INVESTIGATING THE FACTORS AFFECTING SMART TRANSPORTATION MOBILE APPLICATIONS ADOPTION IN THE SULTANATE OF OMAN

A thesis submitted for the degree of Doctor of Philosophy

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May 2023

ABSTRACT

The transportation condition in developing countries generally and in Oman particularly is characterized by inadequate public transportation, Inefficient transportation modes and Limited access to clean transportation. This condition has resulted in profound challenges in the transportation sector. One of the leading transportation problems that have existed for a long time is traffic congestion. This further caused an increment in the travelling costs, waiting time for passengers, and late arrivals for work, schools, and businesses. Also, most of the central areas in cities face a high demand for parking slots in which drivers spend a reasonable amount of time searching for parking space which can be compensated by money. Moreover, transportation decisions directly influence land use by reducing open areas such as parks and wildlife. The implementation of the new smart transportation technologies, including smart mobile applications, in addressing these urban transportation challenges through offering better traffic management, enabling automatic fee collections, ensuring safe driving, reducing trips via private cars, and providing cost-effective and simply accessible flexible transportation modes contributes to enhancing the cities' ecological condition, presenting a healthier style of living.

Smart transportation services and smart mobile applications implementation involves troves of smart technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), and big data. Therefore, the public adoption and acceptance of smart services and smart mobile applications in smart transportation are vital to reduce congested traffic and improve quality of life. Yet, most of these services and applications are relatively new, with limited data exploring the extent of end user's acceptance of smart city services, especially in developing countries. Therefore, this thesis explored factors affecting citizens' acceptance of smart transportation mobile applications in Oman to enhance the successful implementation of these smart applications.

The majority of technology acceptance models have been developed and evaluated in developed countries. It would be imprudent to assume that these frameworks can be universally applicable among all nations, particularly in developing countries. Therefore, the latest UTAUT2 model was used to develop a model which was further extended and expanded in two ways to better address the developing nation context such as Oman. Firstly, an in-depth literature review on the smart city, smart transportation and technology acceptance studies revealed two new constructs: trust and satisfaction. Later, interviews with the smart transportation services providers also introduced two unique variables: awareness and former practice. A quantitative study was conducted on 383 Omani citizens for model validation.

The finding indicates that only social influence, habit, and former practice directly influence Omani citizens' behavioural intentions to adopt smart transportation mobile applications in the Omani context. The results represent a valuable contribution and a sign of progress for the

literature on Information Technology acceptance, smart cities, and smart transportation. Also, provide recommendations for smart city services providers to improve the acceptance of smart transportation mobile applications.

DEDICATION

I dedicate this accomplishment to God, to whom all glory shall always belong, for granting me with patience, wellness, and motivation to complete this thesis.

(َ رَبِّ أَوْزِعْنِي أَنْ أَشْكُرَ نِعْمَتَكَ الَّتِي أَنْعَمْتَ عَلَيَّ وَعَلَى وَالِدَيَّ وَأَنْ أَعْمَلَ صَالِحًا تَرْضَاهُ وَأَدْخِلْنِي بِرَحْمَتِكَ فِي عِبَادِكَ الصَّالِحِينَ
(١٩))

ACKNOWLEDGEMENTS

I am forever grateful to God for assisting me in accomplishing my thesis. Throughout the extensive and challenging times, I often felt doubtful of myself. However, every time I turned to God in prayer, I felt clarity and serenity that helped me keep going. Completing this thesis would not have been possible without God's guidance and assistance. I also want to express my heartful thanks to a group of people whom God has placed in my path as a support and aid throughout my PhD journey. These people were instrumental in the successful completion of this PhD thesis.

- First and foremost, I want to express my sincere gratitude to my supervisor, Professor George Ghinea, for the time and effort he has invested in me. His invaluable expertise, tremendous support, constructive comments, and encouragement kept me motivated throughout the research process. I feel grateful for having been supervised by a highly experienced supervisor not only in my research field but also professional in handling difficult times by being flexible and open to all possible solutions.
- I would like to thank the Ministry of Higher Education in the Sultanate of Oman for providing me with a scholarship to pursue my study. It is an excellent honour to be chosen as one of the recipients of this privilege.
- My deepest gratitude, appreciation, and love to my sons Abdullah and Turki for cheering me on and encouraging me to keep going. I am grateful for their sacrifices by leaving their school, friends, and life behind to join me in the United Kingdom to help me achieve my dreams. I would also like to express my gratitude to my beloved daughter, Meera, who was born during my doctoral journey. Her arrival brought immense joy and motivation to my life, and I am forever indebted to her for being a constant source of inspiration throughout my study Journey. I would like to thank her patience and understanding when I was busy for long hours. I promise that the future will be better with the help of God.
- I am grateful for my soulmate and loving husband, who constantly showers me with affection, tenderness, and support. Thanks to him for the endless inspiration, help and crucial support in looking after our children while I was focused on my study. His tolerance in listening to my continuous complaints about my research challenges and the guidance and suggestions had lightened my way. I am genuinely privileged to have him as my partner in life, and I will always be thankful for his sacrifices and dedication to our shared goals. His love and support mean everything to me, and I will be eternally grateful for everything he did.
- I would like to express my gratitude to my family for their unwavering love, support, and prayers which aided and facilitated this achievement. I extend my deepest

gratitude to my parents, Maryam AlBulushi and Abdullah Al Bulushi, whose guidance and encouragement have been crucial in my attainment of the doctoral degree. I am also thankful to my brothers, Fathi, Ahmed, Marwan, and Muhammed, for their constant encouragement, assistance, and thoughtfulness. Furthermore, I give special thanks to my sisters, Shaima, Balqees, Kawther, and Rayan, for their endless inspiration, aid, and support.

- I am also thankful to my best friend, Fatima, for being such an amazing friend. She has been there for me through thick and thin, always offering a listening ear, a shoulder to cry on, and words of encouragement when I needed them the most. Whether we are laughing together or sharing our deepest fears and dreams, I know that I can always count on her to be there for me.

DECLARATION

The following is the list of accepted/submitted publications resulting from the thesis:

- Al Bulushi, H.A. and G Ghinea. (2023) “Transportation mobile applications in the smart city era: An empirical study of important adoption factors among Omani citizens”, *IET Smart Cities* (Submitted).

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LIST OF ABBREVIATIONS

Information and communication technology	**ICT**
Internet of Things	**IoT**
Artificial Intelligence	**AI**
Unified Theory of Acceptance and Use of Technology2	**UTAUT2**
Chief Information Officers	**CIOs**
Carbon dioxide	**CO2**
Road Transport Authority	**RTA**
kilometres	**Km**
Electricity and Water Authority	**DEWA**
Global Positioning System	**GPS**
Radio Frequency Identification	**RFID**
The Theory of Reasoned Action	**TRA**
Theory of Planned Behaviour	**TPB**
Technology Acceptance Model	**TAM**
Technology Acceptance Model 2	**TAM2**
Diffusion of Innovation theory	**DOI**
Unified Theory of Acceptance and Use of Technology	**UTAUT**
Habit	**HB**
Social Influence	**SI**
Behavioural Intention	**BI**
Price Value	**PV**
Facilitating Conditions	**FC**
Effort Expectancy	**EE**
Performance Expectancy	**PE**
Structural equation modelling	**SEM**
Effect Size	**f2**
Heterotrait-Monotrait	**HTMT**
Variance Inflation Factor	**VIF**
The coefficient of determination	**R^2**
Predictive Relevance	**Q2**
Model of PC Utilisation	**MPCU**

Chapter 1: Introduction

1.1 Smart City Background

Throughout history, most of the world's population has lived in villages, rural areas and small towns, yet during the last few decades, the share of people living in towns has grown at an accelerated pace (Li, Westlund and Liu, 2019; Peter and Yang, 2019). This movement from rural areas to cities is increasing for many reasons; for example, cities are the focal points of countries' economic activities; thus, they provide valuable opportunities for their residents to live, develop, and learn (Monzon, 2015). The United Nations declared that 55% of the world's population lives in cities, which is expected to increase to nearly 68% by 2050 (United Nations, 2018). As a result of this movement, urbanisation is declared as a global trend fuelled by this shift from rural areas to cities.

On the other hand, this urbanisation has generated a wide range of urban problems, such as serious environmental effects, social divides, conflicts, pressures on cities' natural resources, traffic congestion, waste management challenges, and high energy demand. To tackle these problems properly, cities are encouraged to take a thoughtful reaction. In other words, cities must address these urban challenges to achieve the ultimate goal of providing an appropriate quality of life for their citizens (Broere, 2016). Today, the market is experiencing rapid development in the field of information and communication technology (ICT), and therefore for most urban cities, technology has become one of the major solutions for saving resources and enabling a better quality of life (Bifulco *et al.*, 2016). For instance, different cities have started implementing ICT technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), big data and many other technologies in promoting smart solutions to address their cities' urban problems (Al Nuaimi *et al.*, 2015; Albino, Berardi and Dangelico, 2015; Medina, Perez and Trujillo, 2017; Angelidou *et al.*, 2018). Cities involved in this revolution are usually labelled as smart cities (Chourabi *et al.*, 2012). Both industrial partners and academic researchers have considered a smart city concept as an ideal solution to bring positive inputs to address the different urban challenges and encourage saving cities' natural resources (Vanolo, 2014). A smart city improves not only citizens' quality of life but also the administrative tasks to cope with the complexity of the urbanisation challenges (Lee, Phaal and Lee, 2013). It involves various attractive outcomes for governments, citizens, and companies (Bakici, Almirall and Wareham, 2013) and contributes to optimising cities by making them more integrated and liveable, lowering their living cost, supporting more interactive and responsive administration, besides enhancing their economic growth through unprecedented windows of business opportunities (Medina, Perez and Trujillo, 2017).

However, the smart city concept lacks a consensual definition, and its dimensions and factors are yet to be formalised (Monzón *et al.*, 2015). Accordingly, different definitions are emerging based on the cities' desire for change, their resources availability, the level of city readiness and the perceptions of their inhabitants (Myeong, Jung and Lee, 2018). However, a general definition of a smart city is stated by Patel and Parmar (2022, p.2) as a *"municipality that uses information and communication technologies to increase operational efficiency, share information with the public, and improve both the quality of government services and citizen welfare"*. All definitions associated with smart cities agree on three basic dimensions: technology (wired city, Intelligent city and information city), institutional components (smart community) and human (creative city, knowledge city) (Nam and Pardo, 2011). Currently, different cities have adopted the smart city concept to address their urban challenges of reducing pollution, conserving their natural resources, and improving their health and transport services. This high demand for smart cities increased the academics, companies and government's attention to the smart cities concept, and different efforts have been introduced to mitigate the failure and loss efforts.

1.2 Research Motivation

Many studies consider a smart city concept implementation as an opportunity and a solution to address their urbanisation challenges and meet the needs of their citizens (Monzon, 2015; Boykova, Ilina and Salazkin, 2016; Jeyun Yang, Youngsang and Daehwan, 2020). Therefore, the number of cities labelled as smart cities is growing sharply in both developed and undeveloped countries. Joss *et al.* (2019) mentioned that around 5,553 cities from different continents are branded as smart cities. Smart city has been adopted extensively by governments, private companies, non-governmental agencies, business and academics as a new direction and essential component of the city's strategic planning (Nam and Pardo, 2011b). With regard to the Gulf region, different initiatives and projects have been established, such as Lusail in Qatar, Masdar in the United Arab Emirates, and King Abdullah Economic City in Kingdom of Saudi Arabia (Doherty, 2014). Despite this high demand, the smart city concept has faced multiple contradictory views since it emerged to date. For instance, the smart city is accused of being a fuzzy idea (Caragliu, del Bo and Nijkamp, 2013). Its dimensions and understanding are still evolving and developing. In other words, smart city dimensions and factors are not fixed but are growing over time as more elements are added to the concept (Kogan and Lee, 2014). Moreover, there is no specific definition of the smart city, and its definition depends on different factors such as the economic level and the political rules of each city (Myeong, Jung and Lee, 2018). Furthermore, researchers are doubting the forces behind the smart city projects and wondering if it is really helping to solve urban problems or if they are just another form of a fashionable brand city (Yigitcanlar, 2015).

Therefore, many smart city projects have failed in different countries, causing unwanted consequences (Praharaj, Han and Hawken, 2018). For instance, Santander in Spain, Lavasa in India, Ordos in China and Plan IT Valley in Portugal are a few samples of smart city projects which have failed to meet their promise. According to Elgazzar and El-Gazzar (2017), Masdar City in Abu Dhabi was built not only as a green city but also as one of the most luxurious cities in the world, yet it failed to contribute to the economic prosperity of the city. A lack of funding and an inappropriate transportation system, which misses the proper connection with vital points needed by the Masdar smart city's residents, are among the many reasons behind its failure. Therefore, it is currently empty except for a few university students, and project workers. Some smart cities worldwide have also failed to attract citizens to live in them, and instead, they have been remarked as ghost cities (Lehtinen, 2017; Cooke, 2021). Similarly, smart city projects have faced numerous failures in China (Liu and Peng, 2013). The failure of many smart city projects in different parts of the world requires further investigation to understand the factors behind their failure.

Accordingly, many researchers conducted studies to understand the dimensions and nature of the smart city, and their outputs have varied from frameworks, and models to assessment indices and form definitions. For example, Boyd Cohen's Smart city wheel, developed by Cohen, (2012), provides a guideline for cities to go easy in their transformation process. Giffinger and Pichler-Milanović (2007), developed the European smart city ranking model, which is among the most quoted and adopted models in smart city research. Nam and Pardo (2011) have explored the conceptual approach of smart cities, demonstrating three main dimensions: technology, people, and institution. Besides, as smart city implementation involves troves of smart technologies used in delivering smart services in various sectors such as governance, administration, health, environment and transportation, a wide range of studies were conducted to investigate the technical issues associated with smart cities implementations such as (Cohen and Money, 2017; Jo *et al.*, 2019; Lai *et al.*, 2020). As smart cities are designed by the adoption of highly advanced technologies, their prosperity is mainly depending on the involvement of the end public as potential end users of these smart services (Peng, Nunes and Zheng, 2017). A user-friendly, embedded, and easily adopted technology is important throughout implementing new innovations (Baig, Gholam Hosseini and Connolly, 2015). Yet, the failure of smart transportation projects involves reasons more than technical issues, and the citizens' involvement should not only focus on exploring the technical issues alone.

By reviewing lessons learnt from existing smart cities, it can be observed that there is a set of non-technical barriers to smart cities' acceptance and adoption (Yigitcanlar and Velibeyoglu, 2008). In the smart cities context, non-technical factors related to end users' implementation are considered the most critical barrier to their adoption (Nam and Pardo, 2011a; Balakrishna, 2012; Chourabi *et al.*, 2012; Wu *et al.*, 2018). A more accurate investigation of the smart city revealed that investigations on challenges to citizens' perceptions of smart city projects are essential to support practitioners to successfully implement them (Chourabi *et al.*, 2012). Obtaining the advantages of smart cities relies mainly on their end user's usage, and most of the economic and environmental advantages can only be gained after their daily usage. This is especially important given that people are the most important aspect of the smart city project implementation process. Therefore their attitudes, perceptions and experiences become critical in solving the contemporary issues of smart cities (Visvizi, Mazzucelli and Lytras, 2017; Lytras and Visvizi, 2018). Besides, smart city implementation involves substantial investments, a proper understanding of the factors influencing the interactions with these solutions and active utilisation of these solutions by end users, necessitating a serious investigation of citizens' behaviours. Otherwise, investments in smart city solutions will become ineffective and inefficient. Yet, most smart cities' services and applications are relatively new, and a very limited amount of research focuses on exploring the extent of end users' acceptance of such services. Very few investigated the human side of smart cities, including citizens' acceptance and adoption of smart transportation services and applications.

According to Lara et al. (2016), cities need to pay special attention to their citizens' needs besides understanding their requirements while designing and adopting smart technologies to ensure smart cities' sustainable development. Thus, the absence of end-user engagement has been reported as one of the main reasons behind information system projects and services failure (Kappelman and McLean, 1994; Ferneley and Sobreperez, 2006; Claussen, Kretschmer and Mayrhofer, 2013). Putting end-users at the core of their work as policymakers is critical for smart city project implementations to succeed (Praharaj, Han and Hawken, 2017). Indeed, Simonofski et al. (2019) pointed out that the inadequacy of citizen engagement has led to many smart city projects not achieving their objectives. For instance, Chinese smart cities have failed to encourage people to adopt the new smart services because it missed considering their citizens' needs, and instead, they rely on "*the technology-centric and top-down features*" perception, which ignores understanding of how to promote the acceptance (Liao and Chen, 2022, p. 9). Thus, most smart cities' experiences reveal the importance of the citizen's role in successfully implementing the smart services (Dameri and Rosenthal-sabroux, 2014; Yeh, 2017; Al-Musawi *et al.*, 2021; Wirtz, Becker and Schmidt, 2021). However, most of the current smart city practices are implemented without the involvement of citizens (Sweeting *et al.*, 2022). Implementing the most advanced technologies and initiation of smart cities is mainly to ease the lives of citizens (Yamamura, Fan and Suzuki, 2017). The concept of a smart city is mainly presented to create an innovative life and support people's potential (Preston, Mazhar and Bull, 2020). Hence, most researchers say that smart cities should involve citizens and people as they are the aim and the end users (Nam and Pardo, 2011a).

Despite the relatively few studies on the factors influencing the acceptance and successful implementation of smart cities, most lack a comprehensive view of the factors needed by the different city's stakeholders to depend on while building smart cities to avoid failure. Today the smart city has become a common practice worldwide, and city planners and decision-makers must consider its requirements and guidelines before undertaking any urban expansion (Neirotti *et al.*, 2014). Thus, it is important to involve the perceptions of both service providers and citizens to facilitate the successful implementation of smart transportation services. A study conducted in Tehran found that the lack of coordination and cooperation between different stakeholders is one of the main issues in adopting the intelligent smart transportation (Behruz *et al.*, 2013). Opening a bridge between end users and smart transportation services providers helps in understanding their perceptions and enhances the acceptance and transformation processes of the smart city services (Pelau, Dabija and Ene, 2021). Thus, cooperation between stakeholders is essential for successfully implementing smart city projects. In particular, this involves citizens' participation in supporting these projects since citizens are the end users of their services. On the other hand, service providers play a crucial role in designing appropriate activities that enable collaboration, cooperation, and partnering with different parties and engage citizens to participate in the project (Granier and Kudo, 2016). Nam and Pardo (2011) argued that organisations could be also considered as one of the main barriers to successful implementation, and accordingly, it is vital to explore their perceptions and strategic plans and how they are planning to encourage citizens' acceptance. Service providers must collaborate, engage citizens, and ensure their involvement in smart city projects. Thus, in order to ensure smart city services acceptance, it is important to make their end users fully aware of the availability and benefits gained, as well as ensure their abilities and willingness to use smart city services. It is useful to enable a communication channel among stockholders to construct an acceptance model designed for the context of the smart services besides enhancing the successful implementation of smart services.

In light of the above discussion, it can be noticed that a smart city is a complicated concept; therefore, conducting research on smart city services acceptance is very important. It is known that the end user's acceptance is not an automatic process. Consequently, many scientists and researchers investigated the acceptance of new technologies in different contexts as it contributes to better design and reduces the chance of failure. A range of information technologies acceptance models is available, which are discussed in detail in chapter 3. Each model consists of different elements affecting acceptance. Moreover, each model has its own strengths and weaknesses, and each has been designed for particular contexts. Accordingly, each has its own limitation when implemented in different settings. As these acceptance models have been shown to be very powerful in different contexts, it can be argued that some of the factors within these models may also influence the acceptance of smart city services and applications. Yet, most of the publications in the field of Information Communication Technologies (ICT) are related to the developed countries' experiences (Odendaal, 2003). Agbali (2019), stated that despite the growing number of smart city projects aiming to overcome urban problems, there is a scarcity in the number of studies on building appropriate smart city frameworks to assist their acceptance in developing countries. For example, a smart city might represent a different meaning in Oman than in any other country. Simply adopting the models based on developed countries may cause many problems. For example, the social differences between developed and some specific developing countries, such as Oman, may result in various contextual factors needing to be incorporated (Mütterlein and Hess, 2017). Surprisingly, little attention has been paid to the local contextual components and circumstances (Sepasgozar et al., 2019). A clear understanding of the factors influencing citizens' acceptance is critical to promote the acceptance of smart transportation services in Oman both now and in the future. Therefore, this study will investigate the different influences that affect the successful adoption of smart transportation services and applications in the Omani context. Studying local factors influencing the success of smart cities is an essential and effective approach to helping city planners to initiate smart city applications successfully and minimise the probability of rejection (Sepasgozar et al., 2019). A smart city includes different elements, and each element's value varies from one city to another based on the city's priorities, goals, conditions and context (Giffinger and Gudrun, 2010). In other words, smartness is applied to specific aspects within each city based on the problems considered most critical to be solved in each city. According to Hayat (2016) and Park and Yoo (2023), the term smart city varies from one city to another and from one country to a country based on the citizens, resources availability, readiness to change, and the dominant problems the city faces. Accordingly, one of the main motivations behind conducting the current investigation is designing an acceptance model identifying the key factors enhancing citizens' acceptance of the smart cities' services and exploring other contextual factors in the Omani context. It aims to synthesize the different factors influencing the acceptance of smart cities by exploring and incorporating perceptions of service providers and citizens to provide a generic view of these factors and investigate potential missing factors to promote smart city project acceptance.

This research, in particular, focuses on one of the main smart cities' services under the smart city umbrella, namely smart transportation services and applications. Many researchers have investigated the transportation challenges and shown that traffic congestions, car accidents and air pollution are common in most cities all over the world (Thompson and Bonsall, 1997; Olayode *et al.*, 2020; Rocha Filho *et al.*, 2020; Mohammadi *et al.*, 2022). Transportation is a serious issue worldwide, and the problem is becoming more critical in developing countries where traffic congestions and car accidents are higher due to the rapid increment in the adoption of private vehicles (Djalalov, 2013; Greene, 2022). As regards The Sultanate of Oman, similar to the other Gulf countries, has initiated different smart city projects in order to solve the urban challenges the country is facing (Maksood and Achuthan, 2017). According to Al Maqbali and Refeque (2017), the transportation sector in Oman is poor, and it is facing an increase in traffic congestion due to poor traffic management. Transportation is one of the main urban challenges facing the Omani government, and therefore different solutions are proposed by different parties to offer smart solutions for the transportation sector in Oman. However, most of the current Omani smart projects are implemented while the city planners are missing a clear understating of how to achieve the goal successfully. Moreover, when talking about smart transportation services and applications, like all other smart services, they face the challenge of a low adoption rate and sometimes rejection. According to Mabry (2018), in Oman, it is critical to develop smart transportation services and activities based on citizens' needs and preferences to encourage a greater acceptance of smart transportation services by making them attractive services. Besides, in most cases, information is transmitted between the Omani government and the people via a top-down approach. Thus, most projects, including smart city projects, implement this approach too. This approach leads to difficulty in understanding and communicating between citizens and the government. In addition, this approach will complicate the issue of understanding and encouraging citizens to accept smart transportation services.

Based on the above discussion, it is important to build a framework facilitating the acceptance to enhance the design and implementation of smart transportation services and applications by formulating clear guidelines in any specific context (Oman, in this case). The success and failure of smart city implementations are strongly related to the extent of understanding the different factors involved in the processes of constructing smart cities (Kansal and Singhal, 2017). According to Lin et al. (2011), end users' acceptance of modern technologies and their awareness and engagement has become one of the main concerns the researchers are motivated to explore. Notably, citizens' involvement and engagement are considered one of the main elements behind the failure of new smart cities (Kogan and Lee, 2014). However, the issue of citizens' engagement, involvement and adoption in the process of acceptance of the smart environment has not yet been adequately investigated (Nikki Han and Kim, 2021).

In the absence of understanding of the local needs and factors related to the Omani context, there is a strong need to develop a local framework to effectively design smart transportation services and applications in Oman by addressing the factors influencing acceptance while also considering the perceptions of the Omani population of smart city as well as the perception of the services providers. Accordingly, a clear understanding of citizens’ acceptance is essential for all parties to ensure the successful design and implementation of smart transportation services in Oman. Thus, this research promotes an understanding of the Omani population’s perspectives by digging down on the perceptions of the smart city among Omani citizens and accommodating it in the built framework. The study will also open a bridge between the end users and the smart transportation services providers, helping explore their perceptions and enhancing the acceptance and transformation processes of smart city applications (Bakici, Almirall and Wareham, 2013). Such development of a framework based on both services providers' and citizens' perceptions will spread awareness among citizens and city planners, helping investors and the decision makers to accommodate the different elements, concerns and acceptance factors while planning smart city projects in Oman.

This study on the acceptance of smart transportation mobile applications in Oman is targeting to contribute to the field by developing successful projects by exploring the main factors enhancing the accepted of these services by their end users. Therefore, this research will explore the acceptance and extensively analyse it to specify the main factors influencing citizens' acceptance of smart city services, especially in developing countries. Since the motivations and the challenges vary from one city to another, there is a strong incentive to investigate the Omani context and build an acceptance framework of the factors influencing citizens' acceptance in the Omani context to enhance the success of such projects within Oman. To address this issue, this research will investigate smart transportation mobile applications' acceptance and adoption in an Omani context to address the main factors influencing the adoption of smart transportation applications.

1.3 Research Questions

The study aims to identify the contextual factors influencing Omani citizens' acceptance of smart transportation mobile applications from both the services providers' and citizens' perceptions. Therefore, to address the aims of the research, the following research questions are formulated:

RQ 1: What are smart transportation service providers' beliefs and perceptions regarding the contextual and main factors affecting the acceptance and adoption of smart transportation mobile applications among Omani citizens?

RQ 2: What are the factors that actually affect citizens' acceptance of smart transportation mobile applications?

RQ 3: What should be done to improve and facilitate the acceptance of smart transportation mobile applications among Omani citizens?

1.4 Research Aims and Objectives

Based on the problems and the needs outlined in the previous sections, this research will first explore the factors influencing citizens' acceptance of smart transportation mobile applications in a developing country such as Oman. It also digs into the missing factors from the literature to have a reflective list of acceptance factors to avoid citizens' resistance to adopting smart transportation mobile applications in developing countries, generally and specifically in the Sultanate of Oman. A theoretical framework will be built by combining the UTAUT2 model's traditional factors along with other factors explored from the literature of the various technology acceptance models. Subsequently, the research aims to align the model constructed with the smart transportation services providers' perceptions to build a model to accept smart transportation mobile applications suitable for the Omani context. This stage involves exploring Omani smart transportation service providers' understanding and experiences with facilitating the acceptance of smart transportation mobile applications by Omani citizens. It also involves revising the proposed theoretical model by involving new influencers generated from analysing the service providers' interviews. Finally, the Omani citizens will further approve the proposed model through a questionnaire distributed online. The model will be further modified based on comparing the perceptions of both service providers and Omani citizens of the proposed acceptance factors. This ensures the successful implementation of the Omani smart transportation mobile applications projects. To achieve this aim, the following objectives are formed:

- To undertake a comprehensive and detailed literature review of smart city and smart transportation concepts in order to identify different components and factors influencing citizens' acceptance of smart transportation mobile applications.
- To conduct a review of the technology acceptance models to decide on the best model suiting the context of the current research to explore the smart transportation mobile applications acceptance in the Omani context.
- To explore smart transportation services providers’ perceptions about the key factors influencing smart transportation mobile applications acceptance in the Omani context.
- To explore the Omani citizens’ perceptions of the factors influencing their acceptance of smart transportation mobile applications.
- To identify the similarities and differences between the Omani citizens’ and the services providers’ perceptions of the main and contextual factors influencing Omani citizens' acceptance of the smart transportation mobile applications in Oman.
- To construct a framework for the acceptance of smart transportation mobile applications in the context of Oman.
- To propose recommendations for the services providers and city’ authorities to assist them in improving the acceptance and adoption of smart transportation mobile applications among Omani citizens in Oman.

1.5 Research Overview

This research is organised into nine chapters, and an explanation of each chapter is provided below:

- **Chapter 1: Introduction**

This is the first chapter of the research and contains information about the background of the study. It also explains the research needs and the motivation for conducting the study. This is followed by stating the research questions, goals, and objectives. Finally, an overview of each chapter is presented.

- **Chapter 2: Literature Review**

This chapter provides an in-depth literature review to build a sufficient understanding of the smart city concept in general and smart transportation in particular. This chapter reviews the definitions of a smart city, its dimensions and smart transportation dimensions. It also discusses the smart cities’ motivations, barriers, examples, and advantages. It will explore various smart city’ frameworks. It will also discuss the role of citizens' involvement in enhancing acceptance and adoption.

- **Chapter 3: Theoretical Framework Development**

This chapter introduces an in-depth review of the technology acceptance models. The chapter starts by exploring the acceptance concept and revising each technology acceptance model's strengths and weaknesses. A detailed explanation of the reasons behind adopting the UTAUT2 model is provided, besides providing an introduction to each construct of the UTAUT2 model. It also briefly explains the new factors extracted from the review of the acceptance studies generally and smart cities acceptance studies, particularly used to augment the proposed model.

- **Chapter 4: Context of the Study**

This chapter introduces the Omani context background in general and the smart cities and smart transportation situation in Oman to explain the rationality of the study context. It includes a description of the need to implement smart projects and smart transportation in Oman. It also offers a view of Oman's smart transportation services and applications. It introduces examples of smart transportation mobile applications implemented in Oman.

- **Chapter 5: Research Methodology**

This chapter includes validation and reasoning of different research methods and techniques used to address the research questions. Moreover, it also explains the approaches used for the data collection and analysis. It also provides an overview of the reliability and validity techniques used for the current research. At the end of this chapter, a research design is produced to be followed to answer the research questions.

- **Chapter 6: Qualitative Study Analysis and Findings**

This chapter analyses the data collected from smart transportation service providers. The service providers' perceptions will be collected through semi-structured interviews. A thematic analysis will be adopted in analysing the interviews. A concept map visualising the main themes and subthemes will be generated from the analysis. This chapter will modify the proposed model based on the service providers' perceptions. The findings of this chapter will also contribute to the development of the research's hypothesises, which ground the base of the quantitative phase.

- **Chapter 7: Quantitative Study Analysis and Findings**

This chapter explains in detail the results of the data collected via the survey and provides the final granted acceptance factors deemed to be more suitable for the Omani context. This chapter presents the various quantitative tests implemented to accept or reject the proposed research hypotheses from the previous stage.

- **Chapter 8: Discussion**

This chapter provides an extensive discussion of the findings of both methods from the previous two chapters to identify the primary and contextual factors enhancing the acceptance of smart transportation mobile applications in the Omani context. It relates the findings from the services providers' interviews and citizens' surveys with the existing literature review. It also compares stakeholders' perceptions to build the final comprehensive and customised acceptance model to the Omani context to better facilitate the Omani citizens' acceptance of the smart transportation mobile applications.

- **Chapter 9: Recommendation and Conclusion**

In this chapter, answers to the different research questions are presented. This chapter ends the research narrative as it discusses the thesis's contribution. It also explains the findings and outcomes of the research. This chapter provides a conclusion of the investigation while also admitting the different limitations of the current study. Recommendations for enhancing the acceptance of smart transportation mobile applications in Oman will be discussed. Finally, it provides suggestions and ideas for future work.

1.6 Summary

The above chapter explains the importance of the current research and the need to conduct it. A discussion of the key research components, such as research motivation, questions, aims, and objectives, has been presented. The overview of the research chapters is also specified to give the reader a clear view of the research.

Chapter 2: Literature Review

2.1 Introduction

The literature review demonstrates knowledge and awareness of the studies in a particular field, enhancing the researcher's theoretical and practical understanding before conducting new research. It is neither possible nor acceptable to explore all prior studies. Therefore, choices must be taken to involve the most relevant literature to the ongoing research and its aim and objectives. With this in mind, the literature investigation was based on a better understanding of the challenges, influencers, factors, and obstacles of the smart transportation mobile applications to enhance better adoption and acceptance of them.
Thus, in the case of this particular endeavour, the research starts by exploring literature related to smart city concept definitions, its dimensions, its motivations, its implementation challenges, and examples of its initiatives from different regions around the world. Later, the thesis focuses on the smart transportation domain as one of the most demanding domains in many countries besides being the primary domain of the current study. An exploration of the smart transportation systems and solutions is presented, administrating issues related to their implementation. As highlighted in the previous chapter, to achieve effective and smooth acceptance of smart transportation services, a clear understanding of the end users' perceptions is needed to be explored. Therefore, citizens' involvement and engagement in smart city constructions are also explored as organisations need to investigate their users' needs and understand their perceptions to increase fulfilling their needs and accordingly improve their adoption level. This process will build the researcher's understanding and knowledge in the field and enhance her ability for critical thinking. As a result, this chapter will review the literature on smart cities, smart transportation, and citizens' involvement to highlight the research problem and reveal the most critical factors shaping citizens' acceptance of smart transportation mobile applications in the Omani context.

2.2 Conceptualisation of Smart City

2.2.1 Smart City Definitions

Different definitions have been introduced for the smart city in different contexts. According to Allahar (2020), there is neither a single method to construct a smart city, nor one common definition that suits all. Similarly, Lara *et al.* 2016 and Esposito *et al.* 2021 argued that the smart city term is fuzzy and reflects meanings that are not always constant. This indicates that there is no one-size-fits-all definition. Despite the extensive moves toward building smart cities, there is no official agreed definition for the smart city, and the identification and issues related to its strategic planning are still an ongoing process (Margarita Angelidou 2015). Various definitions of the term are generated by different academic researchers, community groups, governments, and commercial agencies (Albino, Berardi, and Dangelico 2015b; Gil-Garcia, Pardo, and Nam 2015). Accordingly, it is recognised that since the concept of a smart city is still evolving, there is thus no universally accepted definition, and the issue of defining it is not a matter of agreement. The following paragraphs discuss the different smart city definitions developed by authors in different research contexts. The objective is to compare the various definitions to reveal a range of smart city characteristics to identify a comprehensive view of the dimensions and elements of smart cities which might work as influencer factors in smart transportation mobile acceptances. Table 1.1 in (Appendix A) gives a brief list of the diverse definitions of the smart city which have been framed through the years.

Despite the various smart city definitions, all existing established definitions assign a dominant aspect: the force of Information and Communication Technologies (ICT) as a main pillar in constructing smart cities. As cities aspire to be smarter, advanced internet connectivity, implementation of the IoT, and adoption of big data concepts are the main elements to make smart cities feasible (Hashem et al. 2016). Harrison et al. (2010) stated that the smart city solves current urban challenges through the utilisation of ICT. Similarly, Toppeta (2010) argued that cities could better face their threats by combining Information Technologies and Web 2.0 technologies with their infrastructures to meet citizens' expectations of better life quality. Further, Arroub *et al.* (2016) reveal that transferring a city to a smart one means adopting different smart technologies from different companies to bring intelligence to the city. Hall *et al.* (2000) conducted a study to protect and better manage cities' natural resources, such as water, green areas, and energy, to build secure and environmentally safe cities. They stressed using technologies such as sensors and computerised systems to produce and process a significant volume of real-time data through various systems to boost operations and inform authorities about emerging problems to enhance informed decisions. They believe that smart cities are mainly built of systems which "sense and act" and firmly insist on protecting natural resources through building such integrated systems. They further highlighted that integrating all related aspects of the city's critical infrastructure leads to building a self-monitoring and self-responding city. Accordingly, smart cities give power to technical solutions and therefore, firms such as Cisco, Siemens and IBM took the opportunity to become the leading companies in providing smart city products and, therefore, indirectly influencing the strategies of the cities (Mcneill 2015). As a result, they have also offered their own definitions of smart cities focusing on their technical products. For example, IBM considered technology and internet connectivity the main elements while building sustainable cities. At the same time, Cisco believes in the abilities of ICT to mitigate urban challenges and foster efficiency (Roche et al. 2012). Thus, there is a strong agreement among all the definitions to include ICT as one of the main pillars to transfer a city into a smart one and improve its abilities.

