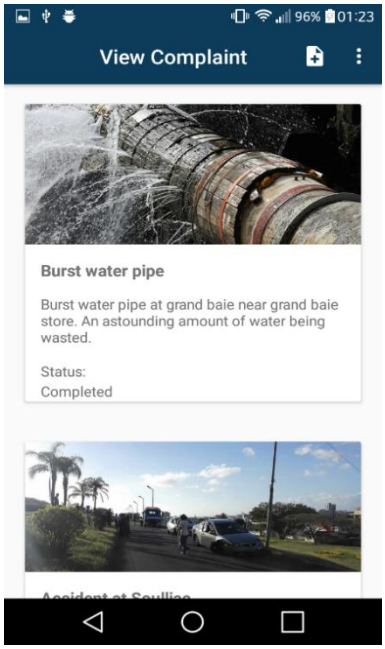
How to use the Complaint App?



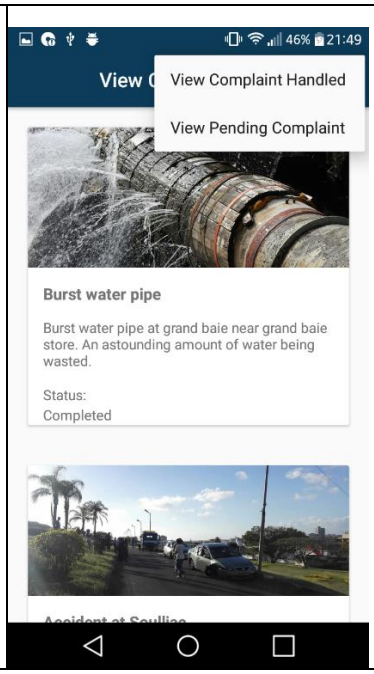
Click on icon + to add a post.



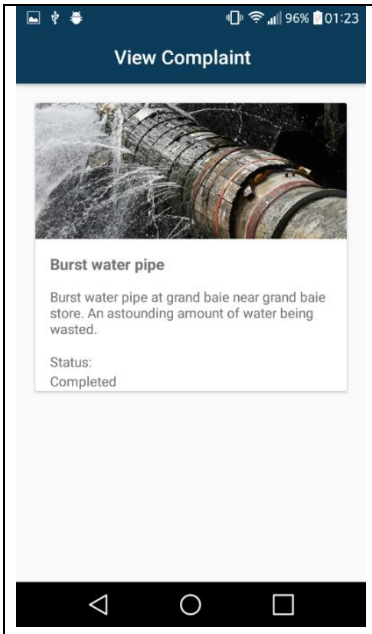
Post Activity Screen will appear. Write your Complaint and click on submit button to post complaint into the database.

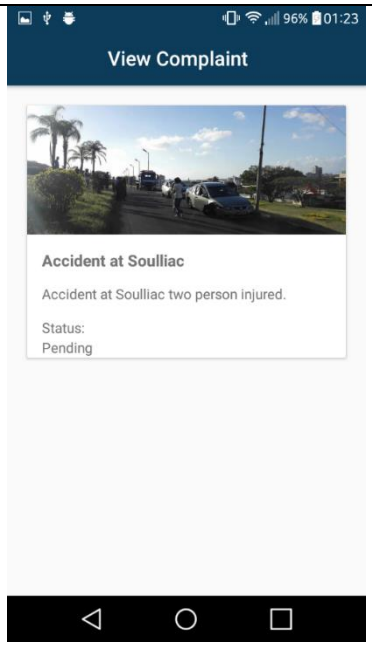


The App will launch to View Complaint



Click on View Complaint Handled to View all complaint handled or click on View Pending to View all pending complaints.





3.7Parking App

Goal: The main purpose of this app is to allow user to find “Vacant Parking” around the smart city.

Features: The Parking App Features are:

1. Give user the exact Parking location.
2. User can view parking space (Vacant or Occupied).
3. Allow parking admin to monitor parking space.

Technologies used to implement the app:
Google Maps API
This API allow the addition of google maps in the android app. It allows a map to be displayed in a google map activity and also allows the user to interact with the map. An API key is required else the google map will not appear in the activity. For Firebase has been covered in previous apps
Firebase
As documented in previous sections.

How to use the app?
The figures below show how to use Parking app.

	
User or Admin can choose (UTM Staff, UTM MAIN PARKING, BPML la tour Koenig) parking from the map activity. Click on the fab button will direct you to the parking activity	User have the only the ability to view parking whereas Parking Admin can change parking to vacant or occupied by clicking on the image button.

Chapter 4: Methodology

4.1 Quantitative Approach

The quantitative method was selected for the study through the use of a questionnaire as it is a suitable way to reach a geographically dispersed audience at a relatively low cost. The survey which consisted some 16 pages is to be administered to a sample of 200 citizens of Mauritius. The convenience sampling method is to be used where citizens will be approached online or through their work place. Respondents were rest-assured about the confidentiality and anonymity of the study.

The content validity of the questionnaire was confirmed by a panel of academic lecturers at the University of Technology Mauritius. The reliability of the questionnaire was estimated by conducting a pre-test in which 10 questionnaires were administered to respondents, who were then excluded from the sample. The response was quite spontaneous and the participants showed ease of understanding for the questionnaire. Following the pilot test, the questionnaire was slightly modified based on comments received from respondents.

The final questionnaire consisted of a short covering letter, and directions on how to fill the questionnaire. The first section of the questionnaire consists of 9 questions related to the profile of the citizen. The second section of the questionnaire consists of 21 questions based on the five features of the SmartCity App which was showcased to them through a video of the interaction with the app. The last section of the questionnaire consists of some 30 questions to assess the acceptance as well as to get input about the factors that may affect adoption such as internet connectivity. Respondents were mainly asked to provide ratings on a 5-point Likert Scale for most questions, which was deemed convenient. The questionnaire is annexed as Appendix 1 of the report.

4.2Sample Size and Facts

The population size (the total number of people being studied) is 1, 263, and 820 at the end of 2016 (Stats Mauritius) out of which 638,267 are women against 625,206 men.

A sample of minimum 200 respondents is being targeted.

4.3 Measures

This section outlines the measurement scales used to operationalize research constructs. Respondents were asked to indicate agreement with each statement in a measure using a five-point Likert-type scale (1, strongly disagree; 2, disagree; 3, neutral; 4, agree; 5, strongly agree). The measures related to each construct then were assessed using respondent perceptions:

(1) Perceived Usefulness (PU):

TAM posits that PU is a significant factor affecting acceptance of an information system (Davis et al.,1989). Davis defined PU as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989). Hence an application perceived to be more useful than another is more likely to be accepted by users. By applying these into the Smart City App context we hypothesize:

Hypothesis 1. Perceived usefulness (PU) has a positive effect on consumer acceptance of the Smart City App

(2) Perceived Ease of Use (PEOU):

According to TAM PEOU is a major factor that effects acceptance of information system (Davis et al., 1989). PEOU is defined as "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989). Therefore, the Smart City App perceived to be easier to use than any other application is more likely to be accepted by users. Therefore, in this case, we hypothesize:

Hypothesis 2a. Perceived ease of use (PEOU) has a positive effect on consumer acceptance of the Smart City App
Hypothesis 2b. Perceived ease of use (PEOU) has a direct effect on perceived usefulness (PU).

(3) User Satisfaction (US) and Perceived Enjoyment (PE):

Previous studies have indicated that User Satisfaction (US) affects the effectiveness of IS, system usage, as well as, directly or indirectly, affecting IS performance through IS usage. Although Davis did not include user information satisfaction in his TAM, we revised it based on prior studies and define it as user satisfaction with the Internet/WWW.Regarding the use of the Smart City App, this study is expected to derive the new relations among US, PU and PEOU. As users usually access the Internet/WWW through WIFI or mobile data to access or downloads apps such as WhatsApp, Instagram etc., this study infers that US directly and indirectly affects user acceptance of the Smart City App:

Hypothesis 3a.User Satisfaction (US) has a positive effect on user acceptance of the Smart City App

Hypothesis 3b. User Satisfaction (US) positively affects PEOU of the Smart City App.

Hypothesis 3c. User Satisfaction (US) positively affects PU of the Smart City App.

Hypothesis 3d. User Satisfaction (US) positively affect Behavioural Intention (BI) of the use of the Smart City App.

Perceived enjoyment refers to the extent to which the activity of using a computer is perceived to be enjoyable in its own right (Davis et al., 1992). This is contrasting to the PU, which be seen as an extrinsic motivation whereas perceived enjoyment (PE) as an intrinsic motivation to use information systems. A number of studies on PE (Davis et al., 1992; Igbaria et al., 1995; Teo et al., 1999) have noticed that PE significantly affects intentions to use computers. Igbaria et al. (1995) found that PE correlates positively with time of use but not with frequency of use or number of tasks. In contrast, Teo et al. (1999) noted that PE correlates positively with frequency of Internet usage and daily Internet usage.