However, focusing on ICT alone as a focal point fails to address the rest of the aspects and circumstances involved in city life. Building a smart city is more than adapting technological advancement (Barrionuevo, Berrone, and Ricart 2012). Thus, Nam and Pardo (2011) have included people, institutions, and technology in the smart city concept. They further claimed that smart cities are more than just technologically driven, in which social factors are at the centre of them. Therefore, they emphasised the need for a socio-technical view of a smart city. Lindskog (2004) argued that adopting updated technologies does not guarantee the success of smart city initiatives as technology is a way to a smart city but not the end. She claimed that having a well-designed ICT infrastructure is essential; however, smart cities will not be successful without the involvement and collaboration of stakeholders such as organisations, governments, and citizens. Therefore, another set of definitions emerged focusing on human dimensions in smart city construction. For example, Peris-ortiz and Bennett (2017) define a smart city as a city that invests in its human and social capital to engage them in the city government to support economic growth and improve the quality of life. Similarly, Giffinger and Gudrun (2010) stated that a combination of determined, independent and aware citizens, is the key factor in building a productive smart city. In related work, Cardullo and Kitchin (2019) conducted research in Dublin exploring the level of citizens' involvement to stress the importance of "citizens- centric" prospects in smart city projects. Likewise, Alawadhi et al. (2012) argued that social infrastructure, including smart people and social capital, is essential to the success of any smart city as it allows for building community through connecting people.

Moreover, Caragliu, del Bo and Nijkamp (2011) observed that smart cities constructions depend on a set of fundamental factors, including not only the hard domain, such as the adoption of recent ICT and infrastructure, but also on the soft domain, such as the availability and the quality of knowledge and human capital to define the smart cities agenda. Their research revealed a positive correlation between the different dimensions presented in their definition since the more cities invest in educating their citizens, the more attention they pay to their environmental aspects, and the more ICT diffuses to support public governance and administration tasks, and the more they will positively affect their city's wealth, economy, and the quality of life. Consequently, creativity is a key factor in building smart cities; therefore, education, learning and knowledge are considered crucial factors for smart cities to grow and prosper (Thuzar 2011). Thus, based on this investigation, combining human and technical perspectives in defining the smart city is important rather than focusing on one prospect.

Interestingly it is noted that smart city definitions are built based on the interest of the three different viewpoints: (i) academia, (ii) private and (iii) public institutions, as is noticed from the definitions table (Table 1.1). Most smart cities' definitions are established by academia. The smart city definitions keywords analysis provided in Table 1.1 in appendix A illustrates that the main interest of the academic view is based on the features of smart technologies such as self-sensing, improved governance and self-optimizing (Nam and Pardo 2011a). On the other hand, public agencies' definitions urge the need to switch the attention from the technological point of view to the economic prosperity aspect and the importance of public policies in enhancing smart cities. Their definitions insist on having a set of measurable goals to assist a smart city's projects' performances. Additionally, their main concern is establishing cost-effective smart cities, sufficient, more sustainable processes, partnerships among different stakeholders, and supporting making informed decision-making (Höjer and Wangel 2015; Cardullo and Kitchin 2019; Alawadhi et al. 2012). On the side of private agencies with a business and industrial bias, the city's smartness is defined by demanding the need to adopt recent intelligent technology products, machines and systems (Lea 2017). Moreover, this viewpoint insists on adopting a common strategy among different smart projects and the importance of governance referring to the policies and regulations instead of funding and financial issues (Kulesa and Dirks 2009).

Another set of definitions can be grouped based on the leading features that smart city initiatives were willing to consider. This category of definitions embraces the interconnectivity aspect in real life of a city and believes that boosting one segment of the city does not implicitly solve the whole raft of urban challenges. These definitions are related to the urban challenges promised to be addressed by smart cities. They focus on certain opportunities and challenges or a particular domain of the application (Peralta Abadía et al. 2022; Höjer and Wangel 2015). The smart city concept embraces different ideological dimensions in the city (Qonita and Giyarsih 2023; Ammara et al. 2022; Hajek, Youssef, and Hajkova 2022). For example, many cities are adopting smart concepts to cope with sustainability requirements, enjoying a better quality of life and economic prosperity. As sustainability is considered one of the main targets of smart cities' development, several authors and researchers define smart cities from a sustainability perspective (Ramamurthy and Devadas 2013; Ringenson and Hojer 2016).

A further deeper assessment of the definitions provides exciting and useful variables elements needed to be considered in the execution of prosperous smart cities. For example, the role of governance, social and human capital, infrastructure, connectivity, and partnerships are a few factors extracted from the listed definitions in Appendix A (Zygiaris 2013; Costa and Santos 2016; Simonofski et al. 2019). The review of the smart city literature manifests that two main acknowledged definitions are cited widely by scholars. The first is Giffinger *et al.* (2007), who focused on the smart dimensions in defining the smart city. The second definition is that of Caragliu, del Bo and Nijkamp (2011), who stressed the components of the smart city.

Based on the above discussion, it is clear that there is no single agreed definition for smart cities instead, the definition is still evolving and developing. The various entities involved in smart city construction provide a wide range of definitions which further caused a significant difference among its definitions. Yet, Lai *et al.* (2020) argued that some similarities could be observed among most of the definitions, including the use of advanced technologies to enhance the quality of living, the importance of the integration among the systems to support making informed decisions, the respect of the sustainability and environmental aspects. They further stated that all definitions vary regarding the domain they are concerned about, depending on each country and city's interests.

Accordingly, and based on reviewing the stacks of relevant smart cities definitions, the researcher decided to adopt the following definition as the most suitable for the current investigation:

> *"A city based on the adoption and integration of smart technologies to provide real information that contributes to improving the city's sustainability in addition to enhancing economic, health, energy, education and transportation sectors and providing smart services contributing to improving its citizens' quality of life".*

2.2.2 The Motivations of Smart Cities

The motive for smart city application varies from one city to another depending on the city's geographic environment, goals, urban challenges, ecosystem and resource availability (Hayat 2016). However, some common reasons have been identified in the literature and considered the main motivations to push governments on smart city implementation in their agendas.

- **Economic Motive**

Economic development is one of the main challenges urban cities are facing. Today the competition is growing sharply among countries to secure jobs, investments, skills and businesses for economic advancement (Vukšić, 2013). One of the major economic challenges most countries face is boosting employment and creating jobs to occupy the growing number of citizens. According to Heintz and Pollin (2003), a real challenge facing developing countries is creating jobs that appeal to the requirements of highly educated graduates. In this respect, Boulanger et al. (2017) conducted a study to assess the unemployment level in both rural and urban cities in Ethiopia and discovered that people who moved to cities seeking job opportunities are facing major obstacles with surprisingly high unemployment rate reported in large urban cities like Addis Ababa. Moreover, most developing countries' economies are suffering to keep up with the fast-growing market conditions and the rapid emergence of high-tech competitors (Kumar, 2019). He further stated that new small businesses lack access to international customers, and that their customer range is restricted to their local customer base. Besides, economic crises continuously demand saving budgets (Colldahl, Frey and Kelemen, 2013).

Today, in the savvy digital world, the gap between the winners' and losers' economies is due to the lack of capitalising on advanced technologies (Morvan, Hintermann and Vazirani, 2016). For example, Toppeta (2010) stated that the competitive situation of a city could be improved by using social networks to build better relations and enhance the collaboration between different stakeholders such as academia, citizens and businesses by creating think tanks which further boost innovations. Smart city, through the combination of using knowledge and a climate of innovation, promotes a high productivity level (Angelidou, 2015; Mei, Ou and Li, 2017). Thus, a smart city is intensively connected with better economic activities (Caragliu and Del Bo, 2019). Therefore, one of the main drivers for smart cities' popularity among the world's governments is the development of economic prosperity (Chourabi *et al.*, 2012). Accordingly, Barrionuevo, Berrone and Ricart (2012) argued that smart cities play a critical role in economic sector strength as these cities will attract foreign investments, talent, tourism, and employment opportunities. A smart city's economy is expected to flourish in different ways. For example, in neoliberal economic models, capital attractiveness is a significant goal for creating smart cities (Cardullo and Kitchin, 2019). In particular, smart cities are meant to build a pro-business environment by enhancing cost-effectiveness, venture capital funds, market opportunities that are easily exploited, facilitating pervasive business incubation, and better banking services (Angelidou, 2016; Allam and Jones, 2019). These guarantee a good environment for attracting enterprises besides acting as a showcase platform for smart technologies. Such environments motivate enterprises to prosper, fuelling the development of the smart cities economy (Mwaniki, Kinyanjui and Opiyo, 2017). Smart cities are not just about improving citizen life and solving environmental problems but also create room for better partnerships to enhance the economic conditions and prepare cities to compete in capital and business attractiveness (Maurya and Biswas, 2019). Different authors argue that smart cities are a strategy to transfer a city's capabilities to attractive places for people, companies and investors to compete (Lombardi *et al.*, 2012; Kolotouchkina, Barroso and Sánchez, 2022). According to Ferraris, Santoro and Pellicelli (2020), the concept of a smart city has become a label emphasising these cities as the best ones worldwide. As a result, many governments are targeting building smart cities not only to be recognised as smart but also to support "*entrepreneurial cities*".

- **Environmental Motive**

The environmental challenge is an ongoing, primordial challenge facing urban cities. Cities are accommodating over half the world's people, consuming around two-thirds of the global energy, and are responsible for around 70% of the carbon emission (United Nations Climate Change Comittee 2020). This further puts cities at a considerable risk of negatively affecting climate changes and causing tremendous coastal storms and sea level rise due to melting ice caps (Deng, Zhao, and Zhou 2017).

The growing number of citizens also caused pressure on the cities' water resources and lands (Prendeville, Cherim, and Bocken 2018). Various developing countries suffer from high demands on water and a lack of proper water management, which further leads to decreased availability (Nair 2010). In terms of lands, the uncontrolled demands on them resulted in many challenges, such as changes in the land cover, which affect the natural resources of cities, land scarcity causing higher land values, urban sprawl emergence, the continuous shrink of agricultural lands (Mundhe and Jaybhaye 2014). Moreover, the constant demand for energy causes air pollution which in turn has a direct and negative effect on citizens' health (OECD 2016). Not meeting the World Health Organization's basic requirement of air quality standards caused air pollution, which has been directly linked to various mental and physical health issues (Petrowski et al. 2021). In 2019, this was the cause of premature death of 4 million people worldwide (WHO 2022). Waste management is another environmental challenge cities face where gathering, discarding and recycling them satisfactorily remain significant issues in cities (Oyedele 2016).

All of these challenges emphasise the need for a proper method to rescue the city's natural resources, reduce pollution and save cities natural beauty (Akadiri, Chinyio, and Olomolaiye 2012). Smart technologies are considered the best option to address these environmental issues and meet the sustainability goals of cities (Razmjoo et al. 2021). Similarly, Su, Hu and Yu (2021) found that constructing smart cities reduces environmental pollution. They further stated that smart technologies implemented in smart transportation contribute to energy saving, promoting green transportation and renewable energy.

- **Governance Motive**

Smart governance, which encourages collaboration between various governmental agencies, private sectors and other institutions, is another motive for smart city development (Viale Pereira *et al.*, 2017). Cities need accurate and real-time information to provide sufficient management and better perform their duties (Kitchin, Lauriault and McArdle, 2015). The lack of the required information affects the speed and the quality of response to different city issues. Moreover, the absence of media to consider all parties opinions, made an informed joint decision missing in urban cities as information is difficult to be shared among various stakeholders such as citizens, governments, and businesses (Colldahl, Frey and Kelemen, 2013).

Smart cities are designed to encourage "*a mix of collaborative, open and participatory governance*" (Lopes, 2017, p. 227). According to the United Nations, adopting the needed infrastructure fosters inclusive development by involving "*informal settlements and informal sectors and other marginalised groups in society*" (UNCTAD, 2016, p. 16). Smart city enables collaboration among the different stakeholders, enhancing the services integration (Snow, Håkonsson and Obel, 2016). Moreover, it also boosts the involvement of citizens in decision-making, which, in turn, promotes building trust and confidence among the participant's (Granier and Kudo, 2016).

One of the main goals of a smart city is to support city governance through the use of recent technologies (Pereira *et al.*, 2018). For example, IoT technologies deliver improved governmental services with limited costs, enabling high-quality experiences through improving communication with the citizen (Smart Africa, 2017; Usak *et al.*, 2020). Big data technologies support open data to enhance making informed decisions (Berntzen, Johannessen and El-gazzar, 2018). It also empowers citizens by monitoring the critical services in cities, such as waste management, air quality and clean water availability (Mishra, 2020). Gathering such information helps better understand the needs and requirements of various groups to better serve them on top of improving their capabilities. Smart cities enable governments to manage various segments of society by offering smart administration channels, which empower them to properly implement policies that benefit society (Johnston and Hansen, 2015). Thus, they enable making citizens more informed besides offering a more advanced transparent and innovative system (Johnston and Hansen, 2015).

- **Life Quality Motive**

The growing population has caused different challenges, such as delivering more efficient services with ramifications on the citizens' quality of life. The American Society of Civil Engineers (ASCE) report shows that America's infrastructure is graded only D and that most of the bridges, drinking water, schools and transports are not qualified to provide quality services to the rapidly increasing population (Washburn and Sindhu, 2009). This is especially true for developing countries with inadequate access to basic infrastructure and face a deficit of US $ 3.7 trillion spent on infrastructure development (Runde, 2019). For example, in Nigeria, the continuous energy shortage resulted in daily outages of power, which subsequently affected the country's economic development and social life through increased violence and crimes (Amadi, 2015).

Another challenge facing urban cities is leapfrogging public services such as healthcare, mobility, and housing (Abubakar and Aina, 2019). For example, The Global Report on urban health demonstrates that taking care of people of all ages is one of the main targets worldwide, but the increased density of people in urban cities is barring health providers from maintaining universal health coverage requirements (World Health Organization, 2016). Catlett et al. (2019) studied safety concerns in cities and stated that the more crowded the city is, the higher the crime rate it records (Catlett *et al.*, 2019). Moreover, Østby (2016) researched inequality and urban social challenges and proved that urban cities suffer from different social problems, such as unequal education opportunities and socioeconomic marginalisation. In related work, Tan and Taeihagh (2020) argued that urban cities are considered unsuccessful if they fail to meet the basic needs of all city dwellers, including the underprivileged population.

These challenges urban cities face are the main reasons for them to be part of the international campaign for smart cities (Vu and Hartley, 2018). Moreover, most of the challenges mentioned above directly affect citizens' lives, and therefore, implementing smart city can change their lives, whether currently or even in the future (Vu and Hartley, 2018). Such a smart city represents a significant consideration to decision-makers and city planners (Lara *et al.*, 2016).

This requires intensive attention to collecting qualitative and quantitative information to understand the needs and the factors affecting the acceptance of smart cities and smart services. Therefore, it is important to understand the local requirements, needs, challenges and conditions to build successful smart cities that better address the local challenges of the community (Appio, Lima and Paroutis, 2019). Building solutions based on each city's priorities and challenges is critical, which probably varies between developed and developing countries. This further encourages the involvement of different stakeholders to integrate their views in all aspects and stages of smart city project development. According to Dameri and Rosenthal-sabroux (2014), delivering services and solutions that are citizen-centric and customised to the need of the population boost well-being.

2.2.3 Barriers to Smart City Development

There are significant challenges facing developing nations in implementing smart cities. An extensive review of the literature reveals that these barriers include barriers related to technical, financial, legal, social and governance. It is important to understand that these barriers are frequently interrelated and do not exist in an isolation (Janssen, Charalabidis, and Zuiderwijk 2012).

- **Financial Barriers**

Building smart cities are about the advancement in adopting a different range of technology, particularly sensors-based information technology such as the Internet of things (Qian *et al.*, 2019). ICT and AI are compulsory prerequisites for constructing a smart city as it has been defined as "*a technologically interconnected city*" which utilises big data in the city's resources planning (Elgazzar and El-Gazzar, 2017, p. 250). Therefore, smart city technical transformation necessitates substantial investments in innovations, research programs, and extensive infrastructure analysis (Arasteh *et al.*, 2016; Aidasani, Bhadkamkar and Kashyap, 2017; Arauz, 2019). Thus, the European Union considered the investment in ICT technology as a main element in initiating smart cities (Barba-Sánchez, Arias-Antúnez and Orozco-Barbosa, 2019). However, financing smart city technologies is among the most common barriers, especially in developing countries (Tan and Taeihagh, 2020). For example, Chourabi *et al.* (2012) discussed the financial barriers to smart cities concerning the high cost of smart technology consultation, installation and operation. The substantial investments in the maintenance cost of a smart city's technological infrastructure also restrict cities' ability to successfully implement smart cities (Tan and Taeihagh, 2020). Besides, most governments are suffering from the continuous requirements of software upgrading, which have budgetary implications (Mukhopadhyay and Islam, 2019). Therefore, most developing countries have become concerned about the amount of money spent on developing smart cities (Portney, 2003). Moreover, Chourabi *et al.* (2012) discussed another financial challenge related to the cost of the IT training and skills-building programmes assigned with the usage of smart services. Wiig (2016) illustrates the need for online training platforms and Digital On-Ramp, social media-style educational applications to create more pathways for the public to be educated and trained to use smart services and technologies.

On top of it all, developing countries are stressed to address other urgent challenges, such as poverty, which consumes most of their budgets (Tan and Taeihagh, 2020). For instance, most developing countries lack investment in basic infrastructure such as proper water and sanitation (Chintagunta, Raj and Narayanaswami, 2019). Therefore, cities' authorities are worried about wasting capital by being "*early adopter*" of smart city products and technologies before exploring and realising their productivity and drawbacks, as it means they have to bear the entire risk of failure (New, Castro and Beckwith, 2017, p. 2). Besides, developing countries are more likely to have budget restrictions. Accordingly, they must diversify their financing through innovative and conventional funding to beef up the budget required for constructing smart cities (Mishra, 2019). Dameri and Benevolo (2016) argued that it is the role of the city government to create different sources of funding by involving both private and public sectors, and therefore stimulating alliances between these two sectors helps in breaking the bureaucracy, enhances cooperation and boosts the efficiency and success of the smart city implementation (Dupont, Morel and Guidat, 2015; Ferraris, Santoro and Pellicelli, 2020; Balcilar *et al.*, 2023). Yet, most developing countries depend only on the central governments for fundraising and face difficulty generating the money needed to support mega projects such as smart city (Kumar, 2017). Monzon (2015) mentioned that most local companies in developing countries are suffering from the absence of competitiveness. Therefore, they cannot support governments' plan to build smart cities. For example, Masdar smart city in Abu Dhabi suffers from different financial challenges as it solely depends on government funding as the only source of constructing the city and accordingly suffers from insufficient funding accessibility (Cugurullo, 2016). Also, In India, smart city projects are failing to generate revenues and suffering from the availability of long-term funding besides the absence of private companies' participation (Khan and Bureau, 2019).

Thus, although smart cities are expected to boost government abilities long-term, financial constraints prohibit cities from adopting it (Chatterjee and Kar, 2015). Neirotti et al. (2014) and Yin, Song and Zeng (2022) argued that the uncertainty in the world economies also affects smart city initiatives in developing countries. Therefore, the Deloitte report considers funding and financing of smart city projects as the most critical barrier to implementing smart cities (Deloitte, 2018). Indeed, Galati (2012, p.1) stated, "*without project capital and secured funding, a Smart City vision will remain exactly that: just a vision*".

- **Technical Barriers**

Technology represents the core of smart city initiation, and the emergence of ICT is the enabling factor to transfer traditional cities into smart urban cities (Hollands, 2015). Technology is the prime mover in the birth and development of smart cities (Moghaddam, Dashtdar and Jafari, 2022). Several smart city definitions depend on technology and ICT, proving the importance of technology in transferring cities to smart and sustainable areas (Harrison *et al.*, 2010; Alawadhi *et al.*, 2012; Komninos, 2014; Ismagilova *et al.*, 2019). The International Communication Union defined it as "*an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects*" (Mohanty, Uma Choppali and Kougianos, 2016, p. 1). Gascó-Hernandez further stated that ICT is a crucial tool supporting and enhancing the efficiency of smart cities by addressing their urban problems and improving the quality of life of their citizens.

Generally, the significance of smart cities increased rapidly with the development of many technologies such as the Internet of Things, Artificial Intelligence, smartphones, the Semantic Web, Big Data and the Cloud Computing (Rathore *et al.*, 2017). Thus, technology enables smart cities to tackle an extensive range of critical urban problems, and therefore the domain of technology applications in smart cities is very wide (Kitchin, 2014). For example, Hashem et al.(2016) provided a comprehensive view of using big data to support making informed decisions. Another study presented the ability of the Internet of Things combined with Artificial Intelligence to provide valuable services in smart cities; specifically, it proposed a system using these two technologies to solve traffic congestion problems (Soomro *et al.*, 2018). Moreover, many authors have conducted studies suggesting different applications of technologies in smart cities, such as a system to solve parking issues and save drivers time (Khanna and Anand, 2016), a driver safety application (Munir *et al.*, 2019), and a "*cloud- oriented smart healthcare monitoring framework*" to help sick people to interact with different smart devices for instant access to health information (Hossain, Muhammad and Alamri, 2019), solving mystery crimes faster by providing a homogeneous data and higher quality analysis by making the integrated data (Catlett *et al.*, 2019). Thus, many authors admit that cities need a solid ICT foundation and infrastructure to build a successful planning strategy and transform their cities into intelligent ones (Papa, Gargiulo and Galderisi, 2013). According to Rana *et al.* (2019), the lack of ICT leads to disaster as it is a major factor and ignoring it leads to smart city projects failure. Although many authors strongly believe in technology as a critical success value for building a smart city, many have argued that various challenges are associated with technology implementation in cities.

Most developing countries suffer from issues related to the technology readiness infrastructure, representing a severe barrier to smart city implementations (Praharaj, Han and Hawken, 2017) and Wu *et al.* (2018) argued that many developing countries also lack the technology infrastructure essential to fuel smart city constructions. For example, internet shortage is considered the most common technical barrier facing developing countries (Viitanen and Kingston, 2014). Although the smart city is mainly associated with fast internet connectivity, Internet technology is not yet a major component of developing countries' infrastructure. Its connectivity is primarily limited to citizens with political interests or those interested in it (Bimber, 2010). In addition, limited and costly internet connectivity also causes difficulty in the business information exchange (Peprah, Amponsah and Oduro, 2019). Developing countries also lack the development of basic technologies needed to operate and manage the information, and they still depend on foreign countries' help (Wu *et al.*, 2018).

Kogan and Lee (2014) also discussed the issues raised by the absence of integration among different city systems and the heterogeneity of communication networks, all of which impact smart city implementation. Citizens in smart cities expect an innovative range of services where interactive information and Internet-based applications are available with easy and real-time interaction (Kuk and Janssen, 2011). In other words, citizens in such cities expect the integration of various services into a single product where they can easily interact with different government bodies (Musa, 2016). However, designing and building such integrated systems is a complicated process as each agency brings its heterogeneous range of systems that further causes a couple of integration challenges (Balduccini *et al.*, 2019). Additionally, this integration requires a set of complicated processes and consequently consumes more resources than planned and expected by the governmental municipalities (Kakderi, Komninos and Tsarchopoulos, 2016).

Chourabi et al. (2012) argued that missing the information needed for technology interoperability is a serious barrier to the successful implementation of smart cities. For instance, the capability of making an informed decision in smart cities depends heavily on the analysis of real-time data provided by different technologies, and the lack of this data is another obstacle which hinders citizens and city authorities from taking instant action to improve the quality of life (Calzada, 2018). Besides, smart cities' systems should be resilient as any failure caused by natural disasters, such as power off, could break down all other components of the smart city (Al-Humaiqani and Al-Ghamdi, 2022). For example, any failure in the city's Wi-Fi system or water metering could entail a whole raft of consequences (Datta, 2016).

On the other hand, Elmaghraby (2013) discussed the privacy and security issues assigned with the technologies used in constructing smart cities. Regarding security concerns, he claims that illegal access to critical information collected via smart technologies represents a serious problem facing most smart cities, which can cause various problems. He argued that citizens' privacy is expected to vanish with the Internet of Things and smart homes assigned to smart cities, which collect data about citizens' locations and other daily activities. Thus, the safety and security of the information are other barriers as different kinds of citizens' personal information, such as their transportation information, health care information, and money spending information, are all collected and missing the responsible restrictions to secure them (Martinez-Balleste, Perez-Martinez and Solanas, 2013). As smart cities require integration with multiple networks supported by the advancement of big data, most citizens will face various security and safety issues, for instance, hackers and cybersecurity attacks (Mboup and Oyelaran-Oyeyinka, 2019; Park, Chung and Defranco, 2022). Missing the adoption of proper safeguards to manage the usage of the rich data collected via various smart cities technologies, such as sensors which capture, picture scan, and trace will be a nightmare (Wu *et al.*, 2018; Thirumalaisamy *et al.*, 2022). For instance, in some of the smart ride-hailing mobile applications users' privacy can be breached via attacks from frauds on their mobile applications (Bilbil, 2017). Thus, today, citizens are worried about losing their data privacy and other security issues (Idele and Mboup, 2019; Yu *et al.*, 2019).

- **Governance and Policy Barriers**

Pereira *et al.* (2018, p. 143) have coined the term smart governance to refer to "*the intelligent use of ICT to improve decision-making through better collaboration among different stakeholders, including government and citizens*". Earlier, Giffinger *et al.* (2007, p. 11) argued that "*Smart governance comprises aspects of political participation, services for citizens as well as the functioning of the administration*". Therefore, several authors indicated that poor governance arrangements cause serious obstacles to the successful transformation into smart cities and can put smart cities at risk of failure (Praharaj, Han and Hawken, 2018). The lack of appropriate smart governance to handle different urban challenges seriously hinders the aspiration to become smart cities (Clever *et al.*, 2018). For example, developing smart cities require the proactive formulation of rules and regulations, as a lack of flexible practices to construct them risks their success (Chourabi *et al.*, 2012; Nunez Ferrer *et al.*, 2017). With some resources of cities belonging to other actors shaping interdependency, actors need to depend on clear policy instructions, a standardised political system and legal rules to reduce uncertainty and achieve their targets (Börzel, 1998). With regard to the smart city context, various stockholders are involved including many public and commercial parties are involved. Although the local government may help with orchestration within this ecosystem, the partnership nature of the quadruple-helix cooperation means that the local government cannot completely standardise the procedures and forms among all parties (Clement, Manjon and Crutzen, 2022).

In this respect, Praharaj, Han and Hawken (2018) have raised the challenge of fragmented authority since smart cities involve applications and projects operating within a range of government agencies. Therefore, they illustrated the significance of a central authority coordinating cooperation among smart city applications. Smart cities' political considerations must also be considered as they affect how various groups with power and political situations access information (Al Nuaimi *et al.*, 2015). Fragmented authority is considered a severe barrier in most developing countries (Akbari, 2022). This further causes a divergence of goals, redundancy in smart city planning, and overlapping tasks and duties in implementing smart city projects (Praharaj, Han and Hawken, 2017; Karimikia *et al.*, 2022). Tan and Taeihagh (2020) also argued the issue of fragmented institutional structure, which caused further complications in governing smart cities, including designing overambitious and unrealistic targets to be achieved by the smart cities. With the inclusion of the different stakeholders, such as city planners, governmental parties, investors, businesses and the private sector, new partnerships among different stakeholders can be implemented to describe the variety of regulation arrangements needed to steer the processes of smart city projects (Carbonnell, 2019). For example, in India, smart city implementation suffers from difficulties in collecting and generating reports regarding the different public services due to a lack of collaboration among governmental departments, technical staff and city authorities (Aijaz, 2016; Praharaj, Han and Hawken, 2018). Most developing countries lack comprehensive frameworks identifying the basic policies, assessment models, strategies, objectives, and development plans to be followed in the process of smart cities implementations (Viale Pereira *et al.*, 2017; Vu and Hartley, 2018; Rana *et al.*, 2019). This further affects smart cities' abilities to monitor and control illicit activities as it gives terrorists a greater chance to easily proliferate in cities (Mboup and Oyelaran-Oyeyinka, 2019).

The needs and problems of each city vary based on its attributes, spatial dimensions, culture, history, political and economic concerns and physical location (Janssen *et al.*, 2019). Hence, the way that smart cities work for some cities might not be applicable elsewhere. Moreover, the meaning of shifting a city to a smart one is not the same among the different cities (Liu *et al.*, 2019). One size fits all technique has been widely used in the smart city concept (Kitchin, 2014). Yet, it is misleading since the main force behind it is technology companies promoting faster smart cities development (Schuurman *et al.*, 2012). Each city is a special case, and smart cities need to be built based on their unique needs (Schuurman *et al.*, 2012). Therefore, smart cities need to adopt a clear and long-term vision statement with explicit aims such as reduction of CO_2, improving quality of life and saving city resources (IBI, 2017; Gasco-Hernandez *et al.*, 2022). Following a well-defined strategy with clear scope and indicators enables the development of smart city projects, monitoring their performances and building smart city projects based on the priorities of the cities and their strategic objectives (Letaifa, 2015). Thus, a context-based strategy is a basic requirement for successfully building smart cities. This facility accepts smart cities among stakeholders and people and provides solutions that suit the local problems the best (Rana *et al.*, 2019b; Bibri and Krogstie, 2021). Therefore, smart cities must align their strategic plans with the different levels of complex rules and regulations assigned by the government (Hodgkinson, 2011). Each policy barrier mentioned, such as insufficient policy instruments, unproductive operation, local government reluctance to smart city plans, and the design of unrealistic goals and objectives to be achieved, has a negative effect on smart city implementation (Lu, de Jong and ten Heuvelhof, 2018). Thus, Myeong, Jung and Lee (2018) argued that smart city initiatives should be aligned with government rules and regulations.

Open data is considered as a main concept in enabling smart cities as it is about making governmental and many other kinds of data such as real-time transportation data, arrival and departures time, and road accidents available and easily used, reused, and redistributed by the public, (TfL, 2017; Gascó-Hernández *et al.*, 2018; Shamoon, Jönsson and Olivella, 2021). Open data support transparent data availability where different software programmes enable data processing into valuable information and useful applications to make city services ubiquitous (Smart Cities Council, 2013). Molinari *et al.* (2014) mentioned the need to implement open data policies and insisted on standard policies within private and governmental organisations to deal with open data sources. Park, Kim and Jun (2022) defined Opening Government Data (OGD) as making governmental data available to the public to be used effectively by citizens, governmental agencies, and business bodies. Implementing different ICT solutions such as sensors, mobile devices and, cameras, and many other actuators allows collecting, analysing and interpreting data such as health, water, education services and transport into valuable information to solve cities' urban challenges leading to a better level of citizens comfortability (Al Nuaimi *et al.*, 2015). According to Šiurytė and Davidavičienė (2016), the successful administration and management of smart cities rely mostly on serving citizens efficiently through the creation of proper applications. On the other hand, open data raises issues related to trust and privacy and unwillingness to share personal data, all considered major concerns hindering the building of open data applications within smart cities (Degbelo *et al.*, 2016).

- **Social Barriers**

An increasing number of researchers focused on citizens as being the end users or, more precisely, as consumers instead of being producers, innovators and a centre of the cities creativity, yet citizens are envisaged to be the cornerstone of the smart city dimensions (Paskaleva, 2011; Shepard and Simeli, 2013; Castelnovo, Misuraca and Savoldelli, 2015). Although intelligent systems, appropriate administration and strategic plans are assigned to be critical in smart city implementation, they are not possible without the involvement of the citizens, and their participation is critical in fostering smart city initiatives. Thus, building a smart community involving different stakeholders and citizens is essential to smart city success (Lindskog, 2004). The California Institute for smart cities defined a smart community as "*a community in which government, business, and residents understand the potential of information technology, and make a conscious decision to use that technology to transform life and work in their region in significant and positive ways*" (Wilson, 1997, p. 2). Thomas *et al.* (2016) explored the importance of engaging citizens, political and governmental authorities, planners, and technology companies in a community to discuss common problems and propose solutions to build more resilient cities. Thus, the lack of citizens' involvement in the processes of building smart cities is further affecting their realisations of smart cities' importance (Komninos, Pallot and Schaffers, 2013), which consequently causes trust and awareness issues between governments and citizens (Gay, 2002; Kogan and Lee, 2014). For example, India's smart cities' governmental applications face low citizen acceptance due to the absence of citizen involvement by the top authorities (Praharaj, Han and Hawken, 2017). Citizens lack the understanding of the idea behind smart cities and how they contribute to improving the quality of life, which consequently hinders the successful implementation of such projects (Kogan and Lee, 2014). Therefore, it is argued that citizens should be involved in the decision-making process as end users of these smart services and as a critical party supporting their successful implementation.

The lack of skills required to use smart city applications is a significant risk which pulls smart city implementation behind. Therefore, technological literacy is essential to remove the digital divide while enhancing the equality of usage among citizens (Almuraqab and Jasimuddin, 2017; Mboup and Oyelaran-Oyeyinka, 2019; Tan and Taeihagh, 2020). With regards to developing countries, the range of skills lacking includes insufficient formal skills in the ICT (Chintagunta, Raj and Narayanaswami, 2019), a lack of technical knowledge in the city's decisions makers (Chatterjee and Kar, 2015), and a lack of technical understanding among cities' planners (Rana *et al.*, 2019a). All these levels of users of smart cities need technical skills to enable them to access and retrieve information and use smart cities services and products (Baltac, 2019). This issue caused many smart cities in India to fail as most suffered from skills deficits that affected the comprehensive planning and management of the smart cities (Praharaj, Han and Hawken, 2017; Tan and Taeihagh, 2020). Therefore, Turkey is working hard to increase ICT human skills as part of its plan to diffuse smart cities development (Bilbil, 2017). Washburn and Sindhu (2009), in their study of helping CIOs (Chief Information Officers) to better understand smart cities, have recommenced different requirements to be followed to shift cities to the smart category. They strongly advise that workers in these cities to be well-trained to sustain and build management systems and fix any system interconnect.

Mousavi, McGrail and Varadan (2017) reinforce this by acknowledging the need for formal technology education and increasing citizens' awareness of IT importance to encourage creative thinking and the ability to handle smart city technical issues. Likewise, Monzon (2015) insists on considering the citizen's education quality besides their income and skill levels.