Some studies have focused on perceived fun and perceived playfulness (Igbaria et al., 1994; Moon and Kim, 2001). According to Igbaria et al. (1994) perceived fun refers to the performance of an activity for no apparent reinforcement other than the process of performing the activity per se. They found that system usage and the perceived fun were positively correlated with each other. Moon and Kim (2001) define perceived playfulness as consisting of three parts: concentration, curiosity and enjoyment. They

discovered that the perceived playfulness had a significant impact on the intention to use the Internet. On this basis, we expect that PE affects the acceptance of the Smart City App:

Hypothesis 4. Perceived enjoyment (PE) has a positive effect on user acceptance of the Smart City App.

(4) Behavioural Intention to use (BI):

Behavioural Intention refers to the user's likelihood to engage in the use of the Smart City App. Therefore, in our research, it can be hypothesized:

Hypothesis 5a. Perceived ease of use (PEOU) has a direct effect on behavioural intention to use.
Hypothesis 5b. Perceived usefulness (PU) has a direct effect on behavioural intention to use.

(5) Quality of Internet (QI):

The importance of a decent Internet connection and its quality was raised in our research. Also, Sathye (1999) used Internet access as one of the factors affecting the adoption of online banking in her research. Without a proper Internet connection, the use of the Smart City App is not possible. Hence, we posit:

Hypothesis 6. The quality of the Internet connection has a positive effect on consumer acceptance of SmartCity App

Chapter 5: Research Findings

5.1 General Profile

Citizens of Mauritius were invited in this research work to participate in the survey by two modes: (1) an email invitation with a link to the online version on the survey hosted on Google server (Google Forms) was sent to some organizations and to students of the university asking them to forward the email to their friends and families for higher rate of dissemination of the survey request; (2) 100 printed copies of the survey was left with various institutions to solicit their participation in the survey. Participation was encouraged by allowing the participants to enter into a drawing to win a power bank as a gift. The first page of the survey provided information about the study and they had to enter a mobile number which is to be used to enter the gift raffle. 68 responses were recorded online and 32 filled printed copies of the survey were obtained. The response rate of the printed survey was 32%. The respondents consisted of 41.2% female and 58.8% male. The age of the respondents is as shown in Figure 5.1. 57.4% of the respondents were of the age group 21-29 years old, 17.6% were of the age group 30-39, 11.8% were of the age group 18-20 years old and only 1.5% response were obtained from senior citizens i.e. 60 years old and above. The average age of the respondents is 21-29 years old.

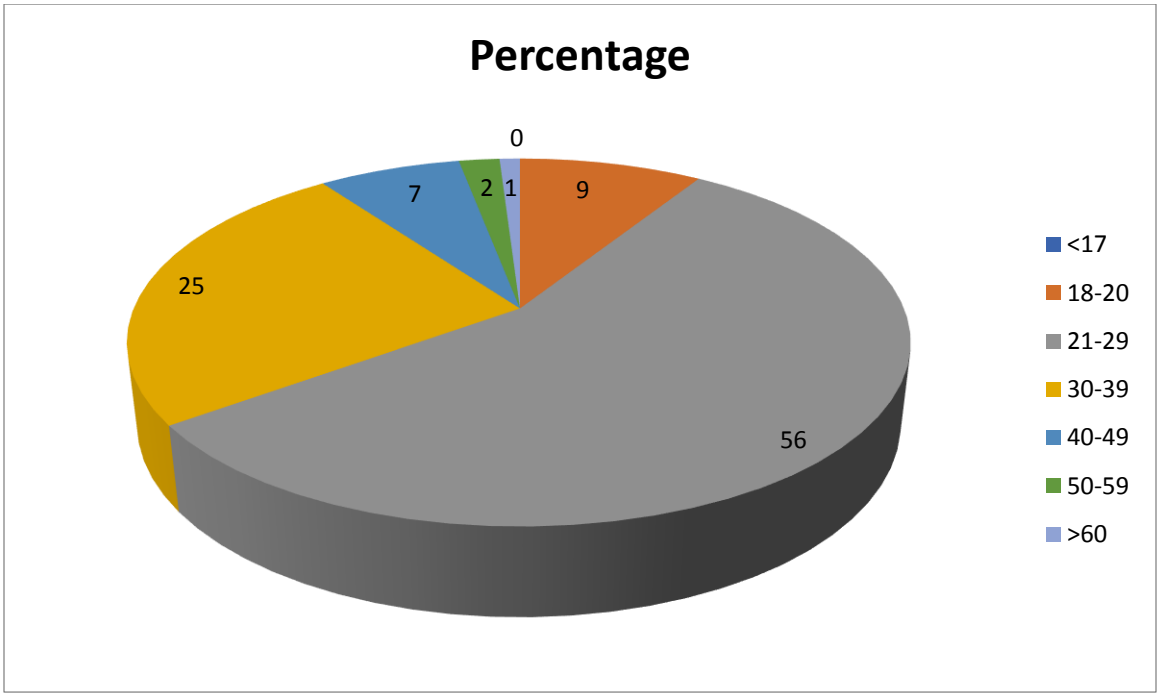


Figure 5.1: Respondents age distribution

The majority of respondents had tertiary education level as depicted in Figure 5.2.

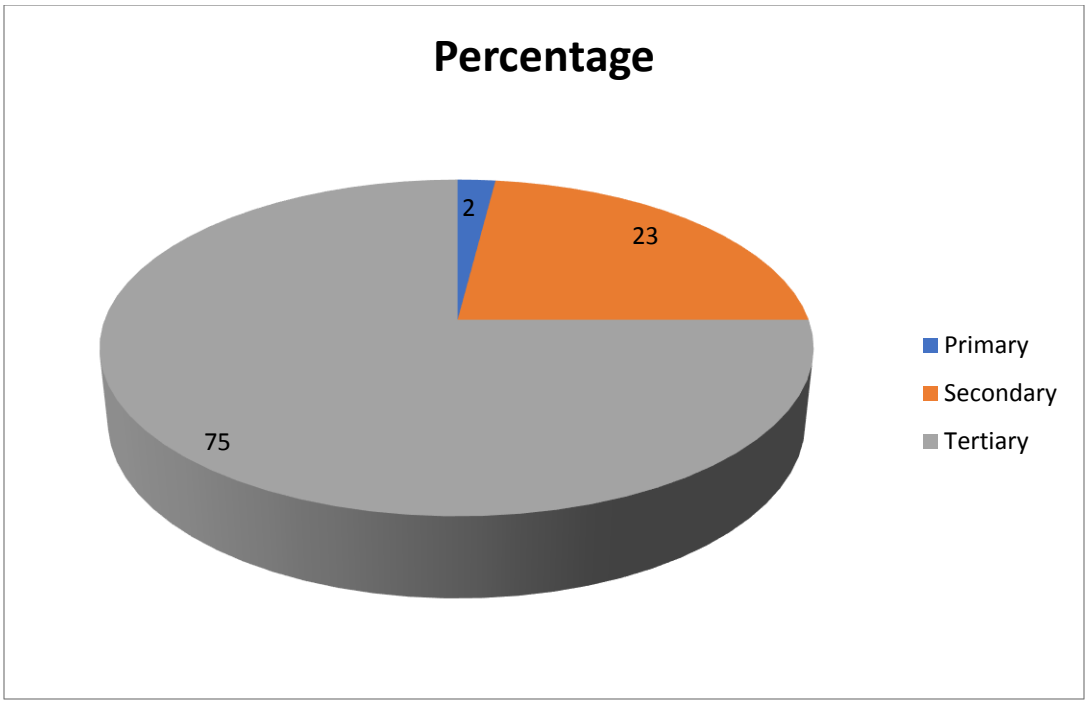


Figure 5.2: Respondents education level

The majority of respondents were using a smart phone, tablets/fablets being the second most popular communication device used as depicted in Figure 5.3.