Masucci, Pearsall and Wiig (2019) later introduced the term "social justice", arguing that for smart cities to achieve their targets, they have to ensure that these technologies are equally distributed among citizens, and they must figure out the most related pressing issues facing them. The lack of technology access knowledge and skills hinders equal access to electronic information, jobs, education and many other services (Rana *et al.*, 2019). Technology illiteracy and the lack of awareness among citizens may impede governments' ability to realise their vision of smart cities, especially in developing countries where the developing human index is very low (Chatterjee and Kar, 2015; Peprah, Amponsah and Oduro, 2019; Rana *et al.*, 2019). They further argued that technology illiteracy could influence technology adoption as it hinders the technology adoption besides the ability to realise the advantages obtained by using smart cities' services. For example, in Ghana, where the technology illiteracy rate is around 25%, the lack of knowledge in technology usage and the low adoption rate have hampered the efficiency of smart cities projects (Peprah, Amponsah and Oduro, 2019).

Sepasgozar *et al.* (2019, p. 1) state that in the last two decades, researchers presented smart cities as being a "*universal aspiration*" regardless of their "*local urban identity, culture and knowledge ecosystems*". Therefore, they conducted a study and administrated that the smart city requests a set of significant tasks before labelling it as a smart city. Since the market is booming with a wide range of smart technologies, selecting suitable technology matching the city's culture is essential. Secondly, along with the appropriate technology selection, cities must manage the selected technologies' acceptance by citizens. Regarding this issue, Lee and Lee (2014) strongly recommended selecting acceptable technologies for citizens.

2.2.4 Examples of Smart Cities Around the World

Building smart cities has become a trend in most developed and developing countries to answer different urban problems (Neirotti et al. 2014b; Yongling Li, Lin, and Geertman 2015). Therefore, Smart city project production has become common in monitoring, regulating, and planning a city (Kitchin 2014). Currently, approximately hundreds of smart city projects are being developed worldwide. As can be seen from Figure 2.1, most of the smart city projects are located in Europe, such as SmartSantander in Spain, which has deployed various IoT devices, such as sensors around the city to collect real-time data that provide valuable information about different environmental concerns such as city temperature, CO_2 emission, noise and vacant car parking (Cheng et al. 2015). Another example is Amsterdam, which is classified as one of the early adopters of the smart city as it has adopted smart technologies to save energy and to work as an open innovation platform that allows various stakeholders from government, private, public and knowledge institutions to better plan for the city future (Komninos et al. 2016). Several smart cities in the United States (US), such as New York, mainly focus on smart waste and water management (Shah, Kothari and Doshi, 2019). Boston Smart City is another example in the US, mainly focused on reimagining its streets. Some smart cities are located in Asia, such as China, Japan, Singapore and South Korea. The map in Figure 2.1 shows that most of the smart city initiatives are located in developed countries, whereas only a few are situated in developing ones (Santana 2019).

Figure 2.1: Smart Cities initiatives around the world; source (Santana, 2019, p. 10)

Studying and evaluating different examples of smart city projects and initiatives from different countries helps identify their experience and challenges to build a better framework to be used as a working guidebook to enhance the acceptance of smart projects. The following paragraphs explore smart city projects from different countries, highlighting the main obstacles, challenges, and lessons learnt to generate knowledge to enhance the successful acceptance and adoption of smart city projects. Elaborating on the different facts observed from existing smart projects helps enlighten governments seeking successful implementations of smart city projects.

- **Seoul Metropolitan City**

There are many reasons that encourage Seoul City to the transformation into a smart city. Seoul metropolitan city is the capital of Korea, and is considered one of the most crowded megacities, with residents accounting for 20% of the total population of Korea (Um and Chung, 2021). Accordingly, it faces different urban challenges ranging from pollution, housing, and traffic congestion to uncontrollable population growth (Lee, Hancock and Hu, 2014). Thus, since 2010, the Korean government has pushed forward the idea of smart city implementation in Seoul city focusing on the engagement of citizens. Since Seoul is considered as one of the most populated cities over the globe with more than 10 million inhabitants, adopting smart city prospect is required to manage the urbanization challenges associated with the city (Khalimon, Vikhodtseva and Obradović, 2021). Another, motivation for building Seoul metropolitan city is improving the standard of living for its dwellers through enhancing for example, the transportation systems, and healthcare services to make the city a more convenient environment for its residents (Lee, Hancock and Hu, 2014). South Korea aims for technological leadership and emphasises the importance of being at the forefront of the worldwide technology industry and innovation (Choung, Hameed and Ji, 2012). Constructing Seoul Metropolitan City showcases South Korea's technological capabilities and also highlights the country's position as a frontrunner in the global technology industry. Another motivation for building smart Seoul Metropolitan City is the economic growth as smart cities contributes in drawing the foreign investments and generating employments opportunities (Joo, 2023).
On the other hand, The Seoul government has encountered many challenges towards being smart. It has faced obstacles in obtaining funds and acquiring sufficient resources has been a constant challenge (KOREATECHDESK, 2023). Thus, it explored the various funding sources, including grants from public-

private partnerships and financial support from national and international organisations (Jeon, 2021). Also, steps have been taken to optimise resource efficiency and allocation. Another major hurdle the Seoul government has encountered while implementing Seoul Smart City is the integration of diverse systems technologies across various domains and sectors (Kwak and Lee, 2021). Tackling these challenges has required extensive collaboration and guidance across multiple stockholders, ensuring the harmonising seamless interoperability. Another significant obstacle has been the challenge of privacy and security (Yoo, 2021). Seoul Smart City is planned to collect a vast amount of data from various sources, such as sensors and citizens' interactions with various applications and digital platforms. Therefore, the government has invested heavily in strong cybersecurity to enhance data protections to enhance residents' awareness of the data privacy (Lee, Hancock and Hu, 2014).

On the other hand, many lessons can be learned from Seoul Metropolitan City. One of the critical enablers of smart Seoul is the availability of open data through building two open platforms to serve two needs: one of them is to allow citizens to get access to governmental services and information, and the second is to work as an open data portal (Smith, 2018; Yoo, 2021). These two portals enable the government to further encourage Korean participation and engagement in the smart city by making better-informed decisions and creating smarter solutions based on their needs. Although open data improves transparency and citizens' innovations, cities must balance open data and privacy concerns to succeed in moving toward being smart (Lee, Hancock and Hu, 2014). Lee, Hancock and Hu (2014) conducted an empirical investigation to examine the Seoul smart city initiative to analyse the homogeneous and heterogenous factors involved in the process of constructing and planning Seoul smart city and have found that "*the social cultural*" and the "*development stages*" of the Seoul smart city needs to be further appreciated and addressed while implementing smart city projects. Also, in 2016, the city decided to build the Seoul Digital Foundation to solve the digital literacy problem of Korean citizens through digital innovation schools and arranging hackathons to facilitate the technical knowledge needed to enhance their innovation (Smith, 2018). Moreover, Seoul Smart City has established a strong partnership between private and public sectors to facilitate collaboration in resolving complex social problems. They are categorised into two major categories: local and municipal projects. Regarding the municipal project, most projects are suggested and proposed by its citizens, as they are planned, implemented, and evaluated through direct collaboration between the Seoul municipality and the citizens. Civic engagement is considered one of the main lessons from Seoul Metropolitan City as it collected around 100,000 suggestions from the public and then implemented the best 180 ideas (West, 2010). Bart Gorynski, the managing partner of Seoul's smart city, said, "*The City of Seoul has recognised the importance of a citizen-centric strategy to successfully develop and implement smart city solutions. Citizen innovators - or 'semanticists' - as we call them, play an increasingly important role in the creation of smarter cities*" (Smith, 2018, p. 1).

- **London's Smart City**

Various factors are driving the development of smart London. London's population is growing sharply, with an acceleration rate of one million per year, causing London's population to reach 9.4 million by 2030 (Trust for London, 2020). This increment raises various challenges in waste management, energy supply, public transport congestion and the quality of healthcare services (Tfl, 2017). ARUP's (2016) report has explained some of the motivations for constructing a smart London. For example, energy challenges, including a secure supply, ageing infrastructure, struggle to find fuel sources, climate change, high water demand, transportation network challenges, social care, and providing adequate health services are some factors mentioned in the report. Therefore, in March 2013, London announced the initiative of the smart London board pushed not only by the mayor of London but also by the Greater London Authority as an answer to the challenges the city is facing and possible opportunities to overcome them. They decided to shape a strategy to implement smart technologies as a solution (ARUP, 2016; Zvolska *et al.*, 2019). They believe that by doing so, London will become a better experience for everyone, besides meeting the consolidation view of London as one of the leading cities worldwide (Zvolska *et al.*, 2019). The plan involves a collaboration of a group of experts from different sectors, including entrepreneurs active in the smart city field, business leaders, digital leaders, skilled people, public and private sectors, and academic researchers to support the Greater London Authority in its journey to achieving smartness. Therefore, London initiated the Talk London website to invite citizens and businesses to participate in designing and exploring possible technological innovations (Zvolska *et al.*, 2019). Since London is one of the earliest cities to adopt Open Data Platforms worldwide, its vision is to put technology at the core of responding to the global challenges the city is facing while also improving Londoner's lives (Greater London Authority, 2013). London's municipal systems are among the most highly ready among the world's countries to incorporate smart tools and data-based technologies (Bibri and Krogstie, 2020). The city has also invested in open data to produce homogeneous data, enabling the delivery of professional services for citizens and enhancing the digital economy (Boyle, Yates and Yeatman, 2013).

On the other hand, London's smart city has faced some obstacles explored by researchers. For example, Peng, Nunes and Zheng (2017) found that most Londoners are unaware of the existence of smart parking systems and applications. Therefore, they are missing the benefits assigned to the adoption of these applications. They assumed that accepting and using these applications among citizens would be very difficult. Likewise, Contreras and Platania (2019) argued that when it comes to climate change mitigating, policy uncertainties and lack of central governmental and international policies risk addressing the climate change effect on London City.

- **Barcelona Smart City**

Several reasons motivated Barcelona to become smart. Although Barcelona is attracting people as a tourism and sporting hotspot, it suffers from high unemployment rates, availability of affordable housing, essential utilities, and services such as water and electricity, and pollution problems. These further caused some social consequences, such as stress on family cohesion. Besides, they also raised various environmental effects such as temperature increments, tidal flooding and fires, which are some of the significant concerns to the city's management (Hofmann, 2021). The main driver of Barcelona's smart city initiative is the weakness in the city's previous strategic planning and the severe consequences of the Great Spanish Recession, which had negative effects on the city's housing, water system, mobility, economy, health, and environment (Bakici, Almirall and Wareham, 2013; Rahyaputra, Muna and Rizal, 2016). Therefore, Barcelona decided to build an emblematic smart city that uses advanced technologies to push its economic development and improve its citizens' quality of life (Gascó-Hernandez, 2018). In 2012, the mayor of Barcelona City, Xavier Trias, formed a team responsible for collecting and coordinating the various smart city projects under one umbrella called Smart City Barcelona (Kuyper, 2016). Its programme is to become smart and be involved in a regeneration plan to build the innovative 22@ Barcelona projects, which embarked on transferring 200 acres of unused industrial lands of the old Poblenou district into a new knowledge hub for the city with advanced technology activities to refurbish the urban landscape to achieve social and economic revitalisation (Leon, 2008). Figure 2.2 indicates all the programs adopted by 22@ Barcelona projects.

Figure 2.2: Barcelona Smart City's 22 programs; Adopted from (Ferrer, 2017)

Barcelona is one of the most successful smart cities in Europe (Bakici, Almirall and Wareham, 2013). It has been declared a leading smart city, and many international studies have considered it one of the cities topping the leader board in smartness in Spain and worldwide (Gascó-Hernandez, 2018). There are many reasons behind its success and prosperity. For instance, in addition to forming a strategy to answer the main challenges Barcelona City faces, it is built on three main factors: people, infrastructure and information (Bakici, Almirall and Wareham, 2013). Thus, it ensures the inclusion of all parties, such as citizens, private and public sectors, and its own organisation (Ferrer, 2017). 22@ Barcelona is designed to bring together four main industrial clusters into the city strategy: universities and academic institutions, industries, residents of Barcelona, and private sectors who together developed a strategic plan aiming to foster smart city initiative and improve the city's competitive profile (Leon, 2008). Barcelona Smart City also encouraged different entrepreneurs, private companies and investors to adopt internationally approved and successful products to Barcelona City's local context (Garrido-Marijuan, Pargova and Wilson, 2017). The two leading investors in Barcelona Smart City are Cisco, with an investment of 30 million dollars to become the main technology provider, and Cellnex Telecom, which runs the city-wide network (Rahyaputra, Khawarizmy Muna and Rizal, 2016). In addition, Smart Barcelona also encourages alliances among private companies such as IBM and Philips, other research institutions and universities such as Dublin Institute of Technology and international organisations such as the European Commission (Ferrer, 2017). Therefore, one of the main building blocks of Barcelona's smart city is the cooperation between the public and the private sectors to ensure supporting each other as a way to keep all parties in Smart Barcelona City interconnected to innovate in their performance continuously within different areas of the city.

Besides this collaboration, the Barcelona City Council supported this plan by providing an explicit vision and directions to work as a guideline for the different projects and programmes conducted in the transformation process. The vision of Smart Barcelona City is "*to become a city of productive neighbourhoods, at human speed, interconnected, eco-efficient, re-naturalised, energetically self-sufficient and regenerated at zero emissions, inside a high-speed interconnected Metropolitan Area*" (Nesti, 2020, p. 25). Moreover, Barcelona City Council developed a new global IT strategy for innovatively introducing and adopting updated technologies to improve city management and operation, economic enforcement, and enhancing the citizens' quality of life (Ferrer, 2017). This strategy is aligned with the European Union strategy and its current agendas to build sustainable cities and improve their economic growth to ensure the development and building of successful smart cities (Archick, 2015). Barcelona's smart city strategy depends on a "*cross -cutting approach*" in order to ensure connecting all the stakeholders together to enhance the innovation in a constant means (Moll, 2018). Adopting the cross-cutting innovation approach in the city's different departments enhanced the provision of innovative services to their citizens. For example, the city's mayor introduced the Innovation Centre, Barcelona's Media, ICT Centre, and the Nord Technology Park to work as a "smart city laboratory" (Zygiaris, 2013). This encouraged private companies such as Cisco to enrich the city with scientists and technological products, giving the city council a chance to focus on various management processes (Zygiaris, 2013). Accordingly, Smart Barcelona acts as an urban field laboratory to test new products. Moreover, this innovation lab has also linked the city with other international innovation centres worldwide. This innovation laboratory helped foster the economic growth of Barcelona's smart city and encouraged job creation through entrepreneurship. As a result, in March 2014, Barcelona Smart City was awarded the prize of "*the European Capital of Innovation, or iCapital*" as a sign of being creative in producing innovative technologies, and this recognition further led to Barcelona being awarded the "*Mobile World Capital*" through 2030 (Gascó-Hernandez, 2018). In addition, instead of stressing the implementation of only a specific aspect of the smart city concept, Smart Barcelona followed an integrated smart city to get the advantages of the full options of the smart city implementation (Angelidou, 2015).

From a technical perspective, technology is critical in supporting cities' innovation and helping them become more productive, intelligent and community-focused (Gascó-Hernandez, 2018). The availability of fibre optic cables in Barcelona fostered the transformation process to smartness and helped in heavily cutting the entitative cost of Barcelona Smart City (Cisco, 2014). Barcelona Smart City has employed different ICT technologies to ease and comfort its citizens' lives. Extensive sensors have been installed throughout the city and connected with widespread Wi-Fi to support government and private sectors with open data about the noise level, traffic jams, and power consumption, fostering citizens to make informed decisions. Moreover, the penetration of smartphones and their widespread use have changed the lives of Barcelona residents by providing them with instant and updated information about jobs, health services, and administration services (Gavin, 2022). For example, there are sensors dedicated to irrigation of green areas, sensing accidents on public roads to prevent traffic jams, capturing the streets to monitor the traffic and automatically notify the police, managing the forest and other wooded lands, and screening the garbage levels in the dumpsters to enhance waste management (Zygiaris, 2013).

With regard to open governance, one of the main objectives of Barcelona's smart city is to get closer to its citizens by offering open data sources with valuable information to support citizens and the various private companies. For example, the open data platform with plenty of sensors collects data from multiple sources. It feeds them to the public through open data called Sentilo, which was created to foster participatory activities in the city. City Operating system (City-OS) is another example, which "*acts as a motherboard where different modules and out-of-shelf products can be plugged in and out. Which is interesting is that City-Os and their modules are willing to be open source, that will accept either open source add-on modules or licensed ones*" (Bennassar, 2016, p. 1). According to Ferrer (2017), these two methods enabled Barcelona to connect people and knowledge to drive change and build an innovative city. By doing so, people, data, and knowledge are interconnected, enhancing people's ability to participate in city-building and constructing sustainable cities. On top of all the above, Angelidou *et al.* (2017) stated that the heritage scope of Barcelona Smart City had also been promoted through a touristic component where the cultural heritage is used as a base to promote the city tourist products. The city is aiming to attract more tourism through this strategy.

Regarding environmental issues, Barcelona recorded different environmental concerns, such as waste management. Therefore, Barcelona's smart city is planned to improve the urban environment to foster the quality of life of its people, and accordingly, it implemented different plans and projects (Xia *et al.*, 2015). Firstly, Green Barcelona has been established with the goal of CO_2 emission reduction through the use of other alternative sources of energy, such as the employment of solar energy and by 2030, solar panels are expected to cover almost 34,000 m^2 of the different building roofs (City of Barcelona, 2018). Concerning the water system, the city supplies warm water through solar energy and sensors to provide citizens with real-time water information (Xia *et al.*, 2015). Moreover, the city's waste is automatically recycled with minimum environmental harm through installation sensors that generate reports about the fill levels and send them to smartphones (Madakam and Ramachandran, 2015). This helps reduce the gases, which further stops the bad smells. Regarding mobility, the city has implemented various electric stations distributed around the city to supply free-of-charge scooters and motorcycles (Woetzel and Kuznetsova, 2018).

On the other hand, Barcelona's smart city has faced various challenges mentioned by some authors. According to Zygiaris (2013), as there is no clear evidence of the citizens' contribution to the city's strategic planning, it is assumed that Barcelona's smart city has adopted a top-down approach as a master planning approach to its strategy (Zygiaris, 2013). Therefore, Gascó-Hernandez (2018) criticised Barcelona's smart city as being built based on a top-down approach, which, on the one hand, supports building a comprehensive view of the city; however, on the other hand, it misses the availability of an engaged community, which is an important element in the implementation of the smart city (Gascó-Hernandez, 2018). Therefore, Gascó (2016) also stated that Barcelona's smart city lacks the bottom-up approach, which plays a significant role in involving citizens in their smart cities' development without formatting environmentally sustainable goals. He further argued that the innovations laboratory project, which is believed to consider citizens, also has negative impacts as it favours mainly talented people. Citizens in Smart Barcelona are enhanced with different activities and enjoy being the end-users of various IT services (Calzada, 2018). For example, citizens can participate in cultural activities by interacting with screens to share different users' media and posting feedback. Also, using smart mobile devices, citizens can send their thoughts and update themselves with real-time data to know what is happening in other cities. However, despite implementing such activities, Smart Barcelona lacks citizens' involvement in the real decision-making process, as their contribution is limited to data providers (Aguilera *et al.*, 2017).

Moreover, one economic challenge Barcelona's smart city leaders face is shifting the economy from a traditional city depending on textile manufacturing to knowledge-based economy industries. Leon (2008) also discussed another challenge Barcelona has faced while transferring to a smart city. For example, most of the city population was not educated enough to meet the needs of the industry changes, the level of entrepreneurship in the city was very low, with only 0.2% active, and problems with capital funding of the projects which were very low especially the early start-up which was only 1 million, difficulties in attracting large firms to invest in the city, and lastly, it was not considered as an attractive city to the global community as it lacks linkage and relation with them.

- **Masdar Smart City**

The smart city phenomenon is considered a new concept in the Arab world, and therefore there are only very few examples located in this region (Tok *et al.*, 2014; Virtudes, Abbara and Sá, 2017). Despite this fact, after the discovery of oil and gas, different Arab countries, especially the six Gulf Cooperation Council (GCC), have encountered considerable changes, and they have transformed from desert cities with almost nothing in terms of urbanisation into the most important, decent and wealthiest cities (Benkari, 2017). Thus, GCC countries showed explicit readiness and willingness to create changes to solve the various urban challenges they are facing (European Scientific Institute, 2014). GCC countries are classified as the most urban cities according to the United Nations statistics due to the rapid increment of the population. Urbanisation raises different challenges to the GCC area, and the transportation sector is one of the main and the most acute ones, as traffic congestion and car accidents are considered among the main deaths causes in GCC countries (Islam and Hadhrami, 2012; Al Turki, 2014). In this sense, CO_2 emissions have become another challenge facing GCC countries (Qader, 2009). Despite this, since 2008 to date the GCC region has been facing oil price crises creating a sense of urgency and positing the importance of the economic diversification (World Bank Group, 2018). Because of all these challenges, GCC states decided to reverse the case and depend on smart solutions to plan for a post-oil era (Gremm *et al.*, 2017). One of the main agreed solutions to these challenges is the digitalisation of the economy and the adoption of smart tools.

Masdar smart city is an example of the recent and highly planned smart city in the GCC region (Kolotouchkina and Seisdedos, 2018). Masdar smart city was initiated in 2006 as a planned smart city from scratch in UAE, located beside Abu Dhabi international airport and 17 kilometres from Abu Dhabi to cover 6 square kilometres. The word "Masdar" in the Arabic language means "the source". The development of the city was a result of the Abu Dhabi government's initiative in having a business-friendly environment to secure the UAE economy through building a knowledge-based economy (Masdar Free Zone, 2014; Masdar City, 2022). Masdar smart city is designed with low-rise buildings, with all buildings from houses, entertainment buildings, and work buildings built close to each other to minimise the use of the transportation (Sanseverino *et al.*, 2017; Ralls, 2022). Masdar Institute of Science and Technology, which is now part of Khalifa University of Science and Technology, was established in 2007 in collaboration with the Massachusetts Institute of Technology is responsible for providing training and educational programs in sustainability to enhance the process of transforming being smart. The city's logo is presented in Figure 2.3.

Figure 2.3: Masdar's logo (Masdar City, 2022)

The city has faced various obstacles; for example, with regard to the project, the budget was estimated to be 22 US billion dollars, but due to the economic crises, has been lowered to 18.5 US dollars. The city was designed to be ready by 2016, but this was extended to 2025 due to the global financial crisis in 2008 (Carlisle, 2010). The global financial crisis in 2008 and the weakening of the global property market caused a crash in the Emirati housing market. Thus, as Masdar smart city purely depends on government funding as the only source of constructing the city, it suffers from insufficient funding accessibility. Currently, the Abu Dhabi government's willingness to sponsor other urban projects without prioritising Masdar smart city reveals doubts about its importance to the government.

The mission of Masdar's smart city is "*to make Abu Dhabi the world's reference for knowledge and collaboration in the advancement of renewable energy, clean technologies and sustainable development*" (Masdar, 2017). The city's initial aim was to be CO_2 neutral along with a zero-waste smart city that depends solely on solar energy and inspires other cities. Masdar smart city has had "The future built" to work as a platform for marketing the technical products which have been tested and produced in Masdar's laboratories in which most of the current products are focused on the energy grid, electric vehicles, and district cooling. Yet, apart from holding two of the world's biggest leading events for entrepreneurs and developers, the World Future Energy Summit and the European Future Energy Forum, no clear marketing strategy was developed for the city. Masdar Smart City has also faced different obstacles, such as the harm from unexpected weather, such as a dust storm that has obstructed the city's solar system performance. Moreover, although Masdar Smart City is designed to accommodate around 50,000 citizens along with 40,000 customers (The Guardian, 2014), it has failed to attract residents as no one is willing to live in a one-size-fits-all all city, and in 2018 there were only 3,500 people living in Masdar smart city (Liu, 2018; IvyPanda, 2021). Different authors have argued that Foster and Partner, who designed Masdar smart city, were too ambitious in the city's vision, and they have admitted that the city has become a "green ghost town" (Woodworth and Wallace, 2017; Lin, 2018). The city suffers significant weakness regarding its vision, mission, and goals (Cugurullo, 2013; Herzog, 2016). The city decided to take a different strategy to encourage citizens to live in Masdar smart city, such as signing a contract with Emirates College of Technology to rent 500 hotel rooms (Randall, 2015). Madhu and Pauliuk, (2019) also argued that Masder's smart city goals had been built while isolating the city from the global ecosystem. They further highlighted studying the environmental impact not only on Masdar city's immediate environment but also on the global environment.

Furthermore, the Masdar project suffers from a high level of bureaucracy and complications in the process of starting up companies, which indirectly affects attracting investors (Angelidou, 2014). The management of the Masdar project has been changed several times due to the resignation of many project managers, which further caused problems in controlling the project (Griffiths and Sovacool, 2020). The project also suffered from insufficient planning at different levels, for instance, being too ambitious: instead of being an energy source, the city is now forced to import electricity instead of producing it (Griffiths and Sovacool, 2020)

- **Dubai smart city**

Smart Dubai is considered a pioneering and leading example of smart cities not only in the Gulf area but also globally. Today it is known as one of the best global business ecosystems, and is recognised for its vital commercial role besides being an international trade city (Virtudes, Abbara and Sá, 2017). Dubai is well known for its impressive development, and therefore, it has multiple reasons for being recognised as a smart city. According to the official Dubai government website, the most recent statistic shows that the city population evolved from only 10,000 people in the early 1900s to almost 3.38 million people living in Dubai in 2020 (GMI, 2022). However, the number of people working in Dubai is almost 3.5 million. This rapid increase in Dubai's population causes several pressures on the city's infrastructure and resources. This further causes challenges in how Dubai can improve the quality of its citizens' lives while also reducing its impact on the environment (Kadhim, 2019). The Happiness Impact Report has mentioned several reasons behind the motive of making Dubai a smart (Labaki *et al.*, 2017). According to the report, the impact of resources and infrastructure are of the utmost crucial role in initiating smart Dubai. To optimise the limited availability of natural resources, Dubai decided to utilise smart technologies. Moreover, the financial impact represents a major motivation toward becoming smart as it attracts significant investments by boosting operational efficiency and lowering expenses. Customer impact is also another motivator as Dubai strives to ensure that its citizens and visitors are enjoying a very high quality of life.

As a smart city is the answer to cities' urban challenges, Dubai, under the guidance of His Highness Sheikh Mohammed bin Rashid Al Maktoum, has established a Smart Dubai office to control the process of transforming Dubai to be a leading smart city model (Dubaismartgov, 2016). The vision of smart Dubai is: "*to be the happiest city on earth*", and therefore, the city plan extends to include deploying advanced technologies to reach sustainability, effective governance and city growth (Fourtané, 2018). Accordingly, Dr Aisha Bin Bishr, director general of the smart Dubai office, stated that "*we want to be the best. We don't want to neglect any of the dimensions we believe are essential to our definition of being the best smart city in the world*" (Smart Dubai, 2015, p. 3). In 2014, Dubai launched its strategic plan to transfer over 1000 governmental tasks into smart services through collaboration between both private and governmental sectors targeting improvement in six main dimensions including (i) Economy, (ii) Governance, (iii) Environment, (iiii) Living, (v) Mobility and (vi) people. Its strategic plan is built on three main pillars (i) communication, (ii) integration and (iii) corporation Dubai (Salem, 2016; Khan *et al.*, 2017; Smart dubai, 2021).

A remarkable aspect of smart Dubai is aligning the happiness vision as a motivational force in aligning citizens' well-being with the country's strategic objectives. This integration has been used as a base for planning smartness concerning the Dubai context (Khan *et al.*, 2017). As a result, different smart solutions have been launched in various sectors. For example, in terms of transportation, Dubai's Road Transport Authority (RTA) integrated smart transportation services such as M-parking, smart drivers, bike lines and enhanced the traffic jams to maintain stable, safe and faster transportation. Moreover, the metro Dubai system is considered the longest automated subway worldwide, with around 70 km tracks (Acuto, 2010). Additionally, Smart Dubai has produced different plans to enhance water and energy efficiency and become environmentally green. For instance, implementing smart buildings with efficient CO_2 footprint besides constructing green buildings assessment system called AlSafat to categorise them to ensure that all buildings meet the requirements of the CO_2 emission (Virtudes, Abbara and Sá, 2017). Dubai Electricity and Water Authority (DEWA) also invested in a smart grid to produce renewable energy by using solar energy. It also installed smart meters in both governmental and private sector buildings to monitor energy and water usage, as well as supporting building the basic infrastructure needed for using electric cars. Additionally, smart Dubai utilises extra attention to the health sectors by providing sufficient health access with high-quality services to its citizens, such as smart health applications for different health information services to be used easily on smart mobiles. It has also promoted a paperless society by reducing internal administration paperwork (Digital Dubai, 2020; Sahib, 2020). Drone, 3D printing, implementation of IoT to sense the city, self-driving delivery cars, and different virtual reality and artificial intelligence applications are some other projects implemented to transfer Dubai to a smart city (Dassani, Nirwan and Hiriharan, 2015; Salem, 2016).

Yet, Dubai has faced many challenges in its journey toward being smart. One of the major obstacles that the Dubai government has faced in their journey to pursue smart is the operational and connectivity challenge (Saleh, Hilal and Haggag, 2022). Another barrier is scepticism or users' acceptance and adoption of the new smart technologies (Cristina, 2015).

2.2.5 Smart City Framework Analysis

Apart from the fact that the term smart city does not have an agreed definition among the researchers, there are no anchored standards, variables, and elements to understand the concept. Moreover, its dimensions and factors are not fixed but are growing over time as more elements are added to the concept (Hollands, 2008; Nam and Pardo, 2011a; Lima *et al.*, 2020). Also, due to the ubiquitous presence of the smart city concept, studying its definitions alone is insufficient to collect a wide understanding of the concept. Most of the definitions are rigid, making it hard to gain a complete theoretical understanding of how to put up a rewarding smart city (Sanseverino, Sanseverino and Anello, 2018). Consequently, to enhance the understanding further, the research considers different smart city models to frame a new and meaningful understanding of the building blocks of the smart city. The current literature reviews many smart city frameworks developed by academic scholars, private companies, and smart city professionals, as examining them is critical in extracting the variables considered critical in understanding the notion of the smart city (Joshi *et al.*, 2016). For this purpose, the following paragraphs explore its main domains and concepts.

While there is an assortment of smart city frameworks, the one constructed by Giffinger *et al.* (2007), which is known as the European smart city ranking model, is among the most significant sources adapted in smart city research and worked as a base for several authors in smart city research (Mora, Bolici and Deakin, 2017; Fernandez-Anez, Fernández-Güell and Giffinger, 2018). It was built initially as an attempt to rank European medium-sized cities while shedding more light on the fuzzy concept of the smart city. Specifically, the framework is built to promote comparison among cities to evaluate their development toward the required directions. In this regard, cities are identified upon the assessment of their current conditions of development, the different sectors in need of further improvements, and finally, what is required for current developments to meet in order to be labelled as a smart city. Figure 2.4 presents the Giffinger *et al.* (2007) framework, which works as a holistic view of the smart city by using a classification system focused on six main elements and each dimension further contains a set of sub-elements used to assess the success of the smart cities:

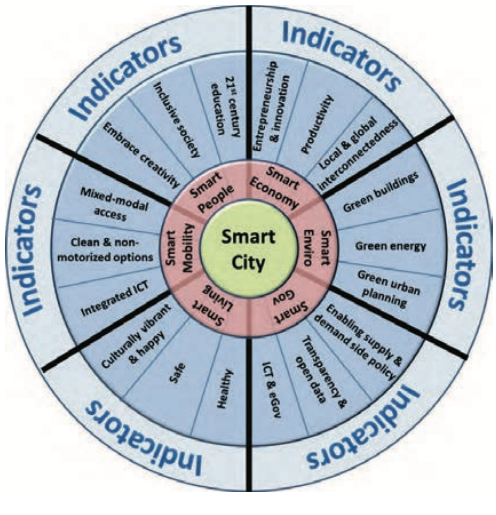
- Smart mobility: It includes the physical infrastructure, such as roads, bridges and stations area. It also involves the digital infrastructure, such as data, where smart systems support minimising urban traffic and enhancing inhabitants' mobility.
- Smart Environment: Aspects related to the environment are widely discussed in Giffinger's research and cover aspects like natural resources protection and management, green spaces, and developing sustainable cities. In a nutshell, a smart environment is about constructing a sustainable environment with proper management of its natural resources.
- Smart Living: This dimension is about the quality-of-life aspect, such as smart health, safety, tourism, and housing. It looks into the social aspects of its citizens to improve their quality of life.
- Smart People: The smart people component looks more into the citizens and their level of education. More interestingly, it emphasises an innovative environment where people interact within themselves and with the outer world.
- Smart Economy: Becoming a smart city also implies a competitive economy enhanced by the availability of proper businesses and of creative entrepreneurship. It also involves the presence of spin-off companies as well as existing ones, business collaboration and crowdfunding opportunities.
- Smart governance: It is about the political aspects of the city, administration issues, participation in decision-making, providing public services for citizens, and transparent, open, and innovative governance.

Figure 2.4: Six main domains of the smart city (Giffinger and Gudrun, 2010a, p. 14)

SMART GOVERNANCE (Participation) • Participation in decision-making • *Public and social services (1.)* • Transparent governance • Political strategies & perspectives	SMART LIVING (Quality of life) • Cultural facilities • *Health conditions (4.)* • *Individual safety (2.)* • Housing quality • *Education facilities (3.)* • *Touristic attractiveness (7.)* • Social cohesion	SMART PEOPLE (Social and Human Capital) • *Level of qualification (3.)* • *Affinity to lifelong learning (3.)* • Social and ethnic plurality • Flexibility • Creativity • Cosmopolitanism / Open-mindedness
SMART MOBILITY (Transport and ICT) • Local accessibility • *(Inter-) national accessibility (1.)* • *Availability of ICT-infrastructure (1.)* • *Sustainable, innovative and safe transport systems (5.)*	SMART ENVIRONMENT (Natural Resources) • Attractiveness of natural conditions • *Pollution (6.)* • *Environmental protection (6.)* • *Sustainable resource management (6.)*	SMART ECONOMY (Competitiveness) • *Innovative spirit (8.)* • Entrepreneurship • Economic image & trademarks • *Productivity (8.)* • Flexibility of labour markets • International embeddedness • Ability to transform

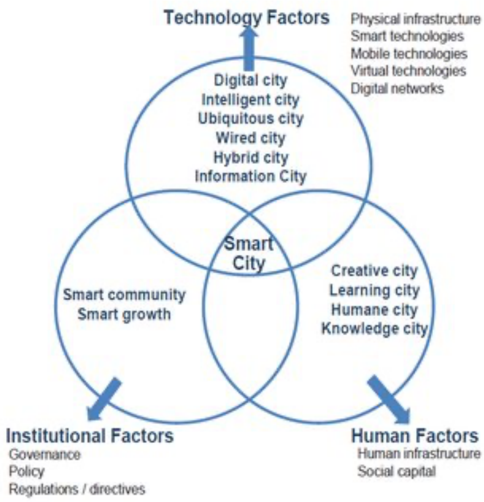
The Giffinger *et al.* (2007) concept was further investigated and developed by Cohen (2014), who built the smart cities Wheel model based on the six aspects found in Giffinger *et al.* (2007). However, the number of indicators of each aspect is unlike Giffinger *et al.* (2007), as they are restricted to only three elements for each dimension, as shown in Figure 2.5. The main reason behind this model was to help build integrated smart city strategies to function as a toolkit in producing smart projects besides supporting a transparent tracking of the growth. This toolkit also stresses prioritising the six aspects and building a strategic plan dedicated to fulfilling those priorities. Cohen (2011) recommended some critical stages to be followed before implementing the smart city wheel (Lekamge and Marasinghe, 2013). According to Cohen (2012), cities must tackle their challenges, targets and vision based on their population, geography, and infrastructure availability and consequently build the best practice to be followed to make their cities smarter. Therefore, in the first stage, he requires cities to frame their vision while involving citizens as an initial step towered understanding their city's needs. This helps build a customised framework to be used later as a baseline to enable cities to track their process toward being smart. Secondly, Cohen (2011) also provides a guideline to cities to go easy in their transformation process by choosing a target which can be easily accomplished, while planning to reach smartness than more complicated targets (Kaluarachchi, 2022). This wheel has been used in ranking cities in different areas, such as the smart cities in North America and the Smartest cities in Europe (Cohen, 2014). Figure 2.5 shows the indicators of each dimension of Cohen's (2014) smart city wheel. These indicators are built to show the extent to which smart city implementations impact the quality of life and services offered to their citizens. Accordingly, citizens are considered the main stakeholders in building smart cities, and their contribution to the process is also critical for the success of smart city initiatives (Lekamge and Marasinghe, 2013). Despite being a famous framework, this model has been criticised for lacking an understanding of the relationship among the different framework domains, and therefore, it is far from building a holistic view. Yet, it plays an important role in shifting the smart city view beyond the technical approach (Yigitcanlar *et al.*, 2018).