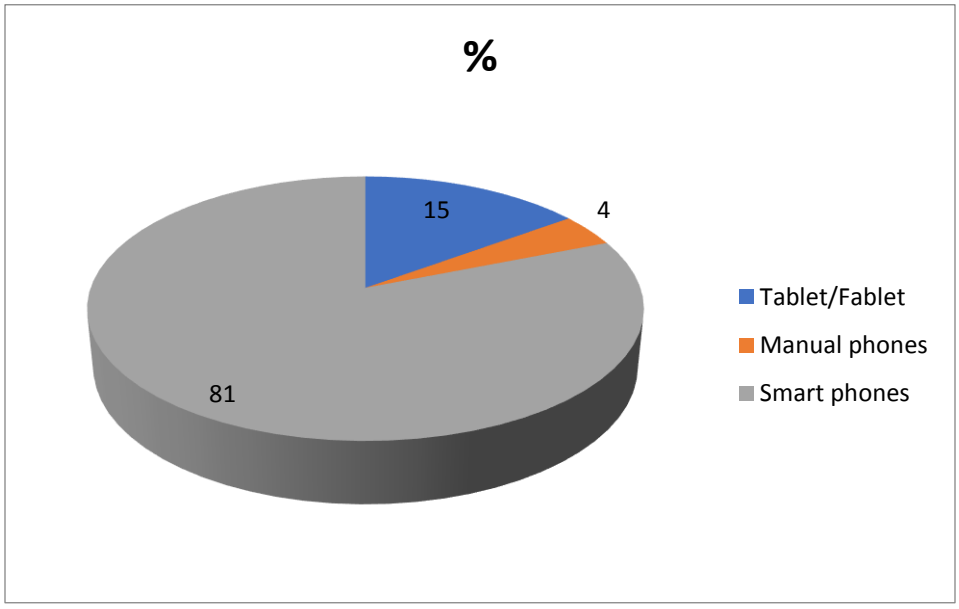


Figure 5.2: Respondents Types of mobiles Used

Most respondents are using their mobile phones for accessing Internet, which is a positive indication towards the use of their smart phones for accessing internet-based services.

Regarding the type of Internet access used, it was found that 68.0% of people used both Wi-Fi when available and mobile data connectivity otherwise. Regarding mobile data connectivity, most respondents were found to spend between 10 MUR and 299 MUR.

Respondents were also asked to indicate their preferences regarding the following popular mobile applications: Facebook, Twitter, Instagram, YouTube, Snap Chat, WhatsApp, Email, Google Search, Online Shopping, Online Banking, News and Games. The following applications were highly favoured compared to the others: Facebook, YouTube, WhatsApp, Email, and Google Search as depicted by Table 5.1.

TABLE 5.1: Statistics regarding adoption of popular mobile applications

	Mean	Median	Mode	Standard Deviation
Facebook	3.69	4.00	5.00	1.46
Twitter	2.40	2.00	1.00	1.64
Instagram	2.89	3.00	1.00	1.70
Youtube	4.12	5.00	5.00	1.18
Snapchat	2.27	1.00	1.00	1.61
WhatsApp	4.31	5.00	5.00	1.17
Email	4.08	5.00	5.00	1.32
Google	3.90	4.00	4.00	1.37
Online Shopping	2.99	3.00	3.00	1.45
Online Banking	3.24	4.00	4.00	1.60
News	3.44	4.00	5.00	1.47
Games	2.88	3.00	1.00	1.68

5.2 Smart City App Features

As described in Chapter 3, the Smart City App includes the following six features:

1. The Nearby Places app
2. The Next Buses app
3. The Weather Info app
4. The Parking app
5. The News app
6. The Complaint app

The perceived usefulness of each feature was separately accessed via the questionnaire using a Likert scale of 5 as follows: (1) Strongly Disagree, (2) Disagree, (3) Neutral, (4) Agree, and (5) Strongly Agree. Responses for the questions regarding each feature were mostly positive as shown in Table 5.2.

TABLE 5.2: Summary of responses for the different features of the SmartCity App

Feature	Question	Observations
1. Search Nearby Places	I find this feature useful to me.	Responses mostly varies from Strongly disagree (1) to Strongly Agree (5).Highest Response : Agree (4)
	I find it easy to use this feature	Responses mostly varies from Strongly disagree (1) to Strongly Agree (5).Highest Response : Agree (4)
	I find the navigation to the shop, pharmacy, etc feature useful.	Responses mostly varies from Strongly disagree (1) to Strongly Agree (5).Highest Response : Agree (4)
2. Bus Information	I find this feature useful to me.	Responses mostly varies from Strongly disagree (1) to Strongly Agree (5).Highest Response : Agree (4)
	I find it easy to use this feature.	Responses mostly varies from Strongly disagree (1) to Strongly Agree (5).Highest Response : Agree (4)
	Information provided by this feature were useful.	Responses mostly varies from Strongly disagree (1) to Strongly Agree (5).Highest Response : Agree (4)
3. Weather Information	I find this feature useful to me.	Responses mostly varies from Strongly disagree (1) to Strongly Agree (5).Highest Response : Agree (4)
	I find it easy to use this feature.	Responses mostly varies from Strongly disagree (1) to Strongly Agree (5).Highest Response : Agree (4)
	Information provided were easy to understand.	Responses mostly varies from Strongly disagree (1) to Strongly Agree (5).Highest Response : Agree (4)
4. Parking	I find this feature useful to me.	Responses mostly varies from Strongly disagree (1) to Strongly Agree (5).Highest Response : Agree (4)
	I find it easy to use this feature.	Responses mostly varies from Strongly disagree (1) to Strongly Agree (5).Highest Response : Agree (4)
	Information provided were easy	Responses mostly varies from Strongly