Figure 2.5: Boyd Cohen Smart city wheel (Cohen, 2014)



Nam and Pardo (2011) also explored the conceptual approach of a smart city. Figure 2.6 presents Nam and Pardo's (2011) model, which demonstrates three main dimensions of smart cities: technology, people and Institutions. They conceptualised their model to work as a guideline for implementing successful smart cities. They strongly insist on comprehensively understanding these three city dimensions and their connection to proceed with smartness.

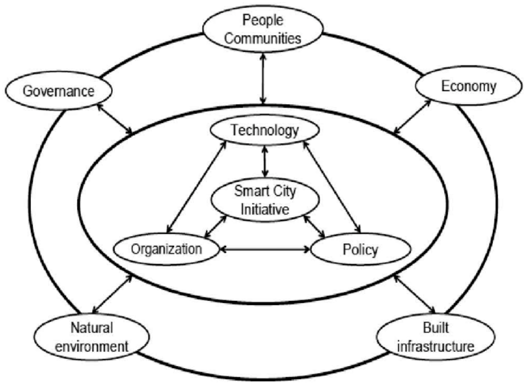
Figure 2.6: Fundamental components of the smart city (Nam and Pardo, 2011).



Different studies have discussed the huge unexplored smart city market and predicted it will reap 873.7 USD billion by 2026 (smart city journal, 2006). Hence, to gain the maximum share in the predicted market, IBM, as a global company, has realised the potential of urban market technology, and it launched IBM's smarter campaign in 2008. In 2011, IBM officially launched the brand "*smarter cities*" as a company trademark aiming to make the company an "*obligatory passage point*" to transfer a city to a smarter one (Söderström, Paasche and Klauser, 2014). IBM is the leader in providing smart city solutions and has been employed to support more than 2000 cities worldwide with smart solutions to be more productive and innovative. It has built a nine pillars model based on three main factors: (i) people (HR), (ii) infrastructure and (iii) management. People service includes education, healthcare, and social programs, whereas infrastructure services include water, transport, and energy. The management service pillar involves city governance, safety, innovative planning, and management of the city's resources. IBM places humans in the centre of its model to emphasise that cooperation between citizen groups, universities, different levels of government, and employees is essential to expand the cities beyond their boundaries and make them smart. It also believes that understanding the skills and capabilities of citizens needs to be addressed in the process of transforming a city into a smart concept. IBM's nine pillars model studies the interaction among the different model elements considering the city as a single whole entity, unlike the smart city wheel model where studying such relations, is not addressed (Lekamge and Marasinghe, 2013). Likewise, Hitachi's smart city solutions have built a model based on three layers almost similar to the general dimensions built by IBM. According to Kohno *et al.* (2011), Hitachi has been producing technology products to be used in three different layers within a city, namely (i) the "infrastructure layer", (ii) the "lifestyle layer", and (iii) urban "services layer". Hitachi provides hardware and software solutions for the infrastructure layers to support customer management, billing, water, and telecommunication systems. Hitachi also supplies elevators, air conditioning, and road, rail, and transport components to enhance the service layer. Regarding the last layer, Hitachi provides products that enhance citizens' life efficiency, such as developing security systems to promote safety in smart cities. The Hitachi smart city concept involves creating new values by combining ICT and communication technology into a city infrastructure to support cities' intelligence (Kohno *et al.*, 2011).

In subsequent work, Chourabi *et al.* (2012) expanded the complexity of Nam and Pardo's (2011) model in which they deployed the smart city initiative at the centre of their model to further explore the smart city concept. They suggested that all elements have different bearing influences on smart city initiatives as each factor has a different impact in different times and different contexts. Moreover, the effect level also varies as some might have a stronger effect than others. Therefore, and as can be seen in Figure 2.7, the factors are presented in two different levels in this model: the internal level includes technology, organisation and policy, and they are known for their direct impact and the outer level which involves government, people, communities, natural environment, and infrastructure. Furthermore, they considered technology a "meta-factor" since it strongly influences all the seven elements proposed in the model (Chourabi *et al.*, 2012).

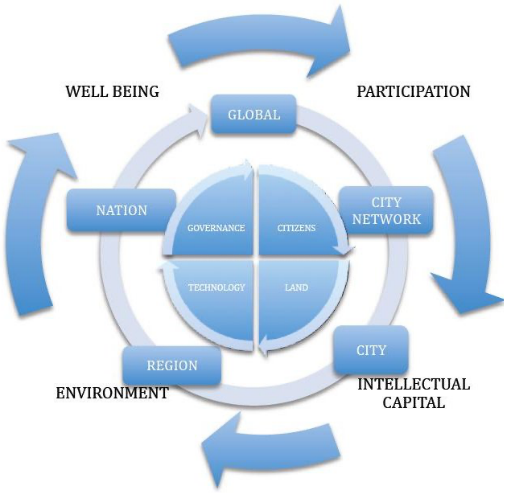
Figure 2.7: Smart City Initiative Framework (Chourabi et al., 2012)



Another relevant work is the investigation of Zygiaris (2013), who built a smart city conceptual model to address the socio-economic and sociotechnical challenges. His framework is called the smart city reference model and is made of six layers: (i) the city layer includes building a smart city vision aligned with the city's districts and infrastructure (ii) the green city layer where smart grids, sensors, green building leading to CO_2 reduction, (iii) the interconnection layer in which real-time data works as a connection between real life and information life through for examples traffic signals and smart meters, (iiii) the open integration layer represents a critical factor in smart city success since it highlights the importance to sharing and communicating data within different systems and platforms, (v) the application layer where the diffusion into a new level of intelligence happens, (vi) the innovation layer in which new business opportunities are created through the connection urban leaders with innovation strategies. He advised constructing smart cities by following this model to describe the urban innovation required by each city in each layer to synchronise the investments and prevent unsustainable investments.

Dameri (2014) argued that many cities around the world label themselves as smart while the attributes of being smart differ each time. Therefore, he proposed a conceptual framework to define a smart city through an extensive literature review and examining different empirical smart city projects aiming to build a logical framework to aid city stakeholders in making successful smart cities. He focused on the goals of the smart city rather than on the processes to build them, and accordingly, he recommended assigning clear and measurable defined goals. The core of the model is formed by the main components of a smart city: land, citizens, technology, and governance. The next layer relates to the boundaries and scope as the spatial approach is considered crucial in the smart city (Catlett *et al.*, 2019). The last layer is related to the goals of establishing smart cities, which are defined as a set of four main goals: environmental sustainability, life quality and well-being enhancing the role of citizens' participation, knowledge and intellectual capital (Dameri, 2014). Therefore, the smart city comprehensive schema model presented in Figure 2.8 is framed to help local and public governments, stakeholders and administrators to launch smart cities meeting their smart city ideal goals.

Figure 2.8: Smart city comprehensive schema model (Dameri, 2014)

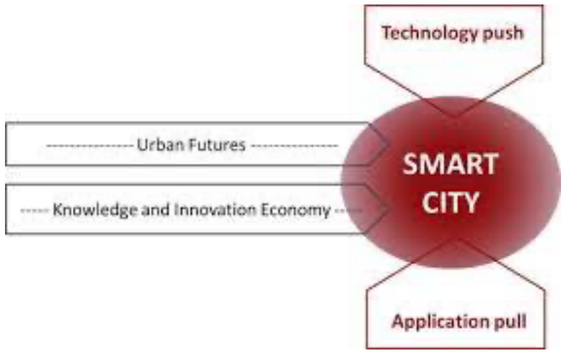


Angelidou (2014) inspects different factors of the evolution of smart cities to clarify the different strategic choices based on a spatial approach that may possibly take part in the planning of a smart city strategy. Thus, four strategic choices were initiated with a spatial reference, including (i) "national versus local strategies", (ii) "hard versus soft infrastructure-oriented strategies", (iii) "strategies of new versus existing cities and (iii) "sector-based versus geographically-based strategies". After conducting a detailed analysis of each strategy, she concludes with the importance of studying what is already obtainable in place and then investigating how it can be enhanced. Particularly, she strongly insists on the importance of the political coordination between different levels of administrations and approaching smart cities through small integrated projects as a part of a wider strategy to work as a pilot study in providing a valuable understanding of the current assets and the requirements and properties of the city. Moreover, she also stated the importance of addressing ethical issues such as privacy, security and social divide, and transparency as critical factors to the success of smart cities.

ASCIMER (Assessing Smart Cities In the Mediterranean Region) is a project carried out by the Universidad Politecnica of Madrid (UPM) to decide which smart city project to finance within the Mediterranean region. Later the project team developed a model based primarily on Giffinger et al. (2007) and the knowledge they gained from investigating smart city projects. ASCIMER project believes that smart city project evaluation should focus on the city's responses to real urban challenges. Thus, the model is used as a tool to initiate smart cities that address the various urban challenges without interfering with the city's sustainability while enhancing the citizens' quality of life. The model views a smart city as a union of the following dimensions: (i) people, (ii) mobility, (iii) living, (iiii) environment, (v) economy, (vi) and governance, with the application of the technologies as a critical element to confer on the smart city. It thus views a smart city as an integrated system where human and social capital meet to achieve sustainable smart cities (Monzon, 2015).

Figure 2.9 indicates Angelidou's (2015) perception, who conceptualises a model based on four main forces: (i) technology push, (ii) application pull, (iii) urban features and (iiii) innovation economy. It is considered one of the earlier models that combined technology and human factor together to enhance the "techno-driven" concept. Particularly, the model suggested that technologies stimulate citizens' knowledge and abilities, which later improve their innovation and contribution experiences and, in turn, help in solving cities' critical problems to reach overall well-being. Thus, the model encourages the importance of investments in intangible components than tangible ones to reach smart cities. Moreover, this model is considered one of the easiest to implement in smart cities as its forces are particularly relevant and can be easily adapted to the city context (Yigitcanlar *et al.*, 2018).

Figure 2.9: Smart cities a conjuncture of four forces (Angelidou, 2015)

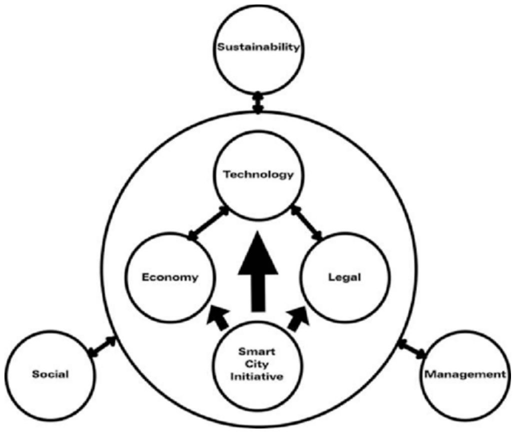


In the same year, Zubizarreta, Seravalli and Arrizabalaga (2016) conducted a comprehensive research of 61 applications of 33 smart cities from Europe, North and South America and Asia. They claimed that most cities implement smart cities only as a tool while missing the broader view of the city. Also, they claim that although different good tools are available, most of the studied smart city projects are built isolated from the broader ecosystem and therefore serve only a limited area whilst failing to address the wider vision of the city. As a result, they produced a series of integrated and holistic approaches and steps to be followed to promote the sustainable development of the smart city. They believe that technology is only a driver and a facilitator of building a smart city and adopting a wider strategy and purposes to guide the technology adoption is a must. Furthermore, they state the importance of "*shift the focus from technology to the people*" (Zubizarreta, Seravalli and Arrizabalaga, 2016, p. 2).

In another related work conducted within the same year ,Gil-Garcia, Pardo and Nam (2015) reviewed the literature to map different building blocks of smart cities in a framework. They identified ten components which are further categorised into four themes, namely: (i) society, (ii) physical environment, (iii) technology and data and (iiii) government. Although their framework has revealed critical elements of smart cities, it is built only based on the definitions review and the smart city ranking indicator missing investigation of the actual smart city projects.

Joshi *et al.* (2016) have built the SMELTS framework presented in Figure 2.10 based on a comprehensive literature study. They argued that cities face various challenges due to the increasing population and lack of open data, services interconnection, and resources limitation. They stated that integrating proper ICT into cities enhances a better relationship with all sectors. They identified six factors in building successful smart cities (SMELTS): (i) Social, (ii) Management, (iii) Economic, (iii) Legal, (v) Technology and (vi) Sustainability (Joshi *et al.*, 2016). This framework is critical as it enhances cities understanding of how to initiate better smart cities and provides a managerial prospect of it.

Figure 2.10: SMELTS Framework for smart city (Joshi et al., 2016)



Similarly, Kummitha and Crutzen (2017) assembled the various views of the smart city stakeholders, especially the private sector and proposed a 3RC framework consisting of four main factors: (i) restrictive, (ii) reflective, (iii) rationalistic and (iiii) critical. The first three factors support the construction of smart cities, whereas the last factor denounces the risks assigned to the smart city. The overall aim of the framework is to understand how cities are different in their “meaning”, “intentions”, and “offering” (Kummitha and Crutzen, 2017). Moreover, Amaba (2014) also suggested the importance of integrating the human factors’ multimedia and user-centric approach in designing smart cities. For example, politicians may alter the public mood to support their decisions, enterprises can engage the customer by collecting feedback about different products, and administrators should understand citizens' prospects for improving their quality of life.

Myeong, Jung and Lee (2018) concentrated on the process of conceptualisation of the key determinant factors in smart city construction. The aim of their work is to build a sound understanding between different stakeholders, including academic researchers, policymakers and beyond. They strongly criticised the idea of simply applying technology to construct smart cities while ignoring all other critical factors necessary to understand the smart city. Therefore, they described a group of factors associated with the successful application of smart city projects. These factors are classified into internal factors comprising citizens participation, leadership, infrastructure and external factors, including those derived from the Fourth Industrial Revolution, policy commitment and stakeholders (Myeong, Jung and Lee, 2018). In related work, Yigitcanlar *et al.* (2018), conducted research to enlighten the importance of sustainability as a critical aim of smart city implementation. Interestingly, they revealed that most smart cities failed to achieve their sustainability goals for a variety of reasons, the main being that: smart cities are too techno-centric. To mitigate these challenges, they recommended that cities need to meet four urban conditions to build knowledge-based smart cities, namely: constructing environmentally friendly cities, economically sustainable cities, socially comprehensive cities and better city planning and governance (Yigitcanlar *et al.*, 2018).

2.3 Smart Transportation System

2.3.1 Challenges with the Urban Transportation Systems

Given most people’s willingness to live independently and individually, car ownership has increased sharply. This increase in car ownership has led to a growth in the number of cars on the roads causing serious issues in the transportation sector (Sperling and Gordon, 2008). Today, road transportation quality and adequacy represent a very important concern for citizens as it affects their access to the main services and components of their cities (Valiantis, 2014). In other words, transportation represents an important task in urban development as it ensures proper access to education, health, works, governmental agencies, markets, shopping and other services (Valiantis, 2014). This is particularly important in developing countries as enhanced mobility and transportation represent one of the prerequisites for achieving their cities' sustainability goals (Sohail, Maunder and Cavill, 2006). Yet, the current reality of the transportation sector in developing countries indicates that it is far from ideal as it involves a range of problems (Valiantis, 2014). The main transportation problem that has existed for a long time is traffic congestion (Olayode *et al.*, 2020). Population growth has affected transportation and road capacity with increased vehicle numbers, leading to road traffic congestion (Lah *et al.*, 2015). In turn, this has caused an increase in travel costs, waiting time for passengers, and delays and late arrivals for work, school, and business (Berg and Verhoef, 2016). Therefore, for instance, Dubai's smart city has initiated the "Metro Dubai" project to minimise traffic by reducing dependency on personal cars, indirectly pushing Dubai's economy by attracting more tourists and promoting pollution reductions (Nasser and Alefari, 2022).

Moreover, urban transportation has caused environmental and health issues (Olayode *et al.*, 2020). With regard to the environment, poor transportation services have led to a higher demand for fossil fuel consumption (Li *et al.*, 2020). According to the World Health Organization, fossil fuel is classified as a major contributor to air pollution (Chin, 1996). According to Song, Zhang and Shan (2019), the transport sector is the main source of CO_2 emission. Additionally, noise represents another environmental concern associated with transportation services (Sohail, Maunder and Cavill, 2006). Fiedler and Zannin, (2015) conducted a study in cities in Latin America and found that the noise level is above the national standards, particularly in areas close to high traffic congestion. Regarding health issues, statistics show that around 12,000 premature death cases yearly are due to the rise of environmental noise (Münzel, Sørensen and Daiber, 2021). Human direct exposure to noise and pollution results in different health concerns, such as asthma, high blood pressure and sleep disorders (Guadalupe-Fernandez *et al.*, 2021). Similarly, safety on roads has also become a universal problem that governments need to take seriously, and therefore, the period between 2011-2020 was declared "*the Decade of Action for Road Safety*" by the World Health Organisation (World Health Organisation, 2017). World Health Organisation (WHO) has also declared that over 1.35 million people died and about 50 million were injured in road accidents (World Health Organization, 2019). Road accidents absorb a huge percentage of the government's financial resources, specifically in developing countries (McIlvenny, 2006). High demand for parking space is another obstacle facing urban cities since vehicles are expected to be parked most of the time (Jaller, Holguín-Veras and Hodge, 2013). Therefore, most of the city's central areas face a high demand for parking slots (Sharma, Prjapati and Jain, 2017). Drivers spend a good amount of time searching for parking space which can be compensated by money (Shoup, 2006). Land consumption is another well-known transportation issue (Olayode *et al.*, 2020). According to Litman (2016), transportation decisions directly influence land use involving the reduction of open spaces such as parks and wildlife and the reduction of the groundwater level.

2.3.2 The Advantages of Smart Transportation Technologies in Cities' Liveability

Drawing on the above discussion, implementing smart systems and technologies in the transportation sector needs to consider a more human angle to address the challenges associated with transportation and deliver health benefits by reducing noise and air pollution. Sustainability in transportation is about balancing citizens' social and transportation needs and the natural resources and environmental needs (Steg and Gifford, 2005; Goldman and Gorham, 2006).

To achieve smart transportation sustainability, it is important to coordinate with various transportation departments to develop transportation strategies that support efficiency and effectiveness (Crainic, Gendreau and Potvin, 2009). Governments are advised to empower citizens with smart transportation choices by cooperating with transportation agencies to adopt advanced transportation systems (Bıyık *et al.*, 2021). Transportation liveability benefits citizens by accommodating people with various transportation choices such as walking, private cars, public transfer, and cycling. Transportation liveability is also about delivering reliable and timely access to cities' services and safe roads, economical transportation choices, cost saving, environmentally green and supporting cities' sustainability goals (Miller, Witlox and Tribby, 2013; Okoro and Lawani, 2022). Moreover, it also empowers people with better access to live transportation information, saving energy, natural resources, time and infrastructure (Jeong *et al.*, 2021; Pompigna and Mauro, 2022). Most of the smart transportation services, applications and systems are designed to serve different needs and solve most of the urban transportation issues discussed earlier. A wide range of systems has been introduced, and most of them are designed to control and manage traffic, enable automatic fee collection, ensure safe driving, and, more interestingly, enable data collection, transfer processing and analysis to enhance informed decisions making (Smart Card Alliance, 2003; Sahal *et al.*, 2021). Moreover, The Transportation Systems and Management and Operations (TSMO) is a set of strategies designed to enhance the efficiency and effectiveness of transportation by improving the capabilities of the transportation facilities a city already has (Clark *et al.*, 2017).

Thus, Traffic Management and Operations are one of the strategies designed to support many activities such as traffic surveillance, traffic management and traffic signals control. Road weather operation is another strategy which helps generate road weather information. Public transport management strategy enhances security, travel connection and public transport fare collection. Incident and Emergency Management strategies contribute to emergency vehicle routing and management of traffic incidents (Clark *et al.*, 2017).

Accordingly, it can be concluded that by designing effective transportation systems and adopting properly designed strategies, citizens and communities will gain a wide range of advantages. Adopting a smart transportation system helps citizens save travel time as it supports drivers with information to choose the better routes, which helps avoid cruising (Chen, Ardila-Gomez and Frame, 2017). It also provides citizens with more free time; for example, smart traffic signals are expected to decrease the delay (Chen, Ardila-Gomez and Frame, 2017). Also, it enables less wasted fuel as it saves time wasted in traffic congestions. Consequently, it supports the reduction of air pollution by, for example, providing a variety of transportation modes such as walking, cycling, and sharing rides (Nikitas *et al.*, 2017). Enhancing liveability is a critical goal achieved by smart transportation as it offers a wide range of affordable and accessible transportation options (Grindsted *et al.*, 2022). It also has economic advantages such as reducing unproductive time and helping goods and citizens get to the market faster (Bıyık *et al.*, 2021). Furthermore, smart transportation mobile applications are critical in enhancing safety and security by offering real-time tracking, reporting of hazards and suspicious activities, emergency aid, and integration with traffic lights to reduce accident occurrence and enhance safety (Oladimeji et al., 2023). Another advantage is related to the advantages gained by the businesses in improving their supply chain as smart transportation mobile applications help optimise their freight and logistics management by, for example, helping them track their shipments and automate their processes (Kadłubek et al., 2022).

2.3.3 Emerging Smart Transportation Systems

Smartphone applications and sensors revolutionised connecting devices and the execution of smart complicated tasks (Steg and Gifford, 2005; Wang and Wang, 2010; Zantalis *et al.*, 2019; Javed *et al.*, 2021). In addition, the emergence of computer technologies, artificial intelligence, IoT and ICT are also contributing to the innovation of transportation systems by developing proper traffic management (Sumalee and Ho, 2018). Smart transportation is about adopting a wide range of technologies to manage and observe transportation to facilitate efficiency, effectiveness and safety (Zantalis *et al.*, 2019). Smart transportation is accepted as a wide term encompassing road optimisation, improving parking cruising, controlling streetlights, deducting car accidents and preventing them (Paiva *et al.*, 2021). In other words, smart transportation is about improving the efficiency of roaming around a city, making movement more convenient, safer and cost-effective (Bamwesigye and Hlavackova, 2019). Today, there are various practices for the applications of smart transportation systems.

Khan *et al.*, (2022) highlighted that one of the pillars of smart transportation is traffic management information systems, which are composed of management tools in addition to a range of applications that work together to sense and collect traffic data from a variety of sources such as automobiles, traffic lights, and roads in order to reduce congestion. Traffic centres produce real-time information to cope with the situation by directing drivers to the best route with less congestion, thus aiding them to reach their destination faster. Thus, traffic management information helps in upgrading the capacity of the roads without the need to widen current roads or construct new roads.

Nichițelea and Unguritu, (2021, p.2) discussed another smart transportation component namely dynamic traffic lights as being another enabler of smart transportation systems and representing the use of "*smart traffic lights combine traditional traffic lights with an array of sensors to intelligently route vehicle and pedestrian traffic in order to reduce the waiting time and the fuel consumption*". Traditional traffic light relies on phase time which is predetermined and fixed for each direction. It depends on the electromechanical controller, and therefore, it is criticised for being insufficient for urban cities where the traffic flow is variable. A dynamic traffic control system is the best way to manage traffic based on traffic density. This system enables a flexible time for vehicle flow based on the most crowded intersection, besides prioritising emergency cars whenever needed (Chowdhury and Biplob, 2019).

Electronic detection system aims to prevent traffic violence by adopting cameras and sensors (Bommes *et al.*, 2016). Traffic lights and speed cameras are the two main examples of this system (Yabuuchi *et al.*, 2020). Using an electronic detection system improves the city's safety, life, and property and prevents accidents (Qureshi and Abdullah, 2013).

Elkosantini and Darmoul (2013) also explained smart public transportation as a valuable system designed to enhance passengers' experiences by providing them with up-to-date information. It involves a variety of technologies such as smart cards, smart bus stops and bus tracking applications used to monitor, evaluate, and manage public transportation to make commuting around cities more cost-effective and convenient (McDonald, 2000; Eken and Sayar, 2014).

Sridevi *et al.* (2017) described that a bus tracking system is another application used to track and generate real waiting time by informing passengers about real-time bus arrivals. It is about installing electronic devices in buses linked to smartphone applications installed on passengers' devices, allowing them to track the physical locations of public buses. This system works in coordination with GPS (Global Positioning System) to provide vital information about real-time tracking that helps reduce wasted time in waiting as it enables passengers to know the exact bus arrival time (Shibghatullah *et al.*, 2022).

Abdulla, Abdillahi and Abbas, (2018) explained that the electronic transportation pricing system is considered one of the latest technologies enabling instant toll collection automatically. This system depends mainly on Radio Frequency Identification (RFID) and Automatic vehicle identification, which are equipped in vehicles as chips storing each vehicle plate, type and weight beside a money account used to identify each automobile's eligibility and assess their fare. Such systems aim to eliminate delays and reduce congestion by digitally collecting fees without human interaction or stopping vehicles. Today many developed countries introduced congestion costs used to charge vehicles accessing urban areas, especially during rush hour, to reduce traffic, promote the utilisation of public transport and minimise air pollution (Ortúzar, 2019).

Chen *et al.* (2021) also discussed the advanced traveller information systems as another component of smart transportation systems which combine all computers and communication technologies to provide real-time information to assess travellers to move from a starting point to their final destination. The global positioning system also supports them with useful information on the existing and upcoming traffic congestion, best routes, expected road hazards, weather conditions and the accommodation and restaurant services on the road.

Based on the above discussion, it can be argued that most smart transportation systems depend on sharing and exchanging real-time information. Transportation live information is needed to be shared in an easy, user-friendly, and effective manner to encourage and enable users to make informed decisions while also keeping up with their personal movements to access the live transportation information. Thus, mobile technology and its applications are the best to be utilised in support of providing the above-mentioned services effectively and efficiently (Shammary and Saudagar, 2015). Moreover, Sepasgozar et al. (2019) and Zantalis *et al.* (2019) argued that mobile applications are used to deliver a wide set of smart transportation information to end users to enhance their daily commuting. Likewise, Höjer and Wangel (2015) and Mohanty, Uma Choppali and Kougianos (2016) stated that citizens could utilise the sophisticated systems available in mobile applications to receive smart transportation services and information.

2.4 Citizens' Participation in Smart City Initiatives

2.4.1 Top-Down and Bottom-Up Approaches

There are two main strategies to follow in constructing smart cities, respectively, top-down and bottom-up approaches (Letaifa, 2015). The top-down approach is closely related to the technology aiming to incorporate ICT technology into the cities' infrastructure to control urban activities along with providing tools to contact the infrastructure automatically. Washburn and Sindhu, (2009,p.2) define a smart city as "*the use of Smart Computing technologies to make the critical infrastructure components and services of a city—which include city administration, education, healthcare, public safety, real estate, transportation, and utilities — more intelligent, interconnected, and efficient*". This definition illustrates a clear emphasis on the development based on technology infrastructure. This style of smart city strategy consists of large data collection, calculations, visualisation and assumption built upon the collected figures (Rogers, Capra and Schoening, 2013). In addition, this approach includes the integration of different ICT applications such as sensors, IoT, digital footprints and finally, visualisation modelling as a tool to make sense of all collected data (Khan *et al.*, 2015). As a result, this approach to making a city smarter is obviously dependent on ICT technology and therefore presents serious opportunities for different technology companies (Yigitcanlar, Foth and Kamruzzaman, 2019). These companies are expected to generate enormous profits by controlling large and medium urban cities' demand for their branded solutions (Kumar *et al.*, 2016). Recently, some international and leading companies such as IBM, Microsoft, Cisco, Siemens and Accenture have come to the market with smart solutions and intensified the competition in developing smart platforms and smart solutions (Abdoullaev, 2011).

Different cities adopted the top-down method as it facilitates smart city leaders in attaining the advantages of transformational changes and pre-emptively mitigating their associated risks. Nevertheless, despite the widespread proliferation of smart city initiatives (Nicolas, Kim and Chi, 2021). Moreover, according to Meijer, Lips and Chen (2019), the top-down method applied to a smart city enhances the integrated view of the city infrastructure and, as a result, ensures a smooth flow of functions while also having a proper study about city resources before attempting to solve the problem. Finally, this approach is the best to follow to tackle emergency situations since it provides central coordination about city resources and allocates them efficiently where they are needed (lifetusharpatil, 2015).

On the other hand, implementing a top-down smart city method entails a full dependency on technology companies who hold the knowledge and solutions, and therefore cities will rely on them to face their urban challenges. As a result, cities aiming to be smart become a commercial market target for different companies. Moreover, this view fails to address citizens who live and use these solutions. Rio De Janeiro is the most famous city following this sort of smart city implementation (Agostino Nuzzolo *et al.*, 2014), along with other cities, such as Masdar smart city in the United Arab Emirates and Songdo in South Korea. By using these samples, Sennett (2012) argued that the "*danger now is that this information- rich city may do nothing to help people think for themselves or communicate well with one another*.

Regarding the bottom-up approach, it engages all stakeholders in planning and implementing the smart cities (Capdevila and Zarlenga, 2015). It mainly focuses on people who live, use and work in the city as a main source for change while avoiding the involvement of powerful private companies (Ryser, 2019). Although this approach is considered new in smart city implementation, it has been shown to have different advantages (Lange and Waal, 2019). Firstly, it improved cities' governance efficiency by advancing the progress of urban change and, as a result, helped advance the broader acceptance of the smart city changes (Meijer and Bolívar, 2016). Secondly, Le Feuvre *et al.* (2016) argued that cities become more innovative and liveable on the whole as different inputs from different parties enhance the intelligence, knowledge contribution and better understanding of cities' urban problems. Building cities tailored to their people's needs enhance social sustainability and improves the social digital divide issue through accepting conversations between different citizens (Zygiaris, 2013). Further, it leads to economic sustainability due to cost and resource saving since it involves building an application based on the end users' desire(Calixto, Gu and Celani, 2019). Yet, the bottom-up procedure might cause failure in smart city adoption if the received ideas from the citizens are of poor quality or if the response from the participants is very low. Cities follow different methods to adopt the bottom-up approach; the most common are the Living lab and crowdsourcing. Living labs mean using cities as "*a real-world testing ground for new ideas and technologies*" (Cosgrave, Arbuthnot and Tryfonas, 2013, p. 671). In other words, it is an open platform to engage different stakeholders in a real-life experience to assess the smart city concept and its life opportunities generally (Paskaleva *et al.*, 2015). According to the European Network of living labs (2013), living labs consist of four main steps co-creation, exploration, experimentation and evaluation (Pallot, Krawczyk and Kivilehto, 2013). Many authors have approved the ability to live labs to provide valuable knowledge and experience in the smart city implementation (Bakici, Almirall and Wareham, 2013; Engelbert, van Zoonen and Hirzalla, 2019; Spagnoli, Graaf and Brynskov, 2019). In terms of crowdsourcing, this is one of the methods used to collect data about smart city applications. It is about outsourcing different tasks to a crowd to get used to their experiences, skills and knowledge to accomplish one or various tasks (Kucherbaev *et al.*, 2016). Advancement of Web 2.0 technologies has accelerated crowdsourcing procedures tremendously (Bonabeau, 2009) and there are different techniques to encourage people to participate in crowdsourcing, such as " *monetary compensation, altruistic reasons (the 'opportunity to contribute'), fun/pleasure, recognition, self-development, passion for problem solving, and reputation*" (Angelidou and Psaltoglou, 2018, p. 9).

While most of the early research approved the top-down approach to building smart cities, today, most science strongly recommends following the bottom-up method (Arsovski *et al.*, 2018). On the other hand, Suzuki (2015, p. 1) recommended an appropriate mix of both top-down and bottom-up strategies as this combination can guarantee the "*successful leverage of the innovation and knowledge creation made possible by the data infrastructure*" (Suzuki, 2015, p. 1).

2.5 Summary

This chapter has examined many facets of the smart city notion to comprehend the crucial elements influencing the public's adoption of mobile applications for smart transportation. The definitions, models, examples, motives, and challenges of smart cities have all been thoroughly examined to examine the factors involved in creating effective smart transportation services. As the definitions are rigid, the main models of the smart city concept have been discussed to understand better the elements essential to the effective implementation of smart services. Moreover, the domain of smart transportation has been explored as it is the main domain to be used throughout the thesis. Finally, the chapter has discussed the significance of citizens' involvement and engagement in the development process as it directly influences their acceptance and adoption of smart transportation services. The idea of acceptance will be discussed in the next chapter, which will also create the research's theoretical foundation.

Chapter 3: Context of the Study

3.1 Introduction

This chapter mainly considers the case of the Sultanate of Oman, which like many other countries throughout the world has introduced various smart services and projects with the aim of solving the various urban challenges the county is facing. It provides a concise case study that demonstrate the significance of smart city services and projects. It will also discuss the transportation challenges facing Oman. It highlights initiatives undertaken in implementing smart projects in Oman. It will also provide key geographic and demographic information to depict the context of the current study.

3.2 Rationale of the Study Context

The Sultanate of Oman is an independent Arab country with a rich history in the Middle East with an area of 309.5 thousand km^2 (Al-Shaqsi, 2010). It is situated on the south-eastern coast of the Arabian Peninsula facing the Arabian sea and the Gulf of Oman. It overlooks the Strait of Hormuz, which gives it strategic importance as this Strait is where most of the world's oil passes through (Al-Shaqsi, 2010). Figure 4.1 shows that Oman is bounded by three countries and three bodies of water: to the northwest, Oman shares borders with the UAE; to the west, Oman is bounded by Saudi Arabia; to the south, it shares its border with the Republic of Yemen (Manaa, 2013). This geographical location gives Oman strategic economic, political and tourism values (Henderson, 2015). Oman consists of eleven governorates, namely: Muscat Governorate (the capital), Al Buraimi Governorate, Dhofar Governorate, Al Wusta Governorate, North and South Al Sharqiyah Governorates, Musandam Governorate, North and South Al Batinah Governorates, Al Dakhiliyah and Al Dhahirah Governorate (Al Saiti *et al.*, 2017). The formal language in Oman is Arabic, but English, Baluchi and Swahili are also widely used around Oman (Al-Maamari, 2016).

The Sultanate is a member of the Gulf Co-operation Council (GCC) with five countries, namely: United Arab Emirates (UAE), Saudi Arabia, Kuwait, Bahrain and Qatar (Tompkins, 2012). Similarly, to other GCC countries, oil is considered the main income source in Oman. The oil income enabled a dramatic development of Oman over the last decade (Naim, 2021). However, Oman's economy got affected by global oil prices, and the drop in the oil prices has seriously affected the Sultanate's economy (Anasweh, 2021).

Oman has varied topographic features ranging from the desert, which represents 82%of the land, to mountains, making up 15% and coastal regions, which constitute 3% of the land (Al-Marshudi, 2001). As a result of the mountains, it is difficult for the government to establish a road network and other infrastructures in rural areas. However, the government has expanded its funds to leverage the most recent technologies in rural areas. The country suffers from a scarcity of agricultural land which represents only 8% of its surface area (Ministry of Environment and Climate Affairs, 2014). The Omani coastline is around 3165 kilometres, with many strategic ports such as Muttrah, Sohar and Salalah (ITA, 2017).

Regarding the climate, Oman is considered to be arid and semi-arid except in Dhofar governorate, which enjoys monsoon weather. The weather in Oman is hot and sunny all year, with few chances for winter rain (Shboul *et al.*, 2021). Generally, the climate in Oman is very hot and dry over the year except for the higher lands, such as the mountains, where the temperature remains moderate throughout the year.

The government system in Oman is an absolute monarchy, and the revolution started with the appointment of His Majesty Sultan Qaboos bin Said AL Said in 1970 (Neubauer, 2016). Oman, compared to other Arab countries, is one of the most stable countries in terms of politics and safety. According to the Global Peace

Index Field, it was listed as the fourth most peaceful country in 2019 (Olsen, 2019). Moreover, Oman is a member of the World Trade Organisation (WTO) and is categorised as an appropriate country with a friendly environment for foreign investment (UNCTAD, 2014). Additionally, the open market and the tax exemption granted by the government to investors enhanced the investment attraction, besides encouraging the start-up of new businesses (UNCTAD, 2014).

Figure 3.1: Map of Sultanate of Oman (VectorStock, 2022).

3.3 Oman's Society and Culture

Oman is famous for its lively culture, rich history, and welcoming society (Landen, 2015). This culture plays a significant effect in preserving the Omani tradition and respect for the past. Therefore, Omani society and culture significantly influence the acceptance and adoption of new technology (Amri, 2018). Hence, the subsequent paragraphs explore the main prospects of Omani society and culture to improve the understanding of the phenomenon being studied.

The Omani culture emphasises family and community values in all aspects of their life, in which family is the central and pivotal institution (Al-Barwani and Albeely, 2014). Also, Collectivist responsibility is a profound aspect of the Omani culture, and accordingly, its impacts go beyond the environment and society into the acceptance of new technologies (Echchabi, Al-Hajri and Nazier Tanas, 2019). In Omani society, there is a great appreciation of progress and development (Preliminary vision document, 2020). As adopting and accepting new innovations is regarded as a means to enhance the overall welfare of life and the community as a whole, the collectivist culture encourages citizens to embrace new inventions that are agreed to benefit the whole society (Tiessen, 1997). The Omani society is also firmly rooted in the Islamic tradition, and its values and norms are shaped by it (Al Hinai, 2020).Islam emphasises the importance of seeking advancements in all fields and is expected to enhance the adoption of new technologies (Lenchuk, Ahmed and Al-Alawi, 2023).

In addition, Oman’s society holds a significant importance on education and knowledge. The Omani government has invested heavily in education, guaranteeing that all citizens have great access to quality education (Whelan, 1987). This further affected Omani's perception regarding the new technologies as they recognised them as potential benefits in terms of education and the advantages they bring to society. However, the Omani government has less focus on digital skills, and technological literacy represents a primary challenge that impedes the acceptance of new technologies as they lack the important skills needed to utilise the new technologies effectively (Al-Mahrezi, Bakar and Sjarif, 2021). Moreover, Oman’s culture is characterised by a generational gap in which the younger generations are very respective to the new technologies, whereas older generations are more traditional and conservative to changes and new technologies (Al-Riyami, Al-Maskari and Al-Ghnimi, 2023; Madhavan *et al.*, 2023). This divide presents a challenge as older people usually occupy influential roles within society, and accordingly, they may influence the adoption of new technologies. Another feature of Omani society is the digital divide, which is also expected to hinder the acceptance of new technologies in Oman (Al-Riyami, Al-Maskari and Al-Ghnimi, 2023). Although the urban areas in Oman are privileged with advanced technologies, the rural areas are still struggling with regard to access to such technologies, as well as insufficient internet connectivity.

Oman's rules and regulations also play a critical role in shaping the acceptance and adoption of new technologies (Abri, McGill and Dixon, 2009). Oman is well known for its constrictive bureaucratic procedures and is very cautious and careful in assigning new regulations (Abri, McGill and Dixon, 2009). It is expected that these lengthy approvals and slow pace of decision-making make companies slow in utilising the new technologies, which limits their availability (Alamri, Amoudi and Njie, 2017). In addition, privacy and security concerns pose significant concerns regarding adopting the new technologies in the Oman (Amri, 2018). The concern about the potential for personal data breaches and the chances of unauthorised individuals accessing confidential data shape another resistance toward accepting and adopting the new technologies (Shatat, 2017).

3.4 Smart Cities Development in Oman

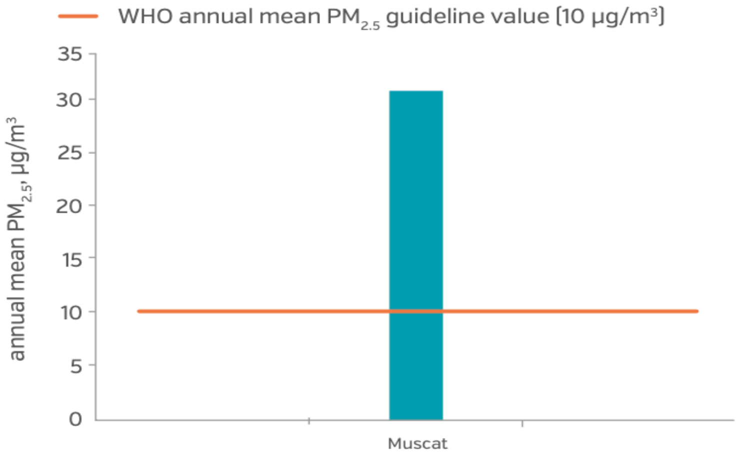
3.4.1 Smart Cities Motivations in Oman

Smart city solutions can solve different urban problems Oman is currently facing. The following paragraphs explain the most critical urban problems Oman is facing.

- **Air Quality Motive**

The WHO declared that the air quality in Oman is affected due to different reasons (WHO, 2015). For example, the rapid economic development in the last few years to offer a better quality of life to its citizens and the extensive population growth have caused air pollution from different sources, including pollution generated from energy generation, vehicles, and different types of industries such as chemical, cement and petrochemical (WHO, 2015). The most air-polluted area in Oman is reported to be Sohar city due to the heavy industrial businesses there. Muscat is also considered an area with high air pollution due to the high rate of nitrogen oxide (NOx) produced by its high traffic density due to the huge number of cars (Amoatey *et al.*, 2020). This air pollution contributes to other challenges, such as the rising global temperature, causing different kinds of natural disasters such as droughts, floods and hurricanes (Islam, 2022). For example, over the last twenty years, Oman has experienced climate change with frequent cyclones, the most famous of which was the Gonu cyclone which caused severe damage to Muscat's infrastructure (Ahmed and Choudri, 2012). Air pollution also directly affects human health as tiny particulates attack the respiratory system and cause lung cancer and many other diseases (Kampa and Castanas, 2008). The following diagram shows that Muscat air is considered unsafe as its indicator for air quality was above World Health Organisation standard level.

Figure 3.2: Muscat PM2.5 rate from 2008-2010. Source: (WHO, 2015).



- **Water Motive**

The Sultanate of Oman is considered one of the most affected countries in the world by water scarcity (WHO, 2015). The Oman Water Society declared that there are three main sources of water in Oman: (i) surface water, such as Afalaj, (ii) groundwater, such as wells, and (iii) wadi and springs (Oman Water Society, 2020). The government decided to reduce the underground water dependency and started producing drinking water mainly from seawater through desalination (The Public Authority for Water, 2015). According to Aziz (2015), Oman's water availability is at risk due to climate changes and population growth. This further threatens agriculture production, and available water per capita (AWPC) is expected to be reduced to half by 2030 (Aziz, 2015).

- **Electricity Motive**

The Public Authority for Electricity and Water (PAEW) in Oman estimated an increase in electricity demand by almost 8% to 10% (Maksood and Achuthan, 2017). Oman depends mainly on natural gas as a main source of electricity, producing around 97% of the total electricity generated (IRENA, 2014). From 2009 to 2010, Oman experienced a serious power outage which further requested an expansion of power production, which also caused pressure on oil and gas resources to meet this high demand (IRENA, 2014). As a result, it is predicted that Greenhouse gas emissions (GHG) are generated from using fossil fuels such as oil and gas to produce energy to become the principal source of the CO_2 and CH4 emissions in Oman (Abdul-Wahab *et al.*, 2015). Interestingly, Oman can use renewable energies such as solar energy and wind power to solve harmful emissions and helps in developing eco green environment (IRENA, 2014).

- **Housing Motive**

Ali Al Sunaidi, Minister of Commerce and Industry, declared that affording a house is becoming one of the main challenges facing Omani citizens and that most Omani couples live with their parents because renting or owning a home is too expensive (Fahad, 2015). This raises the need for master planning focused mainly on offering affordable housing options with sustainable buildings while considering the social infrastructure (Dhama, 2019). He further argued that the fastest-expanding cities in developing countries had shown indicators of crumbling infrastructure coupled with a housing shortage.

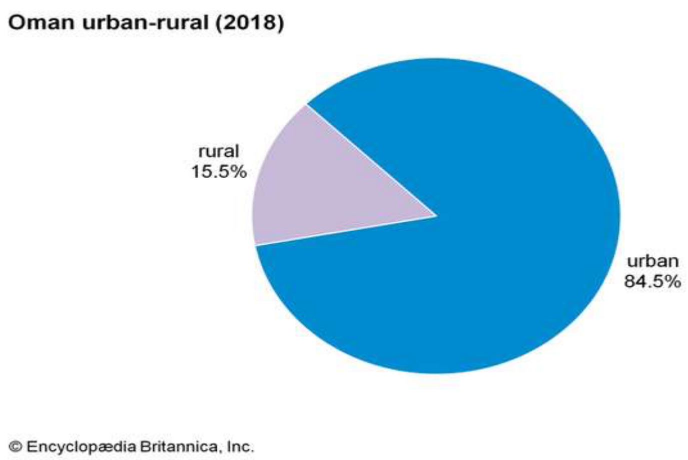
- **Economic Motive**

Oman mainly depends on oil and gas resources as the country's income source, representing around 70% to 85% of the income, depending on the oil prices (Kate, 2019). However, the fluctuation of oil prices causes severe problems. For example, the drop in oil prices in 2016 caused a shortage of 13.8 billion USD in the country's budget (Kate, 2019). Therefore, the government decided to diversify its sources of revenue to include tourism, mining, aquaculture, fishing and farming (Al-Muharrami, 2019). Oman is recognised as one of the largest countries in the Middle East, with rich natural diversity ranging from mountains and beaches (de Pablos, Tennyson and Zhao, 2011). Moreover, Oman is keen these days to attract foreign investment to sustain and improve the economic situation in the country (Pauceanu, 2016). Reassuringly, Oman is considered one of the most stable countries in the region, with zero tolerance policy for corruption besides offering the best condition for foreign investment (Lefebvre, 2010; Elsayed, 2021). These contribute to attracting foreign investment.

3.4.2 Smart Developments in Oman

In the past 50 years, the Sultanate of Oman’s progress has led to major social, economic, and political changes, shifting Oman from a secluded country to a wealthy and technologically advanced one (UNCTAD, 2014). Like other countries in the GCC region, the country’s cities play important economic, social, political, cultural, technological, and administrative roles. Therefore, most governmental investments have focused on cities (Benkari, 2017). On the one hand, these cities became among the top-notch cities worldwide. On the other hand, they absorb the investment and development budget of the GCC countries and thus leave other areas in the country isolated and undeveloped (Willen *et al.*, 2015). Therefore, it is hard to keep young generations in their villages. Instead, most of them migrate to Muscat, seeking jobs and a better quality of life (Shaibany, 2020). According to Figure 4.3, most of Oman’s population is urban, with 85%, but it also has 15.5% of rural accommodations. Crystal (2022) observed that these rural settlements are located next to the Ḥajar Mountains foothills, where irrigation is available due to Aflaj and the rain. Figure 4.4 shows that the urbanisation rate has jumped from around 30% in 1970 to almost 50% in the next few years, and it is predicted that the number will hit 85% by 2040 (Benkari, 2017).

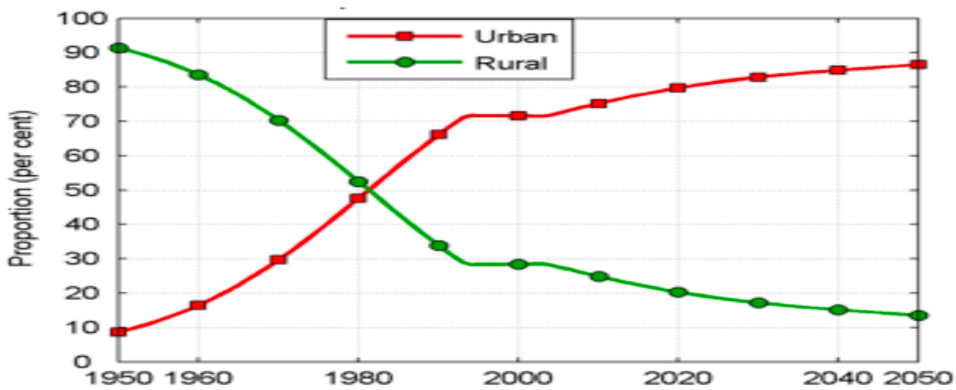
Figure 3.3: Oman urban various rural (2018). Source: (Crystal, 2022).



Shaibany (2020) stated that due to this immigration, the capital Muscat is shouldering great responsibilities in creating employment on top of maintaining the quality of services provided, such as in the health, education, and transport domains. Also, Jalagat and Jalagat (2016). stated that the congestion situation in Muscat is worsening daily, and citizens are haggling to arrive at their work on time each morning, and this problem includes students and other business owners. Moreover, Al Shueile (2015) conducted a study and argued that this social movement has also led to a huge demand for land, further pushing their prices to an extreme level.

Population growth has also raised the investments in the education sector besides affecting the quality of outputs as stated by Mohammed Al Hosni, Director General of Finance at the Ministry of Education, " *the increase in the value of spending is only natural due to the increase in the number of students, teachers, and educational tools used to improve the output and quality of education*" (Times News Service, 2018). Regarding the health sector, although Oman has been ranked as number one by the World Health Organization for the last three periods, Oman is currently facing the challenge of sustaining these achievements as the pressure on health services is increasing sharply (Al Dhawi *et al.*, 2007). Additionally, parking spaces and job creation are other problems raised by this social movement (Shaibany, 2020).

Figure 3.4: Oman Urban vs Rural Population from 1950 to 2050. Source: (Benkari, 2017).



The smart city concept has recently been recognised as one of the most valid methods worldwide to address cities' different urban challenges and meet citizens' needs (Colldahl, Frey and Kelemen, 2013). However, implementing smart city concepts did not occur in Oman until recently when the government launched a different generation of cities (AL-Rawahi *et al.*, 2020). On the other hand, the Oman 2040 vision focuses on sustainability as a baseline for the current ongoing projects. The Fourth Industrial Revolution and Environmental Revolution is considered critical answers to the challenges Oman faces today (National committee for achieving sustainable development Goals, 2019; Preliminary vision document, 2020). Hence, Oman started implementing various smart projects in various sectors. The following paragraphs provide some examples of Oman's smart project initiatives.

Smart city implementation in Oman involves a wide range of services and applications. For example, Muscat Electricity Distribution Company (MEDC) introduced self-reading electricity meters on the houses' walls (Oman Observer, 2018a). This facilitates a convenient and user-friendly way of payment for the customers and the company at the same time (Oman Observer, 2018a). Likewise, in 2018 the company initiated a new way of payment called Sabiq, a prepaid electricity meter where citizens must pay their bills before usage. This service is smart as it enables citizens to monitor their electricity usage and accordingly identify the devices that can save power and discourage the behaviour of leaving appliances on standby mode (Casarín and Nicollier, 2011). In 2018 Oman's Authority for Electricity Regulation (AER) undertook the process of connecting smart grids to the residential rooftop as a step toward an eco-friendly environment and promoting the uptake of environmentally renewable energy in the Oman (Casarín and Nicollier, 2011). This can enhance the reduction of energy costs, energy consumption and emissions (Al-Badi *et al.*, 2020). Today, different parks, shopping malls and airports are connected through Wi-Fi hotspots free of charge (WiFi Map, 2021). In addition to the above-discussed projects, there are a few more projects explored below:

- **Oman Smart City Platform**

The Oman smart city platform was created in 2017 by the Research Council (National committee for achieving sustainable development Goals, 2019). The Oman Smart City Platform is a unique platform designed to work as a central system to initiate smart city solutions in Oman besides distributing knowledge about the smart city projects in Oman (National committee for achieving sustainable development Goals, 2019). According to Oman's smart city platform, the platform's founders are the Supreme Council for Planning, Muscat Municipality and the Information Technology Authority. The founding partners received funding from Oman Telecommunications Company (Omantel), Nama Group and Oman Tourism Development Company (Omran). The main targets of the platform are to exchange knowledge and share ideas between the different stakeholders, promote innovation, establish awareness of the importance of smart cities and smart solutions, recommend the most suitable smart solutions practices to be implemented, and work as a bridge in enhancing the cities transformation processes to being smart.

Regarding spreading awareness, the platform seeks partnerships with different businesses and other governmental and non-governmental agencies to increase awareness through social media, official and nonofficial speeches, organising lectures, conducting cafe assemblies, and visiting sites. In terms of encouraging innovation, which is one of the key tasks of the platform, it brings researchers, academics, and scholars together to enhance research through innovation-based projects and publication-based research regarding smart city solutions. The platform has collected around 150 innovation proposals, six of which have been selected to be implemented. It has also attracted around 300 ambassadors from different regions and cities in Oman.

Moreover, the platform has organised different Hackathons events in three cities, Muscat, Muttarah and Salalah, to discuss challenges facing Omani sectors such as tourism, logistics and the environment. These Hackathons aimed to gather experts from different sectors to discuss the challenges and possible smart solutions. Regarding stakeholder involvement, the platform team has provided consultation to various parties. For example, the platform has provided the climate department in the Ministry of Environment with possible smart solutions raised after linking the ministry's desire to address Oman's environmental challenges.

- **Oman Eco-Friendly House**

With the support of The Research Council and Knowledge, and Technology Transfer Office at the Ministry of Foreign Affairs, Oman has launched the Oman Eco-Friendly House competition designed to raise awareness of the importance of Green Eco design. Eco-Friendly Houses are based on using renewable energy, saving water and using smart solutions. The competition is nationwide among Higher Education Institutes in Oman with two phases. Phase one lasted from 2011 to 2014 and included the Eco Houses' design and construction, besides testing their performance. The second phase involves long terms testing and community outreach (Al-Busaidi, 2016). According to the competition website, the winning institution is the one which better addresses the customers’ needs along with designs that better energy saving and emission reduction (EcoHouse Design Competition Oman, 2020). This competition is considered an excellent test to explore the possibility of integrating smart houses to meet the needs of the Sultanate in saving its natural resources (Hegazy, 2021).

- **AL Duqum as Smart City**

While Qatar and UAE have already started diversifying their economy, Oman and Saudi Arabia are massively depending on their oil (Ardemagni, 2018). In this situation, Oman recently decided to invest in commercial ports and build commercial free zones as an attempt to its economic diversification (Ardemagni, 2018). The Omani government decided to make a special economic free-zone area to work as a smart city with leaders with special ICT, business and managerial skills (Al Harthy, Puteh and Harthy, 2019). The first main step to establishing a fully smart city in Oman is Al Duqum, a Special Economic Zone located south of Muscat (Al Harthy, Puteh and Harthy, 2019). Besides the port, which ensures safe marine traffic, Al Duqum represents an example of a city planned to be transformed into a brand-smart city (Wippel *et al.*, 2016). Oman signed a contract with South Korea to implement this huge project involving an intensive investigation of the possible smart cities' projects. This project is considered the largest in the history of the Gulf states and is expected to contribute to stopping Oman's reliance on oil and diversifying its income sources (AL-Rawahi *et al.*, 2020). Today, the government is working hard to keep the project on track challenging the decline in oil prices (Duqm Refinery Project, 2017).

Al Duqum is considered the first of its kind in Oman and will be built as a smart city in various phases (Oman Observer, 2019a). The city's transformation to be smart includes "*public utility services, tourism, security and safety, smart port solutions, campus solutions, traffic lights, road lighting, intelligent building management, and waste management*" (Oman Observer, 2019a, p. 1). Moreover, the project is planned to implement smart solutions in the following aspects "*transportation services, truck weights, smart bus stations, parking, video surveillance, and identification of car and truck plates*" (Oman Observer, 2019a, p. 1).

Tatweer Duqum, a representer of the Special Economic Zone Authority at Duqum (SEZAD), is the company responsible for developing the infrastructure of Al Duqum (A Quarterly Magazine, 2020). SEZAD introduced the five years plan focusing on encouraging investments in this zone to support national economic development. Al Duqum has signed a memorandum contract with Oman Telecommunication Company (Omantel) to study technology investments compatible with smart technologies, to determine the priorities and expenses and where to start activating the 5G services (A Quarterly Magazine, 2020). The Omani government has also decided to build a business park called Maysan Square Duqm with a 43 million Omani Rial budget. The park will build over 122,000 sqm with around 20 buildings, including shops, commercial complexes, restaurants, apartments, and other free prosperities. The park is planned to be built in five phases (Oman Observer, 2020).

On the other hand, the project faces different challenges, including the absence of the required IT skills among SEZAD staff. According to Saxena (2020), smart city implementation in Oman involves enhancing public services by making them available and accessible to the citizens to make informed decisions. However, this requires intensive attention to the technology from the business side and among the city policy and decision makers to build smart applications compatible with citizens' needs. Moreover, Oman must attract skilled human resources to deal with smart technology solutions to provide satisfactory results (Saxena, 2020). Moreover, attracting local and international companies to invest in the area is another major challenge. In addition, the slow economic development in some sectors in the zone and the oil price fluctuations affect the prosperity of the global economic (A Quarterly Magazine, 2020).

- **Madinat Al Irfan**

Madinat Al Irfan is another urban development project located in the heart of Muscat's capital. It reflects the vision of Oman 2040 of building sustainable urban areas that contribute to the diversification of Oman's economy and enhance its prosperity (Saraf, 2020). The project is a multi-million Omani-Rial joint venture project by Omran and Majid Al Futtaim. In the sustainability forum, Ammar Al Kharusi, director of development at Omran, said that the project is implemented by "*the use of solar water heaters, solar lighting, smart architecture to create natural shade zones, and sustainable materials and efficient HVAC systems among others to decrease total energy consumption*" (Times News Service, 2017).

3.4.3 Smart Transportation Services and Smart Transportation Mobile Applications in Oman

3.4.3.1 Smart Transportation Needs in Oman

After the oil discovery in the late 1980s, Oman became a modern country with a wide development in the country's infrastructure and services (Peterson, 2009). Accordingly, the living standard of its people jumped sharply (Looney, 2013). This further caused changes in the spatial distribution of the population as most people moved from rural areas to developed ones (Benkari, 2017). The government invested in road development in parallel with other development programmes. In the past, Oman used to have only very few paved roads, but today this has increased to include almost all cities in Oman (Islam and Hadhrami, 2012).

On the other hand, the public transport system in Oman is not well developed yet, and therefore people in towns and cities depend solely on their private cars and sometimes on taxis for transportations (Islam and Hadhrami, 2012). Trains, undergrounds, railways and trolleybuses, which are common in foreign countries, are missing in Oman (Belwal, 2017). Consequently, a terrible increase in road congestion resulted in serious problems (Belwal, 2017). For example, this caused an extensive growth in the number of automobiles registered in Oman - in January 2020, this hit around 1.55 million cars which represents an increase of 3.4% compared to the same period the year before, as reported by the National Centre of Statistics and Information (NCSI) (Oman News, 2020). According to the Ministry of Health report, road traffic accidents are considered the worst in Oman, and they are the leading cause of death and disabilities as the report indicates around 637 death cases were reported in 2018 due to traffic accidents (Times News Service, 2019). It also causes different health, economic and social burdens on the government (Islam and Hadhrami, 2012). Other growing concerns have been raised, such as carbon emission, stress levels and frustration rate escalations among people. Therefore, sustainable transport systems are the key answer to the above problems where many people can be moved from one location to another simultaneously and thus contributes to the CO_2 emission reduction (Bamwesigye and Hlavackova, 2019).

3.4.3.2 Smart Transportation Services in Oman

Despite the economic crises due to the oil price reduction, Oman has implemented some projects to improve the public transport sector, which is critical to The Sultanate's 2040 vision plan (Preliminary vision document, 2020). The following sections explore the main smart transportation mobile applications in Oman.

- **Mwasalat Services**

Oman invested in Mwasalat to serve as a modern public transport system equipped with sustainable smart technologies to face the heavy traffic congestion and to address the mobility issues in Oman (INECO, 2016). Oman sees Mwasalat as a smart public transport network fitted with wide advanced technologies such as Wi-Fi which helps track real-time information besides marketing tourism information on the buses (Al Maqbali and Refeque, 2017).

To improve the efficiency of Mwasalat, an intelligent smart transport system supported by artificial intelligence has been launched, enabling Mwasalat services to support drivers on the one hand by empowering them "*with the control centre and report any emergency situation to be addressed immediately*" and on the other hand, enhancing passengers experience by generating full reports of the transportation routes (Muscat Daily, 2021). The Mwasalat smart mobile application is built with various features, including enabling live bus tracking by generating reports about the exact arrival and departure times. It also allows passengers to purchase their tickets and pay for the fares electronically, besides directing them to the nearest bus stations and guiding them with the best routes for their journey (Oman Daily Observer, 2021).

Mwasalat has signed a contract with a Japanese IT corporation to install an Automated Fare Collection System to enable the automatic, contactless and cashless collection of fares using mobile applications (Prabhu, 2022). The contract also involved fitting Automated Vehicle Location Systems to enhance efficiency. In addition, Mwasalat has implemented smart e-ticketing, allowing passengers to access seasonal passes and services access and pay for the services online through their mobile application (Prabhu, 2022).

- **Royal Oman Police (ROP)**

Although the main task of the ROP is to maintain low crime rates throughout the country by saving people's lives and properties, it is also in charge of the road traffic services (Al-Aamri *et al.*, 2021). The ROP is considered one of the leading organisations in Oman in developing and modernising its services by adopting and implementing advanced technologies to meet the high demand for their services. The ROP offers a wide range of transportation services accessible in different ways, for example, through the ROP official website and ROP smart mobile application alongside SMS services. For example, drivers can enquire about and receive traffic offences information by sending an SMS message. Recently, ROP launched three new smart services related to the traffic aspect.

Firstly, the electronic system for testing drivers enables drivers to electronically submit applications, book appointments for driving tests, conduct the theoretical tests online and later progress towards advanced simulation devices that employ augmented reality technologies. The second service is the electronic system for the traffic safety institute, which will use augmented reality to train potential drivers to be qualified for driving vehicles (News Desk, 2021). The third service is the ROP smart mobile application which provides a wide range of ROP services accessible at citizens' fingertips at any time. It enables its users to generate a copy of their driving and car registration licences. They can save these copies in their ROP mobile applications for official use whenever needed. This service also involves the ability to upload users' other electronic papers to create an integrated electronic file which they can print copies of them from their phone. In addition to the wide range of services, this application enables citizens to locate and call the nearest stations, given their GPS coordinates. It also provides news about road accidents

(Veröffentlicht, 2013). In addition, ROP offers a wide range of traffic services through both their website and smart mobile application, including driving license expiry alerts, vehicle registration expiry alerts, exchanging of the eligible foreign licence, vehicle registration, and transfer of motor vehicle' licence (Royal Oman Police, 2022).

- **O-taxi**

O-taxi is considered the main application-based taxi service provider in Oman, which cooperates with trained, licensed car drivers to offer various services that suit different riders' needs (O-taxi, 2022). It offers a high-quality GPS-metered taxi service. O-taxi allows citizens to access taxis anywhere at their doorstep at any time through an app and is supported 24/7 by technical support services. The application allows riders to know about the drivers, their contact information, vehicle kind and number, and an estimation of the fare (Oman Observer, 2019b). O-taxi recently launched a new service called O-taxi Butler, a smart device designed to help riders request an immediate taxi from any mall by simply pressing the button and getting a reference number (O-taxi, 2022).

- **Baladiyeti Application**

Muscat Municipality has implemented a project of smart streetlights which provides intelligent control of the timing besides friendly generating a report showing the lighting network situation, which further helps reduce the cost and increase efficiency (Oman Observer, 2018). Intelligent traffic lights also represent another application that adjusts itself based on the real-time traffic flow (Al Maqbali and Refeque, 2017). An intelligent traffic light system has been implemented in the main highways in Oman, which operates based on green waves to synchronise the traffic signals based on the sensor data. This reduced traffic by 50% and lowered fuel consumption (Oman Observer, 2018). Moreover, Muscat Municipality has launched an SMS service where customers can book and pay for parking.

Besides, Muscat Municipality has also launched Baladiyeti as a smart mobile application which facilitates a user's interaction with Muscat Municipality to get better services and updated information (Omanuna, 2022). The Baladiyeti smart mobile application is considered a portal for the Oman e-government services. The introduction of the Baladiyeti as a smart mobile application is an attempt of the Muscat municipality to improve its ability to improve its interact and communication with the community. The Baladiyeti smart mobile application covers many transportation services such as parking violation payment, parking permission and parking reservation. It also enables its users to send their notes or complaints as a message or a photo of the location, follow up on their communication, and propose suggestions (Muscat Municipality, 2022).

3.5 Summary

It was required to investigate Oman's circumstances in order to examine elements influencing Omani citizens' acceptance of smart transportation mobile applications. Thus, this chapter's objective was to take a deeper look at smart projects in general and at smart transportation projects in particular in the Omani setting. This chapter was added to help create a preliminary research framework appropriate for the Omani setting. This chapter gives a background of Oman in terms of the adoption and use of smart services. At the beginning, it provides some background information, while the second section offers an in-depth analysis of the transportation situation in Oman and sheds light on the needs and challenges related to the Omani context. This aided the researchers' comprehension of the characteristics of the technology under study in the Omani situation. The next chapter will explain the methods selected to validate and refine the proposed research acceptance model.

Chapter 4: Theoretical Framework Development

4.1 Introduction

Research on adopting information technology (IT) has produced several competing frameworks, each with a unique set of acceptance factors. An overview of the models used to anticipate, explain, and comprehend the human behaviour involved in embracing new technology is provided in this chapter. This is necessary for light of the primary objective of the current study, which is to investigate the variables that can influence or predict how people in Oman would behave when using mobile applications for smart transportation. The literature on technology acceptance is rich in theories and models, but it is impossible to discuss them all in this work. However, the primary technological acceptance theories in the literature are outlined in this chapter. The structures of each theory, how it was created and utilised, and its advantages and disadvantages, are described. Due to the interdependence of these models, each part is connected to the one after it. To build a conceptual framework based on the findings of the current body of research, a review of the key concepts, theories, and frameworks in connection to technology acceptance and usage in the literature is conducted. This study gives brief descriptions of the most widely studied theories and models to lay the groundwork for proposing an acceptance model that better addresses the Omani context. Later, it will also work as a base for the qualitative study and form the hypotheses that will be examined in this work.

Investments by companies and governments in information technology are rising as it is expected to contribute to optimising their performances. However, there are some doubts about the extent of the advantages gained from such investments. For example, one concern is the uncertainty of organisations' needs and whether the investments in a specific new technology is the right move for their organisations (Tambe and Hitt, 2015). Another doubt relates to the severe investment of time and money compared to the value-added (Gupta, Raychaudhuri and Haldar, 2018). Moreover, the extent to accept new technologies by their end users is not guaranteed (Dunphy and Herbig, 1995; Sepasgozar *et al.*, 2019a). According to many studies, the target users' acceptance and adoption of new technologies have played a vital role in successfully implementing information technologies projects (Safi, Thiessen and Schmailzl, 2018; Taherdoost, 2018; Sepasgozar *et al.*, 2019). Therefore, over the previous years, scientists have introduced, designed and modified many theoretical models to study and anticipate new technologies' acceptance and adoption (Venkatesh et al., 2003). According to the literature review, there is a range of acceptance models addressing Information systems (IS) acceptance with various factors that have been added to them. Many studies have adopted these models, while others incorporated new factors into them to understand the end user's acceptance better and reduce their resistance (Agarwal and Prasad, 1999; Hsu and Lin, 2022). Thus, no single model can be easily fitted into all contexts. Today there are several powerful models developed to address user acceptance, and the following are the main ones:

- The Theory of Reasoned Action (TRA); (Fishbein and Ajzen, 1975).
- Theory of Planned Behaviour (TPB); (Ajzen, 1985).
- Technology Acceptance Model (TAM); (Davis, 1989).

- Technology Acceptance Model 2 (TAM2); (Venkatesh and Davis, 2000).
- Diffusion of Innovation theory (DOI); (Rogers, 1995).
- Social Cognitive Theory; (Bandura, 2001).
- Unified Theory of Acceptance and Use of Technology (UTAUT); (Venkatesh *et al.*, 2003a).
- Unified Theory of Acceptance and Use of Technology 2 (UTAUT2); (Venkatesh, Thong and Xu, 2012).

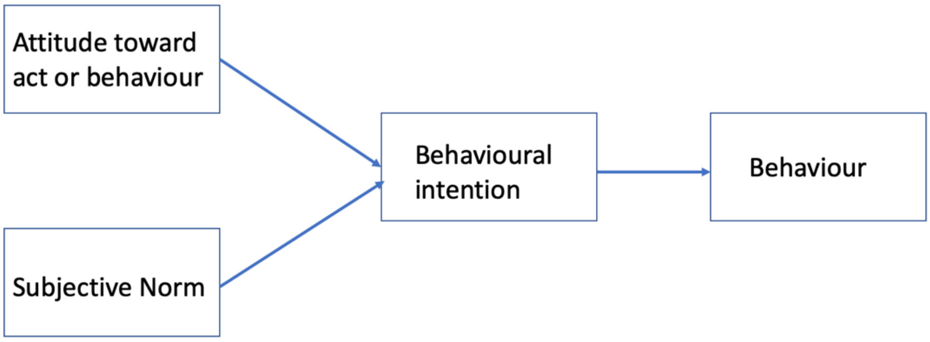
From a practical view, this research is intended not only to study the reasons behind customers' acceptance or rejection of the smart transportation mobile applications in Oman but also to determine the main factors influencing their acceptance to build a comprehensive acceptance framework that better addresses the Omani context. Venkatesh *et al.* (2003, p. 426) recommended a "*need for a review and synthesis to progress toward a unified view of user acceptance*". Accordingly, a review of the above-listed and most popular theories will be conducted to gain a better overall picture of them. Although some of the above theoretical models are more famous and considered to be more durable in explaining the adoption behaviour of new technologies, it is essential to shedding light on all of them in the context of this study, particularly smart transportations mobile applications. Thus, an intensive review of each of them will be conducted to select the most applicable model besides synthesising other contextual factors affecting the acceptance of smart transportation mobile applications among Omani citizens.