	to understand.	disagree (1) to Strongly Agree (5).Highest Response : Agree (4)
5. Complaints Feature	I find this feature useful to me.	Responses mostly varies from Strongly disagree (1) to Strongly Agree (5).Highest Response : Agree (4)
	I find it easy to use this feature.	Responses mostly varies from Strongly disagree (1) to Strongly Agree (5).Highest Response : Agree (4)
	How useful to do find the photo/video upload feature of the app for complaints?	Responses mostly varies from Strongly disagree (1) to Strongly Agree (5).Highest Response : Agree (4)

Responses from citizens also indicated the Bus information feature as being the most useful. The most important features listed in descending order of preference are as follows:

1. Bus Information
2. Parking Information
3. Search Nearby Places
4. News
5. Complaint
6. Weather Information

5.3 Quality of Internet

To use the SmartCity App, having internet connectivity is crucial. Respondents were also asked to provide feedback regarding the quality of Internet access. 79.0% of respondents claimed to have access to Wi-Fi in their work or home environment. 21.0% of people though indicated not readily having Wi-Fi access for Internet connectivity. In case, Wi-Fi access is not available, the respondent's intention to use mobile data connectivity to use the SmartCity App was evaluated using the Likert scale. More than half of the respondents indicated a high likelihood of paying for mobile data connectivity to access the SmartCity App. 48.0% respondents found the current cost of accessing the Internet via mobile data connection expensive, while 22.0% of respondents found the cost of mobile data acceptable and 29.0% found the cost of Internet highly acceptable. On average, users found the speed of accessing the Internet both via Wi-Fi and mobile data connection acceptable. Response indicates that the quality of both Wi-Fi and mobile data connection tends to be good quality. Table 5.3 depicts the factor analysis results for the Quality of Internet access. Thus, it can be concluded that access to Internet connection

for the SmartCity App is not an issue and people find the quality of internet connectivity to be acceptable.

TABLE 5.3: FACTOR ANALYSIS RESULTS: Quality of Internet (QI)

Factor	Factor Loadings
Is Wi-Fi easily accessible in your area? (QI1)	.638
On a scale of 0 to 5, how often do you receive Wi-Fi access in your area? (QI2)	.955
On a scale of 0 to 5, how likely are you to use Mobile Data connectivity in case there is no Wi-Fi access at all in order to use the app? (QI3)	.571
I find the current costs of accessing the Internet via Mobile Data acceptable. (QI4)	.949
I accept the current network speed of the Internet via Wi-Fi. (QI5)	.804
I accept the current network speed of the Internet via Mobile Data. (QI6)	.821
On a scale of 0 to 5, how would you rate the quality of Wi-Fi___33 connection in your area? (QI7)	.774
On a scale of 0 to 5, how would you rate the quality of Mobile Data connection in your area? (QI8)	.825

Note: Items that loaded below .30 are not presented

5.3 SmartCity App

5.3.1 Psychometric Properties

5.3.1.1 Factor Analysis

Two factor analysis using the Principal Component Analysis (PCA) with Varimax (orthogonal) rotation were carried out. All items having a loading greater than 0.3 on each factor were retained. Table 5.4 to 5.7 represent a rotated component matrix for Perceived Usefulness (PU), Perceived Ease of Use (PEOU), User Satisfaction (US) and Personal Experience (PE), Behavioural Intention (BI) and Quality of Internet (QI) respectively. All yielded factors had Eigenvalues greater than one and accounted for more than 56.2% of the total variance. The factors were labelled as such due to high loadings (> .5) on their respective items as shown in their respective tables.

TABLE 5.4: FACTOR ANALYSIS RESULTS: Perceived Usefulness (PU)

Factors	Factor Loadings
…this SmartCity App useful to me. (PU1)	.842
…is functional. (PU2)	.775
…will enhance my effectiveness. (PU3)	.849
…help to increase my productivity. (PU4)	.736
…make some tasks easier. (PU6)	.526

…greater control over my schedule. (PU7)	.505
Timeliness of information provided…(PU8)	.792

TABLE 5.5: FACTOR ANALYSIS RESULTS: Perceived Ease of Use (PEOU)

Factors	Factor Loadings
Interaction with this SmartCity App is clear…(PEOU1)	.836
Learning to use this… (PEOU2)	.853
I find it easy to locate the information… (PEOU3)	.788

TABLE 5.6: FACTOR ANALYSIS RESULTS: User Satisfaction (US) and Personal Experience (PE)

Factors	Factor Loadings
Factor 1: User Satisfaction (US)	
Overall, I am satisfied…(US1)	.743
I am satisfied with the features or services…(US2)	.758
Factor 2: Personal Experience (PE)	
My choice to use… (PE1)	.788
I expect to become skilled…(PE2)	.683
Using the SmartCity App…(PE3)	.500
Using the SmartCity App…(PE4)	.798

TABLE 5.7: FACTOR ANALYSIS RESULTS: Behavioral Intention (BI)

Factors	Factor Loadings
I will recommend others to use …(BI3)	.823
When I need it again, I intend…(BI4)	.889
The use of this… (BI7)	.843
If I were asked to express my opinion…(BI8)	.868

Note: Items that loaded below .30 are not presented

5.3.1.2 Cronbach Alpha

Cronbach Alpha was also carried out to test for the reliability of the factors obtained from Perceived Usefulness (PU), Perceived Ease of Use (PEOU), User Satisfaction (US), Personal Experience (PE), Behavioral Intention (BI) and Quality of Internet (QI). The results are shown in Table 5.8 and were as follows:

Table 5.8: Cronbach Alpha Results

	Cronbach Alpha
PU	.962
PEOU	.772
US	.947
PE	.754
BI	.970
QI	.686

All of the above yielded values greater than 0.5, showing high reliability.

5.3.1.3 Mean, Standard Deviations and Correlations among Study Variables

Table 5.9 shows the correlation between Perceived Usefulness, User Satisfaction, Behavioural Intention, Personal Experience and Quality of Internet. As expected, a very strong positive correlation (r=+807) was obtained between perceived usefulness and user satisfaction, indicating that the higher the user will perceive the SmartCity App to be useful, the greater he/she will be satisfied. Therefore, perceived usefulness predicts user satisfaction to a very great extent. Likewise, another very strong correlation (r=+.867) was observed between perceived usefulness and behavioural intention which means that, the greater the user will perceive the Smart App, the higher he/she will have the intention to use it again. However, a weak positive correlation (r=+.267) was observed between perceived usefulness and quality of internet indicating that perceived usefulness is less likely to predict the quality of internet. This implies that the extent to which the user will perceive the Smart App as being useful will less likely predict the quality of internet. Furthermore, a positive association between perceived ease of use and user satisfaction(r=+.743) was observed, which implies that the greater the user will perceive the App as being easy to use, the more likely he/she will be satisfied. Finally, a strong positive correlation (r=+.838)

between user satisfaction and behavioural intention was observed, which means that the greater the user will be satisfied, the more likely the user will have the intention to use it again. Hence, user satisfaction predicts behavioural intention very strongly.

TABLE 5.9: Correlations between Perceived Usefulness, Perceived Ease of Use, User Satisfaction, Personal Experience, Behavioral Intention and Quality of Internet and their Means and Standard Deviations.

Measures	1	2	3	4	5	6
1. *Perceived Usefulness*	1					
2. *Perceived Ease of Use*	.741**	1				
3. *User Satisfaction*	.807**	.743**	1			
4. *Personal Experience*	.743**	.592**	.755**	1		
5. *Behavioral Intention*	.867**	.710**	.838**	.773**	1	
6. *Quality of Internet*	.267**	.237*	.352**	.260**	.372**	1
MEAN	3.64	3.76	3.68	3.64	3.62	2.89
STANDARD DEVIATION	.896	.926	.968	1.11	.996	1.35

*. Correlation is significant at the 0.05 level (2-tailed)

**. Correlation is significant at the 0.01 level (2-tailed).

5.3.2 ANOVA Results

Table 5.10: Mean Scores (and standard deviations) for measured variables across different age groups