Each listed technology acceptance model has different factors, utilisations, and angles in addressing the intention and attitude to adopt new technologies. Therefore, there is a strong need to review them to explore the main influencers that may determine citizens' intention to accept the new smart transportation mobile applications for developing countries characterised by a high smart mobile phone penetration rate like the Sultanate of Oman. The study analyses these technology adoption frameworks with a focus on each model's advantages and limitations while highlighting the differences among them. It also evaluates each of them to test the applicability of their main constructs to build a theoretical framework for the current study context. In addition, the chapter explains why a specific acceptance model is insufficient in addressing this research's purpose. This will be coupled with insights from the acceptance literature review to build a model that better addresses the acceptance of smart transportation mobile applications in an Omani context. Later, an intended framework is designed to fulfil the gap and work as a model to conduct empirical studies in the specified context. Thus, this section enhances the researcher's understanding and supports the decision to choose the most suitable model to work as a base to build the contextualised framework that better addresses the research issue.

4.2 Technology Adoption Theories and Models

4.2.1 The Theory of Reasoned Action (TRA)

Figure 4.1: The Theory of Reasoned Action (TRA). Source (Fishbein and Ajzen, 1975).



TRA is considered one of the first widely applied behavioural models in technology acceptance studies (Fishbein and Ajzen, 1975; Mi *et al.*, 2018). It has been extensively used in explaining individuals' behaviours across a wide set of fields (Fred, Bagozzi and Warshaw, 1989). Within this model, and as can be noticed from Figure 3.1, the individual's behavioural intention is identified by two main factors: subjective norm and attitude. Subjective norm refers to the beliefs of what an individual or a group of people will feel about a particular behaviour. It is defined as "*the person's beliefs that specific individuals or groups think he/she should or should not perform the behaviour and his/her motivation to comply with the specific referents*" (Ajzen and Fishbein, 1980, p. 8) while attitude is "*an individual's positive or negative feelings (evaluative affect) about performing the target behaviour*" (Fishbein and Ajzen, 1975, p. 216). Behavioural intention refers to the motivational factors to perform a particular behaviour in which the stronger the person's intention is, the more likely the behaviour will be followed (Fred, Bagozzi and Warshaw, 1989). That means individuals are identified as logical beings and they use the data and information they have before pursuing any action. In other words, they consider and evaluate the consequences and results of their actions prior to being involved in a particular behaviour (Ajzen and Fishbein, 1980). The model assumes individuals' assumptions about their society's positive and negative impacts design their intentions in using new technology (Otieno *et al.*, 2016). TAM, UTAUT and many other models are generated and strongly influenced by this model (Vatanparast, 2012; Qudrat-Ullah and A. Khan, 2021).

TRA is a general model not built for a particular behaviour or technology; therefore, it is designed initially to be used in a wide variety of fields (Rondan-Cataluña *et al.*, 2015). That is, TRA scope of behaviours excludes a group of potential behaviours which can be only included indirectly as influencers through attitude or subjective norm. For example, factors such as habit, moral values, and other external factors contributing to designing the behavioural intention toward adoption are neglected. Moreover, it fails to involve environmental and economic factors, which may influence an individual's intention to follow behaviour. It does not consider other constructs that contribute to the behavioural intention, such as spontaneous, habit, mindless, fear and experience (Beekens, 2011; Taherdoost, 2018). It is also claimed that this theory ignores the environment surrounding factors that individuals may have no control over and might influence their behaviour toward the acceptance (Sarosa, 2009). Thus, the main limitation of the TRA model, which has been recorded in most social science research, is that people who lack awareness will have limited power over their behaviour and attitude (Marangunić and Granić, 2015).

This theory assumes that an individual's behaviour is usually planned and rational. Sheppard, Hartwick and Warshaw (1988) and Buchan (2005) argued that the TRA model applies to behaviours within volitional control, whereas decisions not consciously taken are invalid in this model. Thus, TRA model validation is limited to the voluntariness usage only (Taherdoost, 2018). As a result, this theory cannot predict the use when there is little or no volitional control. There is also a limitation in which both constructs (attitude and intention) should comply through time, context, aim and target (Sheppard, Hartwick and Warshaw, 1988). In addition, behaviours that require specific skills, unique resources and support from other people are also neglected by the TRA model (Ajzen and Fishbein, 1980).

Despite the above limitations, this model has been implemented widely in information systems contexts and has been recognised as one of the most powerful models to evaluate a person's behaviour(Ajzen and Fishbein, 1980; Venkatesh *et al.*, 2003b; Venkatesh, Thong and Xu, 2012). However, identifying an individual behaviour through only two main factors is impractical and cannot be implemented in reality as these two constructs might be influenced by a group of beliefs (Bagozzi, 2007). As the current study's end users and consumers require special skills and knowledge about internet technologies to build a strong behavioural intention on the acceptance of the smart transportation mobile applications, the TRA model was not approved for usage in this study.

4.2.2 Theory of Planned Behaviour (TPB)

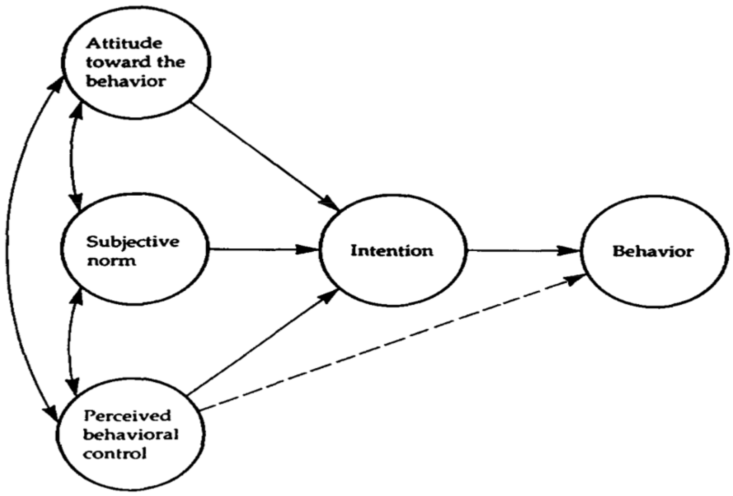
To overcome the limitations mentioned in the TRA, Ajzen (1985) developed a new model called the Theory of Planned Behaviour (TPB), which acts as an extension of the TRA model by including a third construct to the model called perceived behavioural control (Taylor and Todd, 1995). According to Figure 3.2, the TPB framework predicts the intention through three constructs: attitude toward the behaviour, subjective norm, and perceived behavioural control. Perceived behavioural control is defined as how difficult or easy enacting a given task is. In other words, it is how a person perceives their ability to perform a specific behaviour (Cheung and Chan, 2000). Perceived behavioural control influences behavioural intention directly or indirectly (Ajzen, 2005; Noar and Zimmerman, 2005). However, this has been criticised as it assumes that an individual with all the resources will conduct the desired action successfully regardless of the intention (Nigbur, Lyons and Uzzell, 2010).

The TPB model was built by extending the TRA model and turned out to be very powerful compared to the TRA model due to its ability to better understand the user's behaviour (Ajzen, 1991). The TRA model was designed to explain the end user's intention to adopt a particular behaviour. In contrast, the TPB model is improved to involve evolved behaviours without a person's volitional control (Rawstorne, 2005). In other words, the TPB model helps understand the situations in which users have less control over their behaviours (Ajzen, 1991). Therefore unlike the TRA, this model assumes that people are rational in their decisions making, influenced by the information available to them, and are aware of the consequences of their actions (Ajzen, 1985). However, both TRA and TPB models are similar in that behavioural intention is controlling the actual behaviour and that behavioural intention is derived from subjective norms and attitudes.

According to Ajzen (1988), a positive attitude coupled with favourable subjective norms towards perceived behavioural control will most likely result in a significant behavioural intention to perform the action. In other words, the fewer barriers, and the more resources available, the effect of perceived control over the behaviour will increase. This is especially true in the context of technology adoption and acceptance, as the usage and acceptance of a specific technology are expected to be higher when more resources are available to the users. Therefore, this model is treated as one of the most valuable models in explaining and evaluating an individual's behaviour (Conner and Norman, 2005). As a result, it has been applied to understanding consumers' behavioural intentions and technology acceptance in different contexts. For example, it has been adopted in an educational context to assume the student's participation in the blending learning system (Nadlifatin, Ardiansyahmiraja and Persada, 2020).

Moreover, Abraham and Sheeran (2003) declared that this theory has two main advantages. Firstly, the limited number of constructs incorporated in this model smooths the testing. Secondly, it enables measuring and testing the validity of the constructs accurately and efficiently to reflect on how they are compatible with each other.

Figure 4.2: Theory of Planned Behaviour (TPB). Source (Ajzen, 1991, p. 182).



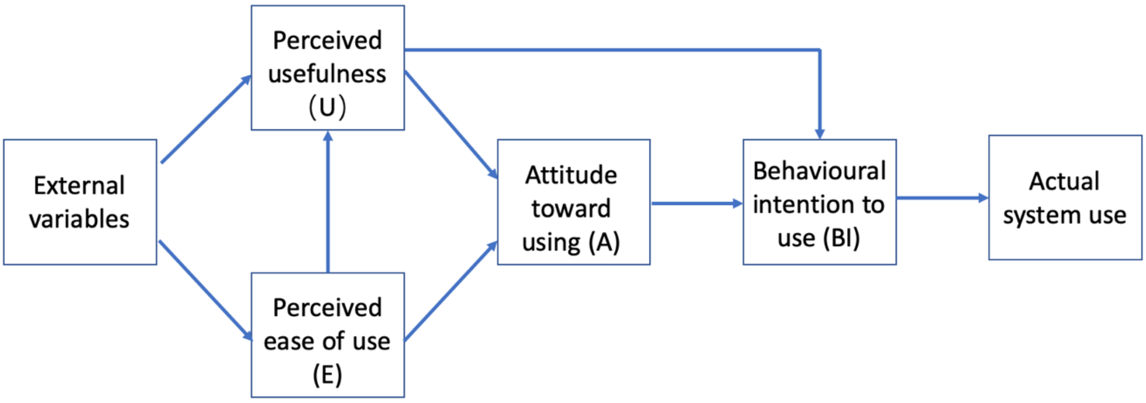
However, some authors, such as Taylor and Todd (1995), criticised the model for the same reasons as the TRA model. They argued that it is difficult to generalise the results obtained by adopting this model because it assumes similar beliefs among all respondents. Besides, as a psychological model, this model is expected to emphasize internal processes. However, it omits demographic factors and accordingly predicts that all users will acknowledge the framework's processes similarly. As a result, the TPB model has been criticised for relying on a single factor: perceived behavioural control as a main factor controlling the adoption and predicting the end users' behaviour (Taylor and Todd, 1995).

The TPB model accumulates all attitudes, subjective norms and perceived behavioural control to build a measure of the beliefs (Ajzen and Fishbein, 1980), but Taylor and Todd did not support this aggregation as it was not allowing the identification of the exact factors that are contributing to the predicted behaviour (Taylor and Todd, 1995). They further argued that according to this model, users' adoption of technology is based on: if they carry a positive attitude towards that technology, if adopting that technology has a positive value from their social network and if they consider themselves capable of the usage of these new technologies. This means that sometimes a person might have a positive attitude as well as positive social support, but he/she may believe that the capability of utilising such technology is absent, or there might be other factors hindering the usage. Therefore, the person will show low intentions for adopting that technology regardless of the positive attitude and the positive social support. Therefore, the TPB model involves some limitations when considering an individual's intention. Moreover, it also misses considering changes in the behaviour (Armitage and Conner, 2001). Perceived behavioural control is used to identify the behaviours that are sometimes adopted or not due to some attributes beyond an individual's power (Ajzen, 1985). In this respect, Ajzan (1985) argued that a consumer might decide about the intention; however, sometimes, factors beyond a person's control or the intention might change over time and contribute to changing a person's decided behaviour. This sometimes prevents a behaviour from being taken in reality even after successfully ensuring that a person will behave in the measured ways. Therefore, this theory omits the timeframe between behavioural intention and behavioural action (Lutchyn and Yzer, 2011).

As noted in the current study, users require skills, internet technologies awareness and experiences to shape a clear intention behaviour on adopting smart transportation mobile applications and services. It is also argued that the TPB model is built to study the normative variables while failing to consider other variables such as trust, economics, and environment. These activities are considered critical in exploring the acceptance in the context of the current research (Sniehotta, 2009). Also, the limitations of this model in considering the demographic and personality factors, which are essential in understating the Omani citizen's acceptance of smart transportation mobile applications, complicate the usage of this model. Furthermore, this model is criticised since "*individuals to be motivated to perform a certain behaviour; this assumption may be problematic when studying consumer adoption and behaviour, in addition to the assumption of an identical belief structure among participants when it comes to performing a behaviour*" (Taylor and Todd, 1995, p. 151). Thus, it is not practical to be considered for the present study; therefore the TPB model was not considered for usage in the current study.

4.2.3 Technology Acceptance Model (TAM)

Figure 4.3: Technology Acceptance Model (TAM). Source (Davis, 1989).



The TAM model is a trendy and widely accepted model among information system scientists besides being extensively cited in the information systems research (Dennis, Venkatesh and Ramesh, 2003; Wu, 2009). It is considered one of the most commonly employed models among researchers to explain a person's acceptance and adoption of various technologies (Dennis, Venkatesh and Ramesh, 2003; McCoy, Galletta and King, 2007). The TAM model is a subsequent improvement of the TRA model to work as a developed theory promoting a better understanding of the acceptance of information systems technologies (Fishbein and Ajzen, 1975; Singh *et al.*, 2006). Although the TAM model is similar to the TRA model in that a person's behavioural intention identifies the actual technology adoption, it differs from TRA in two aspects. Firstly, the TAM model formed two new constructs, perceived usefulness (PU) and perceived ease of use (PEOU), directly affecting the expected users' attitudes towards adopting new technologies. Perceived ease of use (PEOU) is the "*degree to which a person believes that using a particular system would be free of effort*", and perceived usefulness (PU) is the "*degree to which a person believes that using a particular system would enhance his or her job performance*" (Venkatesh and Davis, 2000, p. 187). Accordingly, the TAM model is designed to predict users' acceptance of the new technology if only they are convinced that it will bring them valuable results while also being easily adopted. Attitude towards using construct refers to an individual positive or negative evaluation of a particular technology (Fishbein and Ajzen, 1975). Secondly, the TAM model removed subjective norm as a determinant of intention compared to the TRA model because it is not a sufficient determinant of intention due to its unclear physical and theoretical effect (Rondan-Cataluña *et al.*, 2015).

Markedly, as can be seen from Figure 3.3, both of the determinants, perceived usefulness (PU) and perceived ease of use (PEOU) are positively affecting the attitude, and this further positively influences the behavioural intention (BI) to utilise and accept a technology (Venkatesh and Davis, 2000). There is a high probability that users with a positive perception of the technology will automatically start using the new technology. Also, it is stated that perceived ease of use (PEOU) positively impacts perceived usefulness (PU), while external factors also influence both. The design of the TAM model involves, in addition to the internal constructs, a set of external variables to identify better the technology acceptance (Davis, 1989). Combining internal and external variables enables the TAM model to understand better the influence on the user's intention to accept technologies. It has empowered the model with "*valid, reliable, and easy to administer scales for the key constructs*" (Venkatesh, Davis and Morris, 2007, p. 268).

On the other hand, the TAM model is developed in a way more applicable to the online setting (Lazim, Ismail and Tazilah, 2021). According to Shih-Chih Chen, Li and Li, (2011), the TAM model is explicitly designed for the information system contexts and evaluates the ease of use and perceived usefulness prospects, making it more powerful in various information systems settings. Many researchers, such as (Ma and Liu, 2004; King and He, 2006; Yousafzai, Foxall and Pallister, 2007), have stated that the model has proven to be very credible. It has been adopted in several studies and has been empirically supported in different acceptance contexts such as e-commerce (Valencia *et al.*, 2019), e-banking (Lai and Li, 2005), e-learning (Masrom, 2007), e-government (Sebetci, 2015), telemedicine (Garavand *et al.*, 2022) and spreadsheet (Elsharif, 2017). Many researchers have validated and confirmed the importance of the usefulness and ease of use constructs in understanding the acceptable behaviours of the end users in different ICT situations such as (Al-Lozi, Al-Hujran and Al-Debei, 2014; Azza ALomary and Woollard, 2015; Rabaai, 2015; Andrina and Puty, 2022; Iqbal and Fridayani, 2022). It has also been approved to be applicable in organizational contexts, as it has been used successfully, for example, to investigate how online advertising channels are utilised by small enterprises (Solomon *et al.*, 2019).

On the other hand, TAM has been criticized by different researchers due to many reasons. For example, Siu-cheung Chan and Lu (2004) argued that this model missed the consideration of the antecedent factors that possibly influence individuals' behavioural intention in using new technologies, such as cultural factors in which that specific technology is welcomed in a particular culture and marketing factors adopted by service providers to motivate the potential users to utilise the new technology. Therefore, the TAM model is not designed to fully explain the acceptance in a business environment as it misses consideration of the money and time constructs that might affect the adoption (Taylor and Todd, 1995; Bruner and Kumar, 2005; Ajibade, 2019). It also ignores the involvement of other acceptance factors, which are demonstrated by later models such as UTAUT and UTAUT2. For example, it does not consider factors such as systems characteristics and financial cost for all individuals, organisations, and other technical support.

The TAM model was also criticized for deleting the social and other personal control constructs, which are expected to support a better understanding of the behaviour (Davis, Bagozzi and Warshaw, 1989; Taylor and Todd, 1995). Ramayah and Ignatius (2005) had the same comment as they argued that the TAM model ignores the social construct in addressing the acceptance of ICT, although it was approved in the TRA model. The TAM model has failed to provide information about end users' adoption of a particular technology as it is considered too general and neglected the critical sources of variances in the technology acceptance (Mathieson, Peacock and Chin, 2001). In addition, the TAM model is difficult to be utilised in complicated contexts as it applies only to a single subject, for instance, one group (Dillon, 2001; Dillon and Morris, 2001; Bradley, 2009). Lee, Kozar and Larsen (2003) supported this argument and mentioned that the TAM model is implemented for an investigation of a single topic, for example, a one population sample or one establishment, without integrating other subjects and evaluating them regarding the information system acceptance.

Furthermore, the TAM model assumes that people plan their behaviour and that they are rational in their actions which means it assumes they evaluate the ease of use and usefulness of technologies when they develop an intention to use it and, therefore, they actually use it (Fumiyo and Fumiyo, 2014). However, the problem is that people are not entirely rational in their decision-making and not reasonable in their behaviour either and accordingly, only some things they do are planned. Another limitation of the TAM model has been mentioned by Legris, Ingham and Collerette (2003) which is about the samples adopted in TAM model studies, in which most of the choices are a convenient sample with professional skills, which further cause difficulties in generalising the findings (Sun and Zhang, 2006). Sun and Zhang (2006) have also mentioned two critical limitations of TAM, including the inconsistency between the model factors and explanatory power. Therefore, the relationships between the model constructs need to be better established, mainly when implemented in an information systems context, as it lacks an explanation of the real influences on the usage and acceptance of the technology (Venkatesh and Davis, 2000). Also, it does not measure and evaluate the actual implementation of the technologies; instead, it only explains the prediction use (Lee, Lee and Lee, 2006; Ajibade, 2019). In sum, the TAM model is reported to have many limitations, especially that it fails to consider the information systems implications, besides also needing more integration of the societal constructs that dictate the technology adoption.

With regards to the current study, although the TAM model is considered one of the most widely used frameworks in explaining technology acceptance, it is argued to be less potent while investigating smart technologies as this context involves unique dimensions that the TAM model might not easily define due to the absences of some factors such as security and social influence. The TAM model does not apply to this study as the respondents considered in this study represent a social system. In this respect, various studies have approved the importance of perceived ease of use and usefulness as essential elements in identifying the acceptance of new technologies. However, most have expanded the model with additional factors to improve its explanatory power (Huang, Lin and Chuang, 2007; Binyamin, Rutter and Smith, 2019). Also, as reported earlier, the TAM model excludes some critical constructs such as money, time and other factors that might prevent the usage of new technologies. Since it is essential to explore and realise these dimensions while exploring citizens' acceptance of new smart transportation mobile applications in Oman, the TAM model was avoided. Also, the TAM model is focused on individuals rather than the broader acceptance context. Therefore, wider organizational factors involved in this study, such as the extent of engagement and availability of support, are critical in the context of the current research but not supported by the TAM model (Davis, 1989; Venkatesh and Davis, 2000).

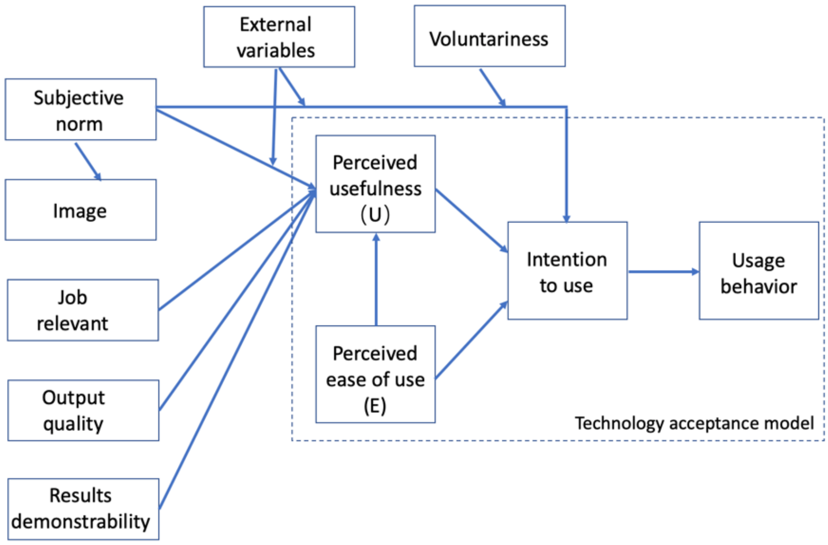
4.2.4 Technology Acceptance Model 2 (TAM2)

As mentioned in the earlier section and according to the TAM model, perceived usefulness (PU) is extensively affected by perceived ease of use (PEOU) because technology is more adopted when it is easier to use. Davis's (1989) empirical evidence and the broad application of the TAM model revealed that the influence of perceived ease of use and perceived usefulness on behavioural intention (BI) are more robust than an attitude, as attitude influence will decrease over time. Accordingly, the attitude construct was disregarded in the TAM2 model (Davis, 1989; Venkatesh and Davis, 1996; Lai, 2017). Later, the TAM model was updated by introducing a new version, namely TAM2, where the original TAM is extended by incorporating theories and validations that identify the perceived usefulness (Venkatesh and Davis, 2000). Compared to the original TAM model, TAM2 included seven additional factors in two groups.

The first group of factors were added to address the social influence, including subjective norms, voluntariness, and image. Hadji and Degoulet (2016, p. 186) stated that "*the TAM2 model introduced a social dimension to capture the influence of the end-user environment*". The second group of variables were added to study the cognitive process comprising of results demonstrability, job relevance, output quality and perceived ease of use construct (Nadri *et al.*, 2018). Experience and voluntariness are incorporated as moderators in the model. Five factors are assumed to affect the perceived usefulness, whereas two are predicated on affecting the behavioural intention to use. Therefore, this gives the model more power to be implemented in voluntary and mandatory contexts as it involves more constructs in shaping the individual's behavioural intention.

However, in this model, the subjective norm is considered a critical factor that can directly affect a user's acceptance of technology in a mandatory setting rather than a voluntary one (Taherdoost, 2018). Social environment influences a person's behavioural intention regardless of the person's positive or negative attitude towards the behavioural intention and the results of the behaviour (Venkatesh and Davis, 2000). Another limitation of this model is that the sample size involved in establishing the model was small to guarantee the external validity (Venkatesh and Davis, 2000). Also, moderators are set to address the link between subjective norms, behavioural intention to use, and perceived usefulness. As the current study targets a considerable sample size and is interested in exploring moderators' effects on other constructs, it was avoided.

Figure 4.4: Technology acceptance model 2. Source (Venkatesh and Davis, 2000).



4.2.5 Diffusion of Innovation theory (DOI)

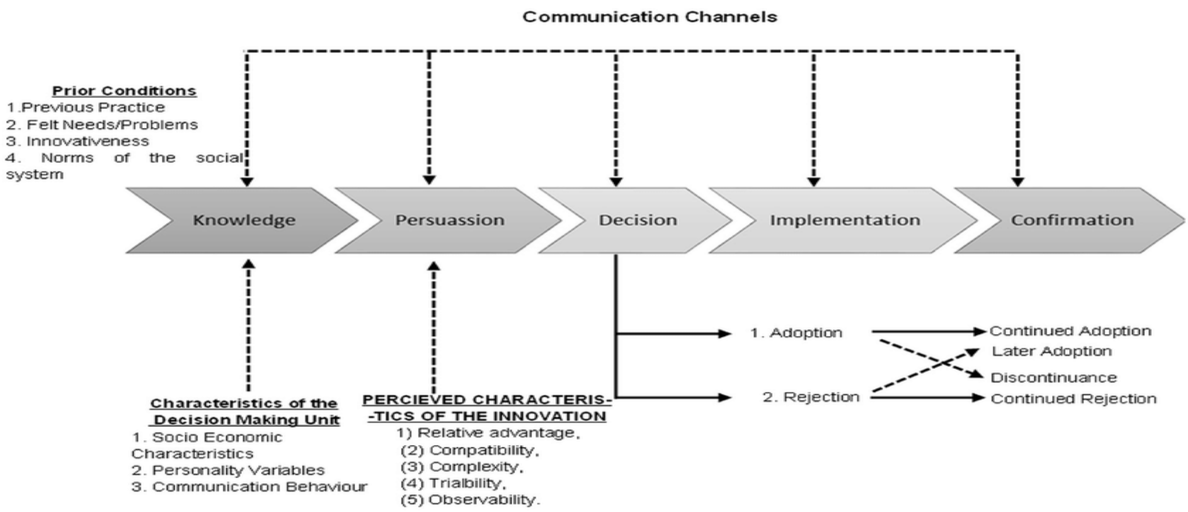
DOI was developed by Rogers (1962), and it is considered one of the oldest theories used to explain how a new technology, idea or product is going to reach momentum and be publicised within a particular population (Rogers, 1995). It focuses on explaining how a specific technology diffuses over time, why it does this and what steps it follows (Rogers, 1995). This model is commonly used in education, marketing, and sociology. Yet, some researchers have also used it to study the acceptance and adoption of new systems, such as in e-government research.

Innovation is "*an idea, practice, or project perceived as new by an individual or other unit of adoption*". In contrast, diffusion is "*the process in which an innovation is communicated through certain channels over time among the members of a social system*" (Haider and Kreps, 2004, p. 3). Innovation diffusion is, therefore, the process in which an individual seeks information to reduce uncertainty (Rogers, 2003). In this model, there are several factors affecting the support or inhibiting the adoption of technology, including (i) innovation, (ii) communication channels, (iii) time and (iiii) social system (Rogers, 2003). The first element - innovation - is determined by five main characteristics: relative advantage, compatibility, complexity, observability and trialability. Relative advantage refers to "*the degree to which an innovation is perceived as being better than the idea it supersedes"* (Rogers, 2003, p. 229). Compatibility is "*the degree to which the innovation is consistent with existing values, past experiences and needs of potential adopters* (Rogers, 2003, p. 240). Complexity is "*the degree to which the innovation is difficult to understand and use*" (Rogers, 2003, p. 258). Observability is "*the degree of visibility of the new innovation results*" (Rogers, 2003, p. 258). Innovativeness has been defined as "*the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a social system*" (Rogers, 2003, p. 37). Based on this, the adopters are classified into five groups: innovators willing to take the risk to adopt the new idea without gaining the whole picture and all the details about the new idea. The second group of adopters is early adopters with leadership skills, better financial resources, and qualifications, and usually younger than other adopters' groups. The third group is the early majority, who take more time than the previous two groups. Laggards are the last group with no leadership skills and lower income resources; therefore, they cannot tolerate the risk of adopting a risky idea (Rogers, 1995).

The second element contributing to innovation adoption decisions is communication channels, defined as "*the means by which messages get from one individual to another*" (Rogers, 2003, p. 18). Communication channels refer to communication media such as radio, television, phones, and the Internet. Communication channels play a critical role in influencing individuals' attitudes towards an innovation, which helps them make up their minds about using or rejecting a new idea (Rogers, 2003). This involves five main steps: knowledge, persuasion, decision, implementation, and confirmation. Knowledge refers to the point where an individual becomes aware of and understands an idea but still needs to know more about how it works. Persuasion is when a person becomes interested in innovation and starts digging for more information. The next step is a decision, considered the most crucial step in which a person finally decides on an innovation based on the collected information. The implementation step is about the actual utilisation of the new idea and started realizing its effectiveness. Finally, confirmation is the last step, where an individual realises the idea's advantages and benefits and decides whether to carry on using it or not.

Rogers (2003) has also integrated time with the innovativeness theory, which classifies it based on a timely manner. Therefore, the third element - time of diffusion- has been incorporated and involves three main dimensions: decision-making processes, individuals' innovativeness rate and adoption rate. The last element of this model is the social system, which is "*a set of interrelated units that are engaged in joint problem solving to accomplish a common goal*" (Rogers, 2003, p. 23). This element includes norms, individuals, organizations, and opinion leaders.

Figure 4.5: A Model of Five Stages in the Innovation-Decision Process. Source (Rogers, 2003).



Chen, Gillenson and Sherrell (2002) compared TAM and DOI, and they noticed some similarities, although they have been built for different contexts. The innovation element in DOI is viewed as Perceive Usefulness (PU) in TAM, whereas the complexity attribute is represented as Perceived Ease of Use (PEOU) construct in TAM. Therefore, they conclude that TAM and DOI support each other. In this respect, Olatokun and Joyce Igbinedion (2009) conducted a study comparing TAM and DOI models to test their abilities in evaluating participants' utilisation of technology and found out that DOI is more complicated in evaluating technology adoption than TAM. DOI is designed to have more factors than TAM; consequently, it is considered more complicated. As a result, most researchers replaced perceived ease of use and perceived usefulness in the TAM model with constructs from DOI to better understand the technology adoption. Consequently, DOI has become a significant model for predicting the intention of innovation adoption (Chen, Gillenson and Sherrell, 2002). Some authors argue that these two models can be adopted together to enhance building a more comprehensive acceptance model (Carter and Bélanger, 2005).

Although DOI has been widely adopted, accepted, and successfully utilised in fields such as marketing, social, agriculture, health, and crime, it has been criticised by some scientists due to its many limitations. For instance, Ardis, Momani and Jamous (2017) stated that complicated IT technologies should be socially effective, yet, DOI should have paid more attention to the possibility of social support and other personal resources influencing the new idea or behaviour. In reality, utilising a specific new technology does not happen simultaneously in a social context but accrues in a way where some people opt faster than other groups in adopting innovation. Interestingly, DOI theory has ignored that life is dynamic and unsteady as it involves continuous development and is subjected to new components (Mansell and Silverstone, 1996). Although DOI theory is designed to explain the factors that affect adoption rate and categorise individuals into different adopter groups, it lacks explaining the processes involved in attitude towards accepting or rejecting a decision (Karahanna, Straub and Chervany, 1999; Chen, Gillenson and Sherrell, 2002). They further argued that innovation is a complex process. Therefore, it undermines the possibility of providing proof of the progress of attitude towards acceptance or rejection nor explains how they fit into a particular process. Also, this theory is limited to specific contexts only as it needs more understanding of many particular details (Lundblad, 2003). Moreover, the researchers have also approved that the group who first adopt the technology have characteristics different from those who utilise them later (Rogers, 2003).

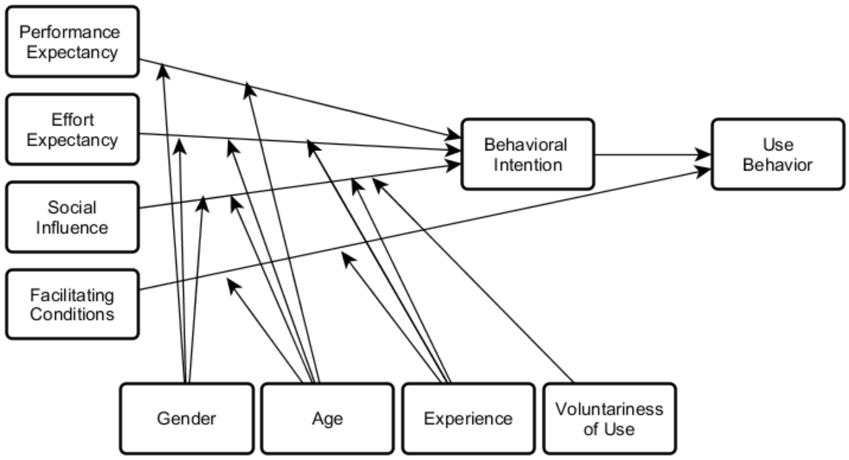
Furthermore, different researchers argued that DOI constructs are mainly designed to explain technological innovation, especially while ignoring other factors weather independent or control factors (Pérez Pérez *et al.*, 2004). Similarly, Chau and Hui (2001) argued that DOI is factors are insufficient to explain the adoption within complex organisational technologies and inter-organizational information systems. Moreover, Clarke (1999, p.17) argued that adopting DOI in an information system context is not the best idea as it is "*at its best a descriptive tool, less strong in its explanatory power, and less useful still in predicting outcomes and providing guidance as to how to accelerate the rate of adoption*". Furthermore, this theory has been criticised as mainly derived from North American culture and, accordingly, more applicable to these countries than others (Clarke, 1999). DOI is also judged for its ability to frame a readily refutable hypothesis.

In short, despite this model's unique contribution to investigating technology usage and adoption, it needs some important elements, such as social, cultural and economic factors that are crucial in understanding citizens' acceptance of smart transportation services and applications (Alonazi, 2019). Furthermore, Sang and Lee (2009) argued that the TAM model lacks investigation of external factors that may affect perceived usefulness and ease of use. As a result, TAM shares with DOI the fact that they both miss the consideration of external factors such as expected users' awareness of the new smart transportation services, trust, the quality of the smart services, compatibility, and cultural prospects related to the Omani context, all of which influence user behaviour towards adoption of the new smart transportation services and applications.

4.2.6 Unified Theory of Acceptance and Use of Technology (UTAUT)

Most of the discussed models above are designed based on many variables or determinants that measure individuals' degree of satisfaction and acceptance towards any technology or information system (Momami, 2017). Venkatesh *et al.* (2003) realised that most IT practitioners and researchers are challenged to choose the best model among the various technology acceptance models or select constructs among these models and therefore omit the contribution of the alternative factors. Thus, they realised the urge to synthesise these models to understand consumers' technology adoption comprehensively. In other words, choosing a particular acceptance model is a complicated task. It may result in inaccurate findings as some are designed to meet the general purpose whilst others are developed to explain the requirement of adopting a specific technology. Therefore, and based on these reasons, Venkatesh *et al.* (2003) developed the Unified Theory of Acceptance and Use of Technology (UTAUT) presented in Figure 3.6.