Variables	**≤ 17**	**18-20**	**21-29**	**30-39**	**40-49**	**50-59**	**≥ 60**	**ANOVA**
Perceived Usefulness	-	4.16	3.62	3.62	3.11	3.88	4.00	F(1.172)=.329
	-	(.62)	(.97)	(.72)	(1.09)	(.29)	-	
Perceived Ease of Use	-	4.18	3.69	3.71	3.86	3.90	4.00	F(.464)=.802
	-	(.72)	(1.01)	(.75)	(1.20)	(.14)	-	
User Satisfaction	-	4.28	3.63	3.76	2.92	3.50	4.00	F(1.682)=.146

	-	(.57)	(1.02)	(.84)	(1.10)	(.71)	-	
Personal Experience	-	4.11	3.49	3.95	3.07	3.83	4.00	F(1.354)=.249
	-	(.83)	(1.05)	(1.27)	(1.16)	(.24)	-	
Behavioral Intention	-	4.15	3.57	3.71	2.82	3.88	4.13	F(1.616)=.163
	-	(.64)	(1.07)	(.83)	(1.10)	(.17)	-	
Quality of Internet	-	3.74	2.81	2.98	2.21	2.56	2.88	F(1.153)=.338
	-	(3.62)	(.85)	(.85)	(1.10)	(.09)	-	

Table 5.11: Mean Scores (and standard deviations) for measured variables across gender

Variables	**Male**	**Female**	**ANOVA**
Perceived Usefulness	3.56	3.76	F(1.226)=.271
	(.93)	(.85)	
Perceived Ease of Use	3.79	3.72	F(.167)=.684
	(.91)	(.96)	
User Satisfaction	3.61	3.77	F(.686)=.409
	(.98)	(.95)	
Personal Experience	3.55	3.76	F(.823)=.366
	(1.06)	(1.18)	
Behavioral Intention	3.65	3.58	F(.105)=.746
	(.96)	(1.05)	
Quality of Internet	3.15	2.55	F(5.021)=.027
	(1.57)	(.88)	

Table 5.12: Mean Scores (and standard deviations) for measured variables across different education levels

Variables	Primary	Secondary	Tertiary	ANOVA
Perceived Usefulness	2.13	3.44	3.74	F(4.167)=.018
	(1.12)	(1.05)	(.80)	
Perceived Ease of Use	2.10	3.63	3.84	F(3.945)=.023
	(.14)	(1.22)	(.79)	
User Satisfaction	2.00	3.48	1.00	F(4.164)=.018
	(1.41)	(1.30)	(.27)	
Personal Experience	2.25	3.67	3.67	F(1.628)=.202
	(1.77)	(1.66)	(.85)	
Behavioral Intention	2.06	3.29	1.06	F(4.835)=.010
	(1.50)	(1.21)	(.25)	
Quality of Internet	2.44	3.11	2.84	F(.474)=.624
	(1.33)	(2.31)	(.89)	

Chapter 6: Conclusion

The aim of this research project is to evaluate and assess the different factors and condition that can have an impact on the perceived ease of use (PEOU), perceived usefulness (PU), attitudes towards using (ATT), behavioural intention (BI) to use and actual use (AU) of smart city technologies. The findings of this study have shown that there is indeed a relationship between those variables and hence support the initial hypothesis.

As expected, a strong positive correlation was observed which supported the study by Franco and Roldan (2005) that the relationship between perceived usefulness and behavioural intention was strong among goal-directed users. Therefore, the more users will perceive the Smart App to be useful, the more they will have the intention of using it again. Furthermore, users will be more satisfied with the app if they find it more useful. This statement has been well supported by the results of this study which has shown a very strong positive correlation between perceived usefulness and user satisfaction.Lack of user acceptance is a significant impediment to the success of new information systems (Gould et al; Nickerson). In fact, users are often unwilling to use information systems which, if used, would result in impressive performance gains (e.g., Alavi Henderson; Swanson, 1988). Therefore, user acceptance has been viewed as the pivotal factor in determining the success or failure of any information system project (DAVIS, 1993).

SUMMARY OF WORK COMPLETED

The aim and objectives set for this research work as mentioned in the introductory section were met to a high extent. The quantitative approach with descriptive statistics and the different user acceptance models adopted following an extensive literature review have produced expected results. Moreover, the mobile apps developed specifically for this study have been core for data collection.

PROBLEMS ENCOUNTERED BY PI

No major problems just to mention 2 issues

Difficulty in finding an appropriate research assistant on time

Communications delays with the university finance dept.

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