Figure 4.6: Unified Theory of Acceptance and Use of Technology (UTAUT). Source (Venkatesh et al., 2003a).



UTAUT is known as a unified model for consumer acceptance of technology as it integrates the main factors from the previous eight different models, namely: the Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 1975), Diffusion of Innovation theory (DOI) (Rogers, 1995) the Technology Acceptance Model (TAM) (Davis, 1989), the Motivational Model (MM) (Davis, Bagozzi and Warshaw, 1992),the Model of PC Utilization (MPCU) (Thompson, Higgins and Howell, 1991),the Social Cognitive Theory (SCT) (Bandura, 2001), the Theory of Planned Behaviour (TPB) (Ajzen, 1991), and combined TAM and TPB (Taylor and Todd, 1995). As a result, the UTAUT model integrated several constructs in addition to many other factors developed by Venkatesh *et al.* (2003), which makes UTAUT an excellent model for evaluating users' acceptance and adoption of new ideas and technologies. As this model reviews many available technology acceptance frameworks, it is recognised by most researchers as the complete model to explain acceptance since it has been developed based on many available technology acceptance models. As a result, Wang *et al.* (2022) argued that this model's explanatory ability is the highest compared to other technology acceptance models.

According to this model, there are four main detriments of individual user behaviour to explain technology acceptance and usage. UTAUT model consists of four primary constructs: performance expectancy, effort expectancy, social influence and facilitating condition. In addition, four moderators have been assigned to it, including age, gender, voluntariness of use and experience. The main factors are explained below:

- **Performance Expectancy (PE):** is "*the degree to which an individual believes that using the system will help him or her to attain gains in job performance*"(Venkatesh *et al.*, 2003a, p. 447). That is the extent to which a person believes that using a particular system or technology will contribute to performing their job better. The actual explanation of performance expectancy is about performing the same task faster and more accurately while also increasing job performance qualitatively and quantitatively by adopting the new system. Perceived usefulness from the TAM model, extrinsic motivation from the MM model, job fit from the MPCU model, relative advantage from DOI, and outcome expectancy from SCT are the constructs from the other models that pertain to performance expectancy. It is evaluated to be the most powerful factor in assessing the intention to use ICT and has been proven to be very significant within many models in both voluntary and mandatory contexts (Lu, Zhou and Wang, 2009)

- **Effort Expectancy (EE):** is "*the degree of ease associated with the use of the system*" (Venkatesh *et al.*, 2003, p. 451). It is the belief that adopting a particular technology will be effortless and easy manner (Tarhini *et al.*, 2019). The constructs in other models that represent effort expectancy are complexity from DOI and MPCU and perceived ease of use (PEOU) from the TAM model. Like performance expectancy, effort expectancy was considered a critical construct in many model in voluntary and mandatory situations (Venkatesh *et al.*, 2003).
- **Social Influence (SI):** is "*the degree to which an individual perceives that important others believe he or she should use the new system*" (Venkatesh *et al.*, 2003, p. 451). This construct means that adopting a new system adds superiority to its adopters compared to their colleagues on the social network who think it is essential for a person to use it. It is an external factor that influences a person's behaviour, attitude, and beliefs to keep up with the demand of the social environment. Social influence reflects the following constructs in the existing model: social factors in MPCU, and subjective norms in TRA, TAM2, TPB/DTPB, TAM- TPB. This factor is considered insignificant in voluntary studies but vital in mandatory contexts. It is observed from the literature that when a person is not mandated to adopt a technology, this construct becomes insignificant in volumetry context, whereas the factor's effect becomes essential when mandatory situations rewards or punishments are implemented (Lee, Lee and Lee, 2006; Lai, 2017a).
- **Facilitating Conditions**: is "*the degree to which an individual believes that an organisational and technical infrastructure exists to support the use of the system*" (Venkatesh *et al.*, 2003, p. 447). Funding, skills, access disparity, pedagogy, training, and equipment are among main challenges affecting an individual's beliefs of how easy or difficult it is to perform a specific task (Paul, Musa and Nansubuga, 2015). This construct encompasses the availability of external resources such as instructions, knowledge and assistance for the end users when needed to use the system better. Interestingly, this factor captures different factors in other models: compatibility in (DOI), perceived behavioural control in (TPB/DTPB) and (C-TAM-TPB) and facilitating condition in (MPCU). Empirical studies revealed that this construct proved a similar relation in voluntary and mandatory settings during the first training period, while the effect is absent in the next second period.

According to Figure 3.6, UTAUT considers the above four elements as the main indicators facilitating an individual's intention to adopt a technology. While performance expectancy, effort expectancy and social influence are hypothesised as the main constructs affecting users' usage intentions, facilitating conditions, and behavioural intention are assumed to shape users' actual use of the technology (Venkatesh *et al.*, 2003). One of the significant differences between UTAUT and other exciting acceptance models is that UTAUT has introduced four essential moderators, including experience, gender, voluntariness and age, which further added more power to this model and became very famous and utilised extensively in explaining people's adoption of the new technologies (Dwivedi *et al.*, 2019). Performance expectancy and effort expectancy are moderated by age, gender and experience, whereas social influence is moderated by all four moderators age, gender, experience and voluntariness. Age and experience mediate the relationship between facilitating conditions and new technology usage.

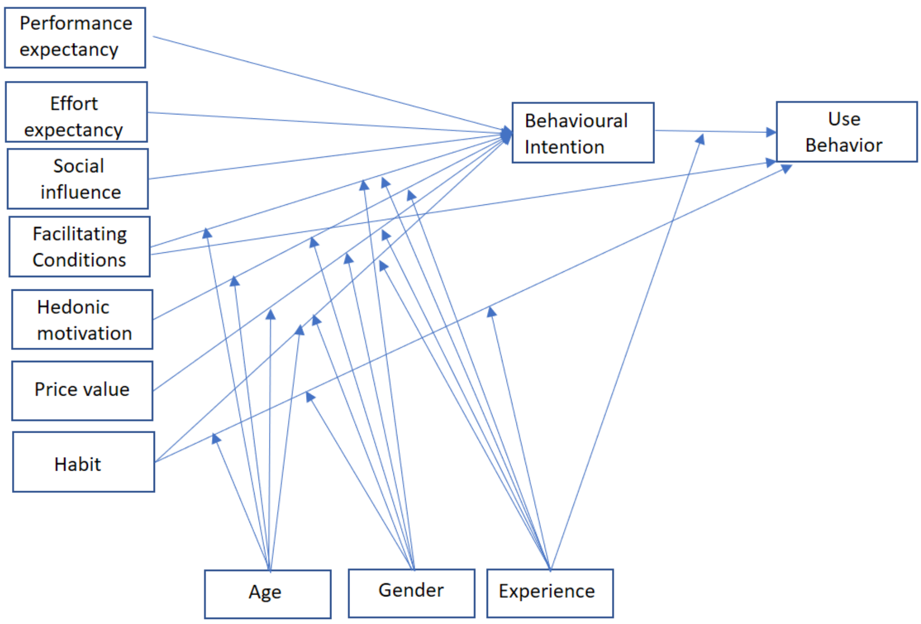
The UTAUT model also differs from other models in terms of removing the attitude construct due to its fluctuated results as it was reported critical in particular context within TRA and TPB models, whereas its influence was not essential in other cases within C-TAM-TPB models (Taylor and Todd, 1995; Venkatesh *et al.*, 2003). Moreover, empirical and previous conditional studies proved that the link between attitude and intention to adopt might involve other constructs, such as performance expectancy and effort expectancy.(Taylor and Todd, 1995; Venkatesh *et al.*, 2003).Therefore, the relations between intention to use and performance expectancy and effort expectancy are predicted to be significant compared to the relationship between attitudes and intention in which attitudes are not considered to influence the intention directly and accordingly have been removed from the UTAUT model. Additionally, according to Venkatesh and Zhang (2010), this model is not limited to only addressing the effect of the constructs on the technology usage from the consumer perception but also investigates the possibilities of extending or constraining the impact of such constructs. UTAUT is approved as one of the powerful models for exploring factors that control new technology innovation in the individual setting. Accordingly, it has been widely adopted to explain individuals' acceptance and utilisation of new technologies (Liang *et al.*, 2020), such as IoT in Public universities (Almetere, Kelana and Mansor, 2020). Interestingly for the current study, this model has been used intensively in transportation research from a technology acceptance viewpoint (Madigan *et al.*, 2016; Hewitt *et al.*, 2019; Kettles and Van Belle, 2019; Chen *et al.*, 2020).

Although UTAUT was developed by some of the leading researchers in the field of computer adoption and acceptance and has been built based on the similarities among the eight famous technology adoption models, there were some limitations mentioned and reported by (Venkatesh *et al.*, 2003). Firstly, the sample size employed by the authors to develop and investigate the model was a relatively small sample of 50 contributors from each group. Secondly, the use of the technology construct in this model does not carry a clear understanding as it might mean a behaviour of permanent use or a behaviour of momentary use (Samaradiwakara and Gunawardena, 2014). Thirdly, the factors used to evaluate a person's intention to use technology in this model are mainly extracted from organisational cases. Besides utilizing it by many researchers to investigate technology acceptance in organisational contexts, many others have adopted it in other settings too (Francisco Javier Rondan-Cataluña, Arenas-Gaitán and Ramírez-Correa, 2015). However, there is a solid call to reveal the silent factors in different contexts, such as the consumer setting (Taherdoost, 2018). Fourthly, according to van Raaij and Schepers (2008), this model combined disparate elements and broad aspects into one single construct. By coming perceived behavioural control, facilitating conditions and compatibility it "*combines items on the fit between the technology and the individual's work style, the availability of assistance, and the availability of required resources. It is difficult to see how such a wide variety of items can reflect one single psychometric construct*" (van Raaij and Schepers, 2008, p. 841). For example, with regards to the smart transportation's mobile applications and services, the construct facilitating conditions is a broad element as it involves, for instance, the rules and regulation availability, the technical support availability, and the technical skills among the users. In addition, Yang (2010) argued that the UTAUT framework lacks an understanding of the influence of performance acceptancy on the end users' acceptance and adoption of new technology. Besides, this model is considered new compared to other technology acceptance models. It requires further investigations to explore it better, validate its constructs, replicate its findings, and prove its power in explaining the acceptance of a technology (Straub, 2009). This model does not involve an explanation of the individual's prospects, such as entertainment assigned with technology usage and personal motivation, that may contribute to better addressing the acceptance issues.

As a result, this model does not apply to this study as some critical factors, such as awareness, privacy, and security, are absent in this model. Such constructs are essential in understanding the acceptance of the wide smart transportation' mobile applications. Thus, later, UTAUT was used to develop a new technology adoption model designed to address consumer perception of technology adoption introduced by (Venkatesh, Thong and Xu, 2012).

4.2.7 The Unified Theory of Acceptance and Use of Technology2 (UTAUT 2)

Figure 4.7: Unified Theory of Acceptance and Use of Technology 2 (UTAUT2). Source (Venkatesh, Thong and Xu, 2012).



Many researchers have utilized the UTAUT model as a fundamental theoretical framework in investigating technology acceptance in organisational and non-organizational settings. The UTAUT model studies factors affecting the adoption in the organization context since it ignores consumer-related aspects, as consumer acceptance of technology involves some particular constructs compared to the organisational context (Venkatesh, Thong and Xu, 2012). Thus, a model was needed to identify the factors influencing consumers' technology usage.

To address the original model of UTAUT criticisms, three new variables were added to the UTAUT2 model to better evaluate consumer adoption of the technology, as shown in Figure 3.7: hedonic motivation, price value and habit while deleting the moderator voluntariness of adoption. By incorporating these three elements, the UTAUT2 framework outbreaks the UTAUT model in the variance of explaining end users' behaviour intention in adopting and utilizing the new technologies. Moreover, individual factors such as age, gender and experience have been hypothesised in the model as moderators that affect a person's behaviour on technology adoption. All these elements were integrated as the target of the UTAUT2 is to examine customer usage and utilisation of technology, unlike the original UTAUT, which was mainly introduced to explain users' acceptance and adoption of the technology in an organisational context (Venkatesh, Thong and Xu, 2012). This model also involved adding experience as a new moderator while excluding voluntariness, which is part of UTAUT, to make the model more applicable to the consumer behaviour context (Brown and Venkatesh, 2005; Venkatesh, Thong and Xu, 2012). The UTAUT2 framework was developed by extending the UTAUT model with three main constructs expected to be critical in investigating consumer settings. Such extensions contributed to making UTAUT2 more robust, particularly in studies related to environmental contexts. These new constructed are explained below:

- **Habit**: is "*the extent to which people tend to perform behaviours automatically because of learning*" (Venkatesh, Thong and Xu, 2012, p. 161). This means that after building the habit of using technology, an individual will continue using it as an automatic action after learning how to use it (Jia, Hall and Sun, 2014). The performance of a habitual action is considered to be more accessible and requires less effort compared to other behaviour (Lankton, Wilson and Mao, 2010). As a result, adding habit as a critical component of the new UTAUT2 model was valuable, as it would directly or indirectly affect an individual's behaviour or behavioural intention.
- **Hedonic motivation:** is "*the fun or pleasure derived from using a technology*" (Venkatesh, Thong and Xu, 2012, p. 161). This factor is an important construct in addressing an individual behaviour towards technology. In the context of technology adoption and, more specifically, mobile phones, this factor is considered very significant as it directly influences individuals' behaviour intention (Yang, 2010). Thus, hedonic motivation has been added to this model as a new determinant that evaluates the extent a person can have fun and enjoy the adoption of the new technology (Venkatesh, Thong and Xu, 2012). This added more value to this model and enabled researchers to adopt it in different research contexts and environments. Most researchers have approved its significant effect on users' acceptance of the new technologies (Brown and Venkatesh, 2005). However, its incorporation into the transportation sector has rarely been explored (Madigan *et al.*, 2017).
- **Price value:** "*captures the trade-off between the perceived monetary costs and the perceived benefits of using a technology*" (Weinhard, Hauser and Thiesse, 2017, p. 4). In particular, the involvement of habit and price value are considered contextual variables that enrich the utilisation of the model compared to the original UTAUT (Venkatesh, Thong and Xu, 2012).

Whilst the current section targets technology acceptance models, which are most commonly used in investigating acceptance behaviour, the following sections will explain in more detail the reasons behind the selection of the UTAUT2 model as the most suitable model for the current research context.

4.3 Reasons Behind Selecting The UTAUT2 Model

Based on the above discussion, it can be realised that scientists have developed several acceptance models used to investigate the acceptance of new technologies. The previous sections have provided a general review of the many technology acceptance models used in understanding end users' acceptance and adoption of new technologies. Choosing one of the above-discussed acceptance models is a complicated decision, especially since most models are mainly extended from one or more of the main models. For example, TAM2 is developed from TAM and TPB models, UATUT2 is extracted from UTAUT, and the TBP model is an extension of TRA. The Technology Acceptance Model (TAM), Unified Theory of Acceptance and Use of Technology model (UTAUT), and Theory of Planned Behaviour (TPB) are considered the three main frameworks adopted in the research. TPB is mainly employed to realise end users' behaviour, while TAM and UTAUT are used primarily to understand the extent of the technology acceptance (Rahman *et al.*, 2017). These frameworks consist of distinct constructs mainly designed to reveal the end user's actual behaviour of adopting new technology and push the end user's acceptance.

TAM mainly depends on two main constructs, perceived usefulness, and perceived ease of use, as two main indicators explaining the behavioural intention in the adoption and acceptance of new technology. It was introduced by Davis (1989) to be implemented in understanding the end user's behaviour in the computer usage context. Paul, Musa and Nansubuga, (2015) argued that TAM is limited to specific contexts and does not explain all kinds of technology adoption due to the absence of external factors critical to consider the acceptance. As such, it is designed to demonstrate the use of technologies in organisational contexts rather than in consumers' everyday life, which further makes it less sufficient to be used in smart transportation as smart transportation applications are daily life applications which link passengers to public transport services. Moreover, the adoption of smart transportation mobile applications involves payments which may be an important factor influencing citizen adoption and cannot be ignored. Besides, TAM neglects the social factors in the acceptance of new technologies, and smart transportation mobile applications' acceptance is a complicated process that may involve factors such as social influence (Shin, 2009). Therefore, some critical variables needed to be incorporated into this model to be sufficient for the current study context.

Later, Venkatesh *et al.* (2003) developed a new model called UTAUT by incorporating the TAM model along with some other acceptance models to be mainly used in the acceptance of technologies in Information Systems (IS) contexts (Zhou, Lu and Wang, 2010; Khalilzadeh, Ozturk and Bilgihan, 2017). This model has been used by Adell (2010) to investigate the implementation of the driver support system. However, it failed to explain the variation of the behavioural intention reported in the research finding. As mentioned earlier, this model misses the inclusion of the self-motivation factor, which may help better understand Omani citizens' acceptance of smart mobile applications. This model has been mainly designed to evaluate acceptance in organisational and business contexts. The current study mainly focuses on exploring acceptance in the consumer context by addressing the factors affecting Omani citizens' acceptance of smart mobile applications. Thus, UTAUT2 has been developed by integrating three additional elements, namely price value, habit, and hedonic motivation, to address the limitations of the UTAUT and better explain the end users' behavioural intention to use. It is claimed that UTAUT2 is designed to give more accurate descriptions of the adoption than the UTAUT model (Venkatesh, Thong and Xu, 2012). In addition, UTAUT2 is a more recent updated model of the acceptance models and is considered a more comprehensive model to be used in the studies of the consumer behaviour understanding (Korkmaz *et al.*, 2021). UTAUT2 model is also the best to be used in understanding the behavioural intention toward new technology in the mobile phone contexts (Ali Khan, 2017). As this study addresses smart mobile applications acceptance and mainly focuses on the consumer context, UTAUT2 fits it the most compared to other technology acceptance models.

On the other hand, TRA is classified as more general to the extent that we need to elicit the silent factors to study a specific behaviour (Ajzen and Fishbein, 1980). Moreover, the factors of TRA are involved in both UTAUT and UTAUT2 models. Accordingly, UTAUT2 is considered more relevant for this research. With regards to TPB, it is considered a general and straightforward model. The construct of perceived behavioural control makes TPB unique. Yet, as UTAUT2 is built based on the finding of TPB, it includes a facilitating conditions construct that replaces perceived behavioural control in TPB.

After reviewing the fundamental technology acceptance models (TRA, TAM, UTAUT, UTAUT2, DOI), the researcher realised that UTAUT2 is the most applicable model over all other reviewed models for this research setting. From the understanding of the researcher, each one of the discussed models has its advantages and disadvantages. Also, some models are more applicable to specific contexts than others based on the study's aims, goals, and objectives. For this study, the researcher decided to adopt the most comprehensive/ holistic model that is more powerful in explaining the acceptance of smart transportation services and applications while also incorporating the benefits and advantages of the previously discussed models. Thus, based on the literature review and the arguments discussed in this section, the author believes that UTAUT2 is the best model to be adopted to answer the research questions of this thesis as it provides a clear explanation of the factors expected to affect citizens' adoption of the smart transportation mobile applications in Oman, a developing country, by collecting empirical data and analysing them from both main pillars of such services: the smart transportation services providers and their customers. The following summarises why the researcher decided to select UTAUT2 as a base for developing this research framework:

- Due to its highly beneficial abilities in explaining an individual’s behavioural intention to use technologies as it combines different external factors (hedonic motivation, habit, price value) that contributes to a better explanation of an individual behavioural intention in using a new technology (Venkatesh, Thong and Xu, 2012). Venkatesh, Thong and Xu (2012, p.157) also discussed that these additional constructs contribute to making a “*substantial improvement in the variance explained in the behavioural intention*” attained in UTAUT2. Thus, this model allows researchers to investigate the relationship between information technology factors and an individual’s behavioural intention. Therefore, UTAUT2 includes widely approved constructs to identify the user’s acceptance of the new technologies but is not tested and investigated in the context of smart transportation mobile applications. These variables include price value, hedonic motivation, and habit. Researchers have shown that the UTAUT2 model is robust enough to be implemented in other countries with different cultures, not only in its originally developed country and culture. Therefore, it can offer a wide cross-cultural explanation of technology adoption and utilisation (Manrai, Goel and Yadav, 2021).
- Moreover, this model is also used to measure the various social influences on the adoption of new technologies, which corresponds to the aim of this research. Accordingly, the UTAUT2 framework helps understand the effect of friends, families, and colleagues on adopting new technologies by including the social influence construct. This study aims to explore a personal social network effect on the adoption of the new smart transportation mobile applications. Therefore, this model's design perfectly supports investigating this prospect.

- UTAUT2 allows researchers to capture additional external factors based on the current research study environment. Therefore, it is recommended to adopt this model to study all potential factors that are expected to impact citizens' acceptance and adoption of smart transportation applications. In comparison to UTAUT, UTAUT2 has been proven to have more explanatory power in investigating technologies acceptance and usage as it incorporates not only UTAUT factors but also researchers are allowed to add new factors and relations in addition to extending it to include other countries and studying a different group of users with different age, gender, and experience level. It is considered the most comprehensive model that combines the essential primary factors that might influence smart transportation applications. It is classified as the most completed model highly utilised to study the successful implementation of new technologies by carefully addressing factors influencing an individual's behavioural intention of adoption (Tamilmani, Rana and Dwivedi, 2017). According to Venkatesh *et al.* (2003), UTAUT models are designed to be a holistic model targeting to explain around 70% of the variance on the end users intend to use a particular technology, which is considered more effective compared to the explanation provided by any earlier model discussed above. Moreover, as UTAUT2 is designed based on the UTAUT, it is expected to have the same advantage while also solving the issues raised by UTAUT to have higher accuracy than UTAUT (Venkatesh et al., 2003).
- Although UTAUT is built by combining eight frameworks and is explicitly designed to understand end users' behaviour in accepting new technology, It is stated that it has a deterministic approach while ignoring other personal values and individual characteristics (Zhang, 2020). While, UTAUT2 theory includes three main factors, which are hedonic motivation, price value and habits which are direct constructs designed to build an understanding of the behavioural intention in the consumer context. Therefore, this study will adopt UTAUT2 as it can be further adjusted to Oman and the context of this research: smart transportation services and applications adoption.

Based on the above arguments, it can be concluded that UTAUT2 is the most suitable model to be adopted for current research as it enables the researcher to build a framework with constructs that influence the end users' intentions to utilise smart transportation mobile applications. It also allows its combination with other external factors confirmed from other literature and models. As a result, it is acceptable theoretically and practically to adopt UTAUT2 as an important model in understanding the acceptance of smart transportation services and applications (Liang *et al.*, 2020).

4.4 Smart Transportation and Acceptance Theories

Accepting any new system is understood to be the first step toward its successful implementation (Abu-Al-Aish and Love, 2013). Venkatesh et al. (2004, p.446) defined acceptance as an "*initial decision made by the individual to interact with the technology*", and accordingly, technology acceptance depends on the end users' direct experience. This section is intended to review previous studies conducted to explore the factors influencing citizens' adoption of smart technologies and services in transportation sectors by utilising technology acceptance models. It is designed to review factors influencing the acceptance and adoption of smart transportation mobile applications and services to understand all possible factors expected to influence the acceptance concerning the perceptions of the citizens and service providers.

Several researchers adopted the technology acceptance models to investigate the adoption of smart technologies in the transportation sector in developed countries such as (Adell, 2010; Madigan *et al.*, 2016, 2017; Rahman *et al.*, 2017; Nordhoff *et al.*, 2018). Similarly, some studies have been conducted in developing countries such as (Choi and Ji, 2015a; Asraar Ahmed and Kranthi, 2019; Indrawati and Amalia, 2019a; Tristiyanto, Fiska and Ardiansyah, 2019; Chen *et al.*, 2020; Santoso and Lamria Siregar, 2020; Jeong *et al.*, 2021; Korkmaz *et al.*, 2021). Some of these studies have adopted factors from various technology acceptance models, while others suggested new elements that may influence the intentions to use smart transportation applications and services. This section reviews studies designed to explore the factors influencing the intention to use smart transportation services and applications based on the technology's acceptance models.

As shown in the Table 3.1, three main theoretical technology acceptance models which are the Technology Acceptance Model (TAM), Unified Theory of Acceptance and Use of Technology (UTAUT), Unified Theory of Acceptance and Use of Technology 2 (UTAUT2), with two main methodological tactics structural equation modelling and regression modelling have been mainly adopted by the previous researchers. The TAM framework can be considered one of the main theoretical models implemented to reflect the distinctive proprieties of smart transportation applications and services, as discussed earlier. However, in most of these studies the TAM model has been extended by external factors to explain the variance in the intention to adopt smart transportation technologies and services. Numerous research suggested different factors involved in successfully implementing smart transportation technologies. Table 3.1 showcases of a range of studies that have been conducted in smart transportation context by utilizing technology acceptance models. It summarises the main studies in smart transportation technologies and services that implemented TAM, UTAUT and UTAUT2 to examine the main drivers and controllers of the user's acceptance of the implementation of the smart transportation services and applications. For example, Khudaibergenova (2017) studied the performance of the smart card in public transportation in Indonesia and suggested extending the TAM model with TRA, IDT and UTAUT2 models to address better the critical factors influencing the adoption of smart cards in transportation. Besides, she extended the model with external factors, including economic profitability, relative advantage, security, transparency, and trust, which have influenced the acceptance of smart card adoption in transportation sectors. Moreover, according to the Table 3.1, most researchers found that trust is one of the main external common factors used to extend the TAM model and has been shown to impact smart transportation technologies and services implementations positively. Psychological ownership, perceived risk, big five personality and sensation-seeking traits, personality traits, perceived safety, trust, perceived privacy, information attributes, perceived convenience, compatibility are some other external factors used to extend the TAM model in explaining the acceptance of smart transportation services and applications acceptance (Choi and Ji, 2015a; Mohamad *et al.*, 2016; Lee *et al.*, 2019; Zhang *et al.*, 2019, 2020). Choi and Ji (2015) decided to utilize the TAM model coupled with the trust theory in investigating the adoption of automated vehicles. They successfully explained the user's intentions to use with a 67% explanatory rate. In related work, Zhang *et al.* (2019) studied the acceptance of automated cars by adopting the TAM model to explain end users' utilization and were able to explain it with 61% explanatory power. On the other hand, many researchers have appreciated the implementation of the UTAUT and UTAUT2 in the field of IS, and they have been widely valued in addressing user acceptance research worldwide (Alghatrifi, 2019). For example, Indrawati and Amalia (2019) implemented UTAUT2 to understand the factors that impact the adoption of an official mobile application to boost train ticket sales. Their results approved the effect of hedonic motivation, system quality, habit, and performance expectancy. Similarly, Madigan *et al.* (2016) implemented UTAUT to understand the factors that impact the adoption of vehicles without drivers in five European cities. Their results underlined the effect of performance expectancy, effort expectancy and social influence as main drivers in the acceptance of cars without drivers. Yet the researchers recommended incorporating other influencers, such as hedonic motivation from the UTAUT2 model, to understand the adoption better. In terms of the end user's acceptance of autonomous public transport in the Turkish context, Korkmaz *et al.* (2021) found that performance expectancy, social influence, habit, and trust and safety were all positive factors behind autonomous public transport adoption. Korkmaz *et al.* (2021) model successfully explain around 72% of the variance in the acceptance prediction of their study. In earlier work, Adell (2010) used the UTAUT model to understand the driver's acceptance of the driver support system. He found that this model helped explain only 20% of the variance. Similar to TAM, several of the studies listed in Table 3.1 proposed to extend the UTAUT and UTAUT2 frameworks by incorporating trust to explain the adoption of the new transportation technologies and the consumer's intention to use them. Most of these studies have revealed that trust is essential in determining the attitude toward smart transportation technologies and services. Reliability, privacy and security, compatibility, structural assurances, technology characteristics, task characteristics, task technology, system quality, safety, risk, consumer satisfaction, and mobility are all extended factors which have been involved in extending these two model and have been approved as valuable predictors of the behavioural intentions to adopt smart technologies in transportation sectors (Rahman *et al.*, 2017; Kaur and Rampersad, 2018; Asraar Ahmed and Kranthi, 2019; Indrawati and Amalia, 2019a; Kapser and Abdelrahman, 2020; Korkmaz *et al.*, 2021; Siyal, Hongzhuan and Gang, 2021a; Wu, Lee and Tian, 2021). Besides, as noticed from the Table 3.1, UTAUT and UTAUT2 are the two main theoretical models implemented in various countries to study new technology adoption in the transportation sector, such as Indonesia, Turkey, China, Korea, Grace, USA, Germany, and Italy.

4.5 Gaps in The Literature

Many countries worldwide have made efforts to offer various smart transportation services and applications. For example, Robo- taxi technology in the United States, known as driverless or self-driving taxis, is operated by one of the ridesharing company (Babones, 2018). Singapore has introduced intelligent traffic management beside electronic road pricing scheme used to control the traffic congestion (Asiag, 2021), while in Dubai, the Dubai autonomous transportation strategy is used to transfer the city into a smart city with smart transportation to improve the productivity and reduce the transportation cost (Dubai Tourism, 2012). Therefore, many endeavours have been conducted to explore the benefits, barriers and strategic needs of such projects (Billones *et al.*, 2021; Choosakun, Chaiittipornwong and Yeom, 2021) and have revealed different kinds of barriers against the implementation of the smart transportation projects such as technological, regulatory, and cost barriers (Iyer, 2021). On the other hand, these researchers have found that psychological barriers are another major barrier to adoption. Nonetheless, studies on the factors shaping end users' intention to adopt smart transportation services and applications are minimal.

To realise the benefits of implementing new technologies, it is crucial to understand citizens and encourage them to use and experience them.

Moreover, most studies are conducted in developed countries, with only a few relevant to developing countries (e.g., China, Philippines, and Indonesia). A study conducted in China found that most community members are interested in such smart transportation, but they have some concerns to be addressed before adopting them, such as the extra payment cost (Chen *et al.*, 2020). Particularly in the context of developing countries and, more specifically, Arab and Gulf countries, the review of the literature in the field of smart transportation showed that there is an insufficient number of studies conducted that explicitly investigate the acceptance of smart cities applications and services (Khan and Ali, 2022). More specifically, the fact that little research has been carried out on the acceptance and adoption of smart transportation services and applications in Oman is one of the main calls of this research. Simply adopting an acceptance model based on developed countries may cause many problems. For example, the social differences between developed and some specific developing counties as Oman, may result in different factors needing to be incorporated. Therefore, it is essential to include the contextual factors related to Oman (Bouwman *et al.*, 2022).

In addition, the researcher cannot point to previous studies performed in the area of the acceptance of the smart transportation services and applications adoption by combining the perception of both citizens and the smart transportation services providers at the same time in previous research. To the best of the author's knowledge, this is the first research conducted to investigate individual adoption of smart transportation services and applications in Oman from both a user's and service provider's perspectives. Venkatesh, Thong and Xu (2016) insisted on exploring the potential contextual and location-based factors of smart transportation service providers to enhance their acceptance. They highlighted this by involving individuals' characteristics, such as age, gender, and experience, within their model. Therefore, this research closes this gap by adopting an acceptance model for smart transportation mobile applications in an Omani context to explore the expected contextual variables. It compares it to the original acceptance model adopted in developed countries.

Also, as can be noticed from the literature review chapter, although UTAUT2 is considered a powerful tool in explaining the acceptance of smart transportation services and applications, only a few studies have adopted this model in addressing smart transportation and services acceptance. The UTAUT2 model has been widely employed in various settings to explore the acceptance mostly in developed countries instead of developing countries such as Oman, more specifically in the transportation context (Foroughi *et al.*, 2023). Hence, there is a strong need to build a comprehensive theoretical framework for the acceptance of smart transportation services and applications in Oman by incorporating all the factors from the UTAUT2 model to address their acceptance better.

At the end of 2017, Muscat became a city where various transportation applications and services were introduced to the market (The National Digital Platform for Transport Services in Oman, 2019). Some of these applications are provided by the private sector, whereas others are delivered by companies owned by the government (The World Bank, 2019). Since then, these applications and services have become an effective and efficient option for the community to adopt. The application-based services offered in Muscat include smart parking, traffic tracking, transportation sufficient payments, public bus information and ticket buying and taxi ordering application (Al Maqbali and Refeque, 2017). Such applications are designed to be accessed by their users wherever, whenever and in real-time. Thus, investigating the elements influencing community acceptance and adoption of such real-time applications is essential, as this will benefit end users and service providers.

To sum up, although urban mobility plays a vital role in the development of smart cities and they intensively contribute to making cities smart, more needs to be done about understanding the different drivers that increase smart transportation services and applications acceptance among citizens. The literature review has also revealed a paucity in the number of studies conducted on the effect of the behavioural component on the user's acceptance of smart transportation mobile applications and services. Such research is critical as it will help build a better understanding of the essential factors that influence their end users' utilisations of such smart transportation mobile applications. Revealing behavioural factors influencing smart transportation applications and services adoption makes it easier to analyse and build relations that indicate the priorities to increase citizens' acceptance of such smart transportation applications and services by their end users. As a result, the findings of such research can be used by transportation services providers and smart technologies companies to develop models to help in better acceptance and utilisation of these smart services, consequently reducing the risk of losing investments.

Table 4.1: Findings related to the TAM/UTAUT/UTAUT2 and smart transportation services and application.

Title	Model	Constructs	Accepted constructs	Extended factors	Reference
Understanding citizens' acceptance of smart transportation mobile applications: a mixed methods study in Shenzhen, China	UTAUT2	Chinese culture, project management, smart city environment, familiarity with issues, facilitating conditions, social influence, performance expectancy, utility data, effort expectancy, price value, trust, habit, network externalities	Effort Expectancy, Habit, Trust, Network externalities, Smart city environment, Utility data	Chinese culture, Project management, Smart city environment, Familiarity with Issues, Utility data, Trust, Network Externalities	(Du, 2019)
The Used of Modified UTAUT2 Model to Analyse the Continuance Intention of Travel Mobile Application	UTAUT2	Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Condition, Hedonic Motivation, Price Saving, Habit, System Quality, Continuance Intention	Hedonic Motivation, System Quality, Habit, Performance Expectancy	System Quality	(Indrawati and Amalia, 2019b)
From Consumer Satisfaction to Recommendation of Mobile App–Based Services: An Overview of Mobile Taxi Booking Apps	UTAUT2	Price Value, Effort Expectancy, Hedonic Motivation, Performance Expectancy, Facilitating Condition, Habit, Social Influence, Consumer Satisfaction	Price Value, Effort Expectancy, Hedonic Motivation, Performance Expectancy, Facilitating Conditions, Habit, Social Influence, Consumer Satisfaction	Consumer Satisfaction	(Siyal, Hongzhuan and Gang, 2021b)
Determinants of m-ticketing adoption using smartphone app among IT employees of Bengaluru city - an extended UTAUT2 approach	UTAUT2	Compatibility, Mobility, Mobile application self-efficacy, Perceived risk, Trust, Habit, Price Value, Hedonic Motivations, Facilitating Conditions, Social Influence, Effort Expectancy, Performance Expectancy	Performance Expectancy, Price Value, Habit, Trust, Compatibility, Perceived risk, Mobility, Compatibility	Compatibility, Mobility, Mobile application Self- Efficacy, Perceived risk, Trust,	(Asraar Ahmed and Kranthi, 2019)
Factors affecting use behaviour to use transportation services applications using Unified Theory of Acceptance and Use of Technology (UTAUT2) model	UTAUT2	Habit, Price Value, Hedonic Motivations, Facilitating Conditions, Social Influence, Effort Expectancy, Performance Expectancy, Behavioral Intention	Habit, Social Influence, Price Value, Behavioral Intention	None	(Santoso and Lamria Siregar, 2020)
User Acceptance in the Sharing Economy: An explanatory study of Transportation Network Companies in China based on UTAUT2	UTAUT2	Facilitating Conditions, Price Value, Hedonic Motivation, Habit, Social Influence, Effort Expectancy, Performance Expectancy	Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Hedonic Motivations, Price Value, Habit	None	(Chen and Salmanian, 2017)
Stop hailing, start apping: adoption of app-cab	UTAUT2	Habit, Price Value, Hedonic Motivations, Facilitating Conditions, Social Influence, Effort Expectancy, Performance Expectancy	Price Value, Hedonic Motivations, Facilitating Conditions, Social Influence, Effort Expectancy, Performance Expectancy	None	(Chakraborty *et al.*, 2021)
Customer acceptance of ride-hailing in Indonesia	UTAUT2	Habit, Price Value, Hedonic Motivations, Facilitating Conditions, Social Influence, Effort Expectancy, Performance Expectancy	Performance Expectancy, Social Influence, Habit	non	(Almunawar, Anshari and Ariff Lim, 2020)

Determining Factors Affecting the Acceptance of Grab Application in the Philippines using UTAUT2 Approach	UTAUT2	Habit, Price Value, Hedonic Motivations, Facilitating Conditions, Social Influence, Effort Expectancy, Performance Expectancy , Security, privacy and Trust	Security, Privacy, Trust, Performance Expectancy	Security, privacy, and Trust	(Prasetyo and Vallespin, 2021)
User Acceptance of Autonomous Public Transport Systems: Extended UTAUT2 Model	TAM/ UTAUT/ UTAUT2	Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Hedonic Motivation, Price Value, Habit, Trust, Perceived Usefulness, Perceived Risk	Performance Expectancy, Social Influence, Habit, Trust, Safety	Trust, Perceived Usefulness, Perceived Risk	(Korkmaz *et al.*, 2021)
Acceptance of autonomous delivery vehicles for last-mile delivery in Germany – Extending UTAUT2 with risk perceptions	UTAUT2	Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Hedonic Motivation, Price Sensitivity, Perceived Risk	performance expectancy, social influence, Facilitating Conditions, perceived risk, hedonic motivation, Price Sensitivity	Perceived Risk, Price Sensitivity	(Kapser and Abdelrahman, 2020)
Analysis of the acceptance factor of android-based parking information systems in Indonesia	UTAUT	Performance Expectancy, Social Influence, Effort Expectancy, Facilitating conditions, Behavioral Intention	Performance Expectations, Effort Expectancy, Facilitating Conditions and Social Influence, Behavioral Intention	None	(Ilham *et al.*, 2020)
User Behavioural Intention toward Using Smart Parking System	UTAUT, TPB, TAM	Perceived Usefulness, Perceived Ease Of Use, Subjective Norm, Performance Expectancy	Perceived Usefulness, Perceived Ease Of Use, Subjective Norm, Performance Expectancy	None	(Kianpisheh *et al.*, 2011)
Adoption of E-hailing Applications: A Comparative Study between Female and Male Users in Thailand	TAM , DOI	Relative Advantages, Ease of Use, Trialability, Social Influence Physical security	Relative Advantages, Ease of Use, Social Influence, Physical Security	Physical Security	(Ruangkanjanases and Techapoolphol, 2018)
Assessment of mobile taxi booking apps: An empirical study of adoption by taxi drivers in Medellín-Colombia	TAM, TPB UTAUT	Complexity, Drivers' support technology, Coercive pressure customers, Innovativeness, Mimetic Pressures competitors, Normative Pressure trade association, Performance expectation, orientation at low prices, Effort Expectation	Performance expectation, Effort Expectation, Coercive pressure customers, orientation at low prices	Drivers' support technology, Coercive pressure customers, Innovativeness, Mimetic Pressures competitors, Normative Pressure trade association	(Sánchez-Torres, Correa Henao and Gomez, 2021)
A Framework of Customer's Intention to use Uber Service in Tourism Destination	TAM	Perceived Safety, Perceived Price, Perceived Convenience, Perceived Accessibility	Perceived Price, Perceived Safety	Perceived Accessibility, Perceived Convenience.	(Mohamad *et al.*, 2016)
Consumer adoption of the Uber mobile application: Insights from diffusion of innovation theory and technology acceptance model	DOI/ TAM	Relative advantage, Compatibility, Complexity, Observability, Social influence, Perceived usefulness, Perceived Ese of Use	Relative advantage, Compatibility, Complexity, Observability, Social influence, Perceived usefulness, Perceived Ese of Use	Relative advantage, Compatibility, Complexity, Observability,	(Min, So and Jeong, 2019)
Consumer acceptance of smart cards in public transportation	TRA, TAM, IDT, UTAUT2	Perceived Usefulness, Perceived Ease Of Use, Relative Advantage, Social Influence, Habit, Security, Transparency, and Trust, smart card media exposure, smartphone use	Habit, Economic Profitability Dimension of Relative Advantage and Trust, smart card media exposure, smartphone use duration	smart card media exposure, smartphone use duration	(Naoual Bouakkaz, 2017)

		duration, economic profitability, relative advantage			
Acceptance of driver support systems	UTAUT	Performance expectancy, Effort expectancy, Social Influence, Facilitating Conditions	Performance Expectancy, Social Influence	None	(Adell, 2010)
Trust in driverless cars: Investigating key factors influencing the adoption of driverless cars	UTAUT	Trust in technology, Performance Expectancy, Reliability, Security, Privacy, Trust	Performance Expectancy, Reliability, Security, Privacy, Trust	Reliability, Security, Privacy, Trust	(Kaur and Rampersad, 2018)
Automated vehicle acceptance in China: Social influence and initial trust are key determinants	TAM	Perceived Ease Of Use, Perceived Usefulness, Trust, Social Influence, Sensation Seeking Big-five Personality	Social Influence, Trust, personality traits, sensation seekers	Trust, Sensation Seeking Big-five Personality, Perceived Ease of use, Perceived Usefulness	(Zhang *et al.*, 2020)
The roles of initial trust and perceived risk in public's acceptance of automated vehicles	TAM	Perceived Ease of use, Perceived usefulness initial trust, Perceived Privacy Risk, Perceived Safety Risk, attitude	Initial trust, Perceived Usefulness, attitude, Perceived Privacy Risk	initial trust, Perceived Privacy Risk, Perceived Safety Risk,	(Zhang *et al.*, 2019)
Autonomous vehicles can be shared, but a feeling of ownership is important: Examination of the influential factors for intention to use autonomous vehicles	TAM	Perceived Ease Of Use, Perceived Usefulness, Relative Advantage, Self-Efficacy, Perceived Risk, Psychological ownership	Self-Efficacy, Psychological ownership	Psychological ownership Self-Efficacy, Perceived Risk	(Lee *et al.*, 2019)
An empirical investigation on consumers' intentions towards autonomous driving	TAM	Perceived Usefulness (PU), Perceived Ease to Use (PEU), Perceived Trust, Social Influence	Perceived Usefulness, Perceived Ease to Use, Perceived Trust, Social Influence	Perceived Trust	(Panagiotopoulos and Dimitrakopoulos, 2018)
Investigating the Importance of Trust on Adopting an Autonomous Vehicle	TAM	Perceived usefulness, Perceived ease of use, Trust (System transparency, Technical Competence, Situation Management), Perceived Risk, External locus of control, Sensation Seeking	Perceived Usefulness, Trust locus of control	Perceived Risk, External locus of control, Sensation Seeking, Trust, Sensation Seeking	(Choi and Ji, 2015b)
Public Acceptance of Driverless Buses in China: An Empirical Analysis Based on an Extended UTAUT Model	UTAUT	Personal Innovativeness, Perceived Risk, Effort Expectancy, Performance Expectancy, Social Influence, Facilitating Conditions, Personal Innovativeness and Perceived Risk	Personal Innovativeness, Perceived Risk, Effort Expectancy, Performance Expectancy, Social Influence, Facilitating Condition	Personal Innovativeness, Perceived Risk	(Chen *et al.*, 2020)
Acceptance of Automated Road Transport Systems (ARTS): an adaptation of the UTAUT model	UTAUT	Performance expectancy, Effort Expectancy, and Social Influence	Performance Expectancy, Effort Expectancy, Social Influence	none	(Madigan *et al.*, 2016)

Perceptions of Online Taxi Utilization in Bandar Lampung Using UTAUT Model (Unified Theory Of Acceptance And Use Of Technology)	UTAUT UTAUT2	Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Hedonic Motivation, Price Value, Habit	Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Condition, Hedonic Motivation, Habit	None	(Tristiyanto, Fiska and Ardiansyah, 2019)
An empirical investigation of mobile ticketing service adoption in public transportation	TAM/ DOI	Ease of use, Usefulness, Attitude, Social influence, Compatibility, Cost, Prior experience, Trust, Risk, Use context, Mobility	Compatibility, Mobility, contextual factors, including budget constraints, availability of other alternatives, and time pressure, contextual and mobile service-specific	Compatibility, Cost, Prior experience, Trust, Risk, Use context ,Mobility, Usefulness	(Mallat *et al.*, 2008)
Testing a structural model of young driver willingness to uptake Smartphone Driver Support Systems	TAM UTAUT	Perceived gains, Perceived risks, Social Influence, Usability, Delay discounting,	Perceived gains social influence, Perceived risks	Perceived gains, Perceived risks, Usability, Delay discounting,	(Kervick *et al.*, 2015)
Analysing Travellers' Intention to Accept Travel Information	TAM	Information attributes, Perceived usefulness, Cognition of alternate route, Trust in travel information, Perceived ease of use	trust in travel information, perceived usefulness, perceived ease of use, information attributes	Information attributes, Trust in travel information, Cognition of alternate route	(Xu *et al.*, 2010)
What influences the decision to use automated public transport? Using UTAUT to understand public acceptance of automated road transport systems	UTAUT	Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Hedonic Motivation	Hedonic Motivation, Performance Expectancy, Social Influence, Facilitating Conditions	None	(Madigan *et al.*, 2017)
Determinants of the Intention to Use Cross-Border Mobile Payments in Korea among Chinese Tourists: An Integrated Perspective of UTAUT2 with TTF and ITM	UTAUT2	Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Hedonic Motivation, Price value, Structural assurance, Personal propensity, firm reputation, task technology fit, initial trust model, technology characteristics, task characteristics	initial trust, performance expectancy, effort expectancy, facilitating conditions, price value, task technology fit, and initial trust	Structural assurance, Personal propensity, firm reputation, task technology fit, initial trust model, technology characteristics, task characteristics	(Wu, Lee and Tian, 2021)

4.6 Theoretical Framework Development

Existing literature explores much understanding of the different factors influencing end users' decisions to adopt new technologies in different contexts. Accordingly, in addition to the traditional factors of UTAUT2, the proposed model for this study will also consider and integrate factors from other sources, such as the previous smart cities studies and the literature review. Therefore, the final proposed model will involve comprehensive vital factors revealed from the literature review and factors explored from the service providers' interviews.

Although many studies have been conducted to understand the different factors influencing consumer adoption and utilisation, the concept of acceptance and adoption is simple. Accordingly, the same constructs could have different effects in different contexts. As these factors may play different roles in other contexts, the following section will review the traditional factors from the UTAUT2 model to revise their applicability in the context of the current study, besides also exploring new possible factors to expand the UTAUT2 model with external factors to better address the topic of the recent research. To this end, a revision of the current UTAUT2 model factors will be conducted, and some new factors will be introduced to extend the UTAUT2 model better address the issue of this study. Moreover, a group of related moderators will also be added based on the literature review. At the end of this section, a new model will be developed based on a critical analysis of the literature review related to technology acceptance in conjunction with the constructs from the UTAUT2 model. This model will help better understand the main barriers to accepting smart transportation services and applications in Oman. Forming such a model that fits the Omani context is essential to this thesis. This proposed model will also build a comprehensive view of smart transportation services and applications projects implementation and adoption within the context of Oman, in addition to working as a roadmap for data collection and their analysis in the following chapters.

4.6.1 Revising the Core UTAUT2 Model

- **Performance Expectancy (PE)**

Performance Expectancy (PE) is defined as the "degree to which using a technology will provide benefits to the consumers in performing certain activities" (Venkatesh, Thong and Xu, 2012, p. 159). With regards to this study, performance expectancy is explained as the extent an individual believes that adopting smart transport services and applications will help users to gain benefits in getting better facilities. This research evaluates the relationship between the performance expectancy of smart transport mobile applications and people's utilisation and acceptance of such services. For instance, if people assume that using a smart transport application will improve their performance by facilitating better transportation services and consequently enhancing their life quality, they will be eager to use the smart transport applications and services. Performance expectancy is expected to have the same effect as the TAM's perceived usefulness.

Performance Expectancy is one of the valuable constructs in identifying the intention of using technology in a smart city context. For example, Hendro (2018) found that performance expectancy is one of the significant factors in smart cities' acceptance in the research of identifying the main factors affecting smart city implementation in Indonesia. Moreover, Leong, Ping and Muthuveloo (2017) also examined the behavioural intention of IoT usage within smart cities context in Malaysia and reported that performance expectancy is found to be significant in the adoption of IoT technologies in smart cities setting. Hou *et al.* (2020) conducted empirical research to determine which factor dominates residents' intentions to adopt smart city mobile applications and reported that performance expectancy significantly influences residents' intention to utilise smart city mobile applications. Moreover, most of the studies listed in Table 3.1 underlined the significant effect of performance expectancy on, for example, influencing customer acceptance of ride-hailing in the Indonesia (Almunawar, Anshari and Ariff Lim, 2020), user acceptance of transportation services in the China (Indrawati and Amalia, 2019a), identifying the adoption of the travel mobile applications (Chen and Salmanian, 2017). In this study, performance expectancy refers to the citizens' subjective feelings about the enhancement of their growing mobility needs, the extent of the travel efficiency improvement and the enhancement in their quality of life when using smart transportation mobile applications. The higher the performance expectancy is, the more likely the public will accept smart transportation mobile applications. In the context of this study, PE means the public is motivated to adopt a specific smart transportation mobile application as they expect that it will contribute to transporting from one place to another while saving time, cost, and effort. Although smart transportation mobile applications are widespread in developed countries, they are not yet fully understood by their users and accordingly many of them fail to function successfully (Lu, Lu and Chen, 2022).

According to Venkatesh, Thong and Xu (2012), age, gender, and experience are the three main moderators affecting the relationship between factors and users' behavioural intentions. Similarly, Venkatesh and Zhang (2010) empirical results found that the influence of performance expectancy and behavioural intention is moderated by gender. Moreover, Yu (2012) conducted a study to test factors influencing individuals' adoption of mobile banking and noticed that men perceived more performance expectancy than women in adopting mobile banking services. Several studies also stated that men are more concerned about task achievements than women, and accordingly, men are more oriented toward the perceived value of adopting a new technology (Minton and Schneide, 1985; Venkatesh *et al.*, 2003a). Many other existing studies have shown that performance expectancy positively correlates with behavioural intention more significantly among males than females (Wang and Shih, 2009; Wang and Wang, 2010). Also, Ghalandari (2012) finds that age plays a vital role in performance expectancy and behavioural intention. As such, the age variable is reported to moderate the effect an individual's intention to use a technology in which younger people are more motivated than older people, mainly if the expected benefits stimulate them towards the usage (Yuliana and Aprianingsih, 2022). Users' existing knowledge, capacities of understanding, access to resources and skills are considered very critical in determining their perception towards innovation, as such knowledge efficiently contributes to their cognition to make a decision (Almaiah, Alamri and Al-Rahmi, 2019). Furthermore, McKenna, Tuunanen and Gardner (2013) argued that existing personal experience affects the capability of understanding the advantages and usability of the innovation, which further contributes to the decision of whether it is beneficial to utilise the latest innovation or not. Therefore, it is expected that gender, age, and experience can moderate the influence of performance expectancy on behavioural intention to adopt smart city transportation and applications in an Omani context.

- **Effort Expectancy (EE)**

The attractiveness of new technology, product and innovation is determined not only by the benefits it offers but also by how easy it is to use, how friendly the interface is and the availability of supportive learning guidance (Chang *et al.*, 2019). Effort expectancy is defined as "*the degree of ease associated with using the system*" (Venkatesh *et al.*, 2003a, p. 450). Ali and Qaisar (2018, p. 504) also defined effort expectancy as "*how an individual feels that he/she easily uses technology and how much strength of ease is there in the usage of technology*". Effort expectancy is considered a significant determinant of people's acceptance and utilisation of new technologies (Malik, Suresh and Sharma, 2017). When comparing a new technology with an old one and recognising that new technology is more accessible, more convenient to use, and requires less training, the intention to adopt and utilise it is expected to be higher (Tsao, Shieh and Jan, 2009). On the other hand, if an individual realises that it requires a serious effort to use, they will generate a damaging prospect of that technology (Chau and Chau, 2003). Therefore, in this study, the researcher considers effort expectancy as the extent a person believes that using smart transport mobile applications will be free of effort. The effort expectancy in this study refers to the citizen's subjective perceptions about the ease and difficulty of using smart transportation mobile applications or the degree of effort they need to put into getting the benefits assigned with the smart transportation mobile applications. The population believes that the more accessible the smart transportation mobile applications are, the more straightforward they are to use. Their intentions will be more positive and less negative towards adoption. Therefore, even if potential users expect a given smart transportation mobile application to be valid, they may also consider the applications too complicated to use. The effort of expectancy of utilising the system outweighs the advantages of utilisation. In general, if smart transportation mobile applications are considered hard to use, complexity will work as a functional barrier and consequently influence the acceptance (Yuen *et al.*, 2020).

Previous research showed that effort expectancy is one of the main factors affecting the user's intention to use new technology. For example, Alalwan *et al.* (2018) conducted a study investigating Jordanian citizens' internet banking usage and found that effort expectancy positively impacts behavioural intention in a banking setting. Similarly, Alharbi *et al.* (2017) studied the acceptance of mobile learning in Saudi Arabia and discovered that effort expectancy strongly affects user acceptance. In addition, findings from empirical research have also supported the conclusion that effort expectancy positively impacts the user's behavioural intention in the mobile applications context (Okumus *et al.*, 2018; Tam, Santos and Oliveira, 2020) . As depicted in Table 3.1, effort expectancy is considered one of the main factors influencing the acceptance of the implementation of smart transportation services.

It has also been noticed that effort expectancy affects behavioural intention more significantly for women (Venkatesh and Zhang, 2010). Moreover, it was noted that females are more worried about perceived ease of use than males, which reflects that effort expectancy is more sensitive among women (Venkatesh *et al.*, 2003). Mekhzoumi, Hilmi and Krishnasamy (2018) also found that the effect on effort expectancy is more substantial among women, especially women with less technology experience. They also demonstrated that this construct would influence women's intention to adopt the innovation.

Regarding age moderators, it appears that adopting information system technologies, specifically mobile applications, is more common among the younger generation (Kleijnen, Wetzels and de Ruyter, 2004). For instance, Cimperman et al. (2016) conducted a study to investigate the acceptance of telehealth home services and found that effort expectancy was confirmed to positively affect older people's acceptance among other people (Cimperman, Makovec Brenčič and Trkman, 2016). Moreover, earlier studies suggested that age moderates the link between effort expectancy and the behavioural intention (Yu, 2012; Kwateng, Atiemo and Appiah, 2019). Since smart city transportation mobile applications are built through information technologies, the dealing between their services and citizens is considered information communication. As a result, it is assumed that young generations will appreciate them more quickly and are more encouraged to adopt them to gain better transportation services and information. In respect of experience moderator, Liu *et al.* (2022) conducted a study on the user acceptance of a mobile payment application. When the status of the user experience is high, it is expected that ease of use had a higher impact on behavioural intention. In the current investigation, the adoption and usage of the new smart transportation mobile applications mainly depend on the citizens' knowledge and experiences with using the internet and smart mobile devices. Such smart services and applications require proper knowledge to know how to, for example, plan for travel, locate free parking lots and pay parking and other transportation fees. As a result, it is predicted that users with higher experience levels might find smart transportation mobile applications easier to adopt.

- **Social Influence (SI)**

Venkatesh *et al.* (2003, p. 451) described social influence as “the degree to which an individual perceives that important others believe he or she should use the new system”**.** Social influence is the degree to which an individual’s thoughts, understandings and behavioural intention are affected by the social network in their living environment, such as family, co-workers, colleagues, friends, etc. Individuals try to interact with others in their social community to get advice and feedback about the innovation to reduce uncertainty in utilising an innovation (Liébana-Cabanillas, Sánchez-Fernández and Muñoz-Leiva, 2014). Roger (2008) further argued that a person’s final decision to adopt new technology is influenced by their social norm beyond their rational decision thinking. Social influence consists of two main effects: information and normality. The influence of information involves the information a person gets from others, whereas the normative effect stands for meeting other people’s expectations to gain or escape punishment (Hsu and Lu, 2004).

Different prior studies have highlighted the impact of the social influence construct on individuals' behavioural intention in other contexts, such as in the electronic government (Li, 2021; Hooda *et al.*, 2022), mobile government (Ahmad and Khalid, 2017), and mobile learning (Al-Lozi, Al-Hujran and Al-Debei, 2014). Social influence significantly influences the individual’s behavioural intention to adopt new technologies (Venkatesh *et al.*, 2003a; Rahi *et al.*, 2019). For example, social influence is a significant construct affecting the behavioural intention to use financial technology (Hassan *et al.*, 2023). Also, it has been noticed that peers, staff and senior students significantly influence the student's adoption of the blended learning mode in the universities (Rudhumbu, 2022). Similarly, many other researchers, such as (Guhan *et al.*, 2022; Inder, Sood and Grima, 2022), investigated the influence of social influence on the adoption of e-banking services and reported its significance.

With regards to the smart transportation context, the social influence construct might directly affect the intention of the adoption of smart city transportation services and applications, as it has been recorded in some studies, such as the utilisation of the driverless public transport (Chen *et al.*, 2020) and the acceptance of the autonomous driving technology (Zhang *et al.*, 2020), where the social influence construct has been shown to be a significant influence of the acceptance. For smart transportation mobile applications, it is expected that communication with a satisfied user of the smart transportation mobile application from their social group will not only convince an individual to adopt them but will also prove that the resistance carried is not valid. Besides, adopting smart transportation mobile applications by a family member or a friend leads to a better willingness to utilise a technology (Bansal, Kockelman and Singh, 2016). The public utilisation of smart transportation mobile applications is directly affected by their surrounding social network. Moreover, according to Im, Hong and Kang (2011), social influence impact is expected to be more potent in developing countries such as Saudi Arabia. Regarding the moderators, the social influence construct affects behavioural intention more significantly for females (Wang and Shih, 2009; Venkatesh and Zhang, 2010). Overall, women are more worried about other people's opinions, besides being embedded with a more remarkable ability to communicate and connect with the community and yield to other people's views more quickly than men. Therefore, they are found to rely more on social influence to decide on utilising an innovation, technology or product (Mazman, Usluel and Çevik, 2009). Moreover, the social impact of females appears to be more rigid in Arabic culture; for instance, in Saudi Arabia, females usually act based on restricted social norms (Al-Gahtani, Hubona and Wang, 2007; Al-Busaidy, 2011; Al-Nasrallah, 2023). On the other hand, many studies have revealed that gender differences in accepting new technologies are not critical anymore as technology usage is spreading widely (Pookulangara and Koesler, 2011). However, smart city transportation services and applications are relatively new and still evolving in Oman. Hence the influence of gender as a moderator for acceptance is still acceptable to be tested. In terms of experience, Venkatesh *et al.* (2003) argued that individuals with valid expertise in technology are expected to be less influenced by social influence. Accordingly, the impact of social influence constructs on a person's intention to utilise technology will decrease with experience increment (Venkatesh, Thong and Xu, 2012). Regarding the experience moderator impact, the new generation is deemed to be technology ordinated, which means they are more motivated and confident in utilising the new services regardless of their experience level (Schuster, Drennan and Lings, 2013). With regards to the age moderator, young individuals are highly expected to build an intention to use new mobile applications even if they are anticipated to be influenced by their family and friends (Koenig-Lewis, Palmer and Moll, 2010). In this respect, Nassar, Othman and Nizah (2019) conducted a study to evaluate the impact of social influence towards ICT adoption. They discovered that age negatively moderates the effect of social influence on behavioural intentioned. Since smart city transportation mobile applications are designed to provide users with valuable information about travel and congestion, it is justifiable to predict that age moderates the social influence impact on the behavioural intention to adopt smart transportation mobile applications in the Omani context.

- **Facilitating Conditions (FC)**

Venkatesh first introduced this construct through empirical research to explore an employee’s usage of personal computers (Thompson, Higgins and Howell, 1991). Eventually, it has been added to the UTAUT2 model as one of the crucial elements in shaping user usage intention. It has been added to the UTAUT2 model as a construct that represents the extent an individual believes that organisational support, technical infrastructure and resources exist to support them in using and adopting the new technologies and systems (Venkatesh et al., 2003).

Facilitating conditions refers to the user's thoughts of resources and support available when conducting a behaviour (Taylor and Todd, 1995; Krishnaraju, Mathew and Sugumaran, 2016). Facilitating conditions factor refers to a person's perception of their abilities to control their behavioural intention to adopt (Venkatesh and Bala, 2008). Previous studies of technology adoption and acceptance have indicated that facilitating conditions factor is very significant in influencing users' behavioural intention and their actual adoption as well (Kijsanayotin, Pannarunothai and Speedie, 2009). Venkatesh *et al.* (2003), the developers of the UTAUT2 model, argued that if a person predicts that the needed support to use and adopt a new technology is insufficient, then the impact on their intention to adopt is powerful. If instant and proper help exists, the facilitating conditions construct is assumed to affect user behaviour positively. As a result, facilitating conditions helps in expecting user behaviour. For example, providing users with easy access to the internet and computer facilitates a higher rate of adoption in the adoption of m-banking (Joshua and Koshy, 2011). Many other researchers also discovered that the facilitating conditions construct is positively related to the utilisation and adoption of innovations such as (Awaluddin *et al.*, 2022; Upadhyay *et al.*, 2022; Upadhyay, Kamble and Navare, 2023). As a result, this study assumes that the availability of, for example, proper software resources, technical support, access to the internet and equipment availability support the acceptance of smart transportation mobile applications.

Facilitating condition is projected to have a different dimension in the mobile application context as users are expected to follow other processes to adopt them. According to Hew *et al.* (2015, 1272), facilitating condition is "*consumer perceptions of how much support, online help and assistance is available for the certain mobile application*". In their research, they have investigated the low usage of mobile applications in Malaysia, and they discovered that the quality of the internet and accessibility as two examples of facilitating conditions affecting acceptance. In the context of this study, smart transportation mobile application adopters need to have some basic skills, such as using mobile devices and abilities to connect to Wi-Fi. Additionally, different users are expected to have different knowledge and skills that facilitate their usage of smart transportation mobile applications. For instance, citizens with minor enabling conditions are expected to have less intention to adopt new smart transportation mobile applications. Facilitating conditions refers to the extent to which existing organisations and the current infrastructure have supported enhancing the smart transportation mobile application. It is mainly used to represent the effect of the external environmental aspects, for instance, management and its policies and their availability to support the usage and utilisation. Regarding gender moderators, previous studies on gender differences show that females consider the importance of help and support more highly than men (Triandis and Hofstede, 1993). In subsequent work, Venkatesh et al. (2012) also analysed the different moderating effects. They found that gender moderates the relationship between facilitating conditions and the behavioural intention (Venkatesh, Thong and Xu, 2012). They also found a more significant influence from females on this relationship, as men are more willing to put extra effort into overcoming difficulties to meet their goals. Men also have a higher desire to expend effort on addressing challenges to achieve their purposes than women, which means that women need extra support if they intend to use new technology. Moreover, older adults also find it more difficult to absorb new information, which further influences them in terms of learning to use the service due to many reasons, such as decreased cognitive ability and difficulties memorising information (Morris, Schindehutte and Allen, 2005; Venkatesh, Thong and Xu, 2012). Regarding the age moderator, it was observed that facilitating conditions strongly influence older users (Dennis, Venkatesh and Ramesh, 2003). In most cases, the older generation faces more difficulty learning and using new technologies and innovations. Accordingly, they need training and support more than the younger generation (Morris, Schindehutte and Allen, 2005). Therefore, it can be assumed that gender and age positively affect facilitating conditions on behavioural intention.

- **Hedonic Motivation (HM)**

Hedonic motivation describes the happiness an individual gains from adopting a technology (Brown and Venkatesh, 2005). It replicates the possible entertainment an individual gets from experiencing the new technology (Brown and Venkatesh, 2005). From the perspective of organisations, most information systems are designed to help employees accomplish specific tasks, and what managers rely on to encourage them to adopt these systems is that they are designed to help employees do their work better in less time. In reality staff will adopt the new technologies to help them perform their work and gain pleasure out of it (Thong, Hong and Tam, 2016). From this perspective, the usage of a new technology or information system is no longer dependent only on the extent of their usefulness but in addition on the level of entertainment and fun they provide, and therefore this factor was added to the UTAUT2 model (Venkatesh, Thong and Xu, 2012). Later, many researchers investigated the influence of hedonic motivation on the individual behavioural intention to adopt innovations. They identified that hedonic motivation is a significant construct influencing behavioural intention (Alalwan, Dwivedi and Williams, 2016; Gumz *et al.*, 2022). It was also reported to affect users' intention to adopt mobile shopping application (Sivathanu, 2019). This has also been studied in a mobile banking context and has been observed to influence the adoption as well (Baptista and Oliveira, 2015). Thus, it was approved that the hedonic motivation construct seems to influence consumer adoption in different information systems studies.

Considering the adoption of smart transportation mobile applications, the hedonic motivation construct is designed for the public mainly to get live information about traffic and commuting in order to improve their travelling experience (Chourabi *et al.*, 2012). Thus, these smart transportation mobile applications and services are unlikely to offer entertainment as other commercial applications. Smart transportation mobile applications are unlike commercial mobile applications, which may focus on entertainment to enhance adoption and acceptance. Accordingly, the Hedonic motivation variable has not been added as a construct in the current study.

- **Price Value (PV)**

The price value was incorporated into the UTAUT2 model by Venkatesh, Thong and Xu (2012, p. 161), who defined it as "*consumers' cognitive trade-off between the perceived benefits of the applications and the monetary cost for using them*". The price value is the value a consumer gains from adopting a new technology. In consumer contexts, consumers are expected to bear the monetary cost of adopting and using the new technology, unlike the organisation's contexts where technologies are freely offered. Adopting new technology, product and innovation is expected to have a monetary cost for the user's (Punj, 2012; Palau-Saumell *et al.*, 2019). Therefore, the economic cost of adoption plays a vital role in citizens' decisions in the technology acceptance (Venkatesh, Thong and Xu, 2012). As a result, Venkatesh, Thong and Xu (2012) incorporated price value in the model and considered it a critical influencer of adopting new technology, especially if the expected benefits of that technology are less than the cost spent to utilise it. It is argued that only if the users' perceived benefits of using a new technology are higher than the associated cost of adopting that technology, then a positive price value is accrued, which is expected to further influence their intention to adopt the new technology (Herrenkind *et al.*, 2019). Therefore, technology developers should be aware of the price value influence when targeting consumers. It is one of the most valuable factors shaping consumers' decision to accept new technologies and systems. The price value is considered a critical factor since it represents consumers' willingness to pay for a specific service or a product (Shi *et al.*, 2022).

Palau-Saumell *et al.* (2019) studied consumer acceptance of restaurants' mobile applications and found that the price value impacts the consumer intention to adopt. Osei, Kwateng and Boateng (2022) also reported that price value is very significant in consumer intention. About the mobile marketing application, it was also noted that one of the critical determinants of the consumer purchase decision depends mainly on the price (Eneizan et al., 2019). Consumers are susceptible to the monetary cost when conducting a business exchange, and the money paid must fulfil the benefit a buyer hoped to be reworded from a technology (Aymen, Alhamzah and Bilal, 2019). The price value was also considered an essential construct impacting Jordanian customer intention to adopt internet banking services and applications (Alalwan, Dwivedi and Rana, 2017). In this context, it has been argued that price value effects can be positive or negative depending if the perceived benefit exceeds the cost of utilising the new technology (Venkatesh, Thong and Xu, 2012). For instance, Rahmiati *et al.* (2022) claimed that price value is insignificant in accepting mobile banking adoption and it involves the cost of internet connection and smartphone devices. Price value has been investigated in many other studies, such as (Al-Okaily, Shaari and Ali, 2007; Park *et al.*, 2022; Musakwa and Petersen, 2023). Interestingly, it is proved to be very significant in the context of the Arab adopters of new technologies (Kamel and Farid, 2007; Alrawabdeh, Salloum and Mingers, 2012). Some researchers argued that the effect of the price value construct depends on a person's income, and Alrawabdeh, Salloum and Mingers (2012) stated that the monetary cost seems to be a barrier to individuals with lower income. Yet, price value can still play a vital role with high-income consumers too (Mallenius, Rossi and Tuunainen, 2007).

The price value is not applicable in all contexts, especially if the application is free of charge. Regarding the smart transportation mobile applications, all of the investigated smart transportation mobile applications involved in the current study can be downloaded free of charge, yet all of the applications involve direct and indirect monetary payments. For example, some citizens may use smart city transportation mobile applications to only search for information about travel time and congestion status, which are free of charge; however, sending messages to pay for parking, traffic fines and taxi ride services involves monetary payments. Thus, the price value of adopting smart transportation mobile applications has to be considered.

In terms of the moderators, Venkatesh, Thong and Xu (2012) found that gender moderated the effect of price value on the adoption intention. They argued that females are more aware of the cost and the perceived value than males. Moreover, Ameen and Willis (2018) found that age is a significant moderator between behavioural intention to adopt smartphones in UAE and the construct of price value. Although older people are expected to hold higher positions with higher levels of income, they are likely to have more responsibilities in addition to their family expedition. According to Deaux and Lewis (1984), logically, older women are found to be more curious about the monetary cost as older women are the ones who handle the family spending. Consequently, it is accepted to presume that both gender and age are moderating the relationship between price value and the intention to use smart cities' transportation services and applications.

- **Habit (HB)**

Researchers proposed two ways of understanding the habit construct regarding the Information system. On the one hand, habit is referred to as a goal-directed automatic (Aarts and Dijksterhuis, 2000), which is in line with the "*habitual goal-directed consumer behaviour*" (Hidayat, 2009, p. 68). On the other hand, habit refers to "*the extent to which people tend to perform behaviours automatically because of learning*" (Limayem, Hirt and Cheung, 2007, p. 705). However, both views have approved habit as a significant antecedent of technology acceptance.

In UTAUT2, habit has been added as individual past experiences and underlines how such experiences contribute to using new technologies (Ajzen, 2002). In this respect, Venkatesh, Thong and Xu (2012) argued that the habit construct is not the same as the moderator experience in which experience is considered an important element in shaping habit, yet the habit factor is not formed only by the experience. They further argued that another distinction is that the extent of individual involvement and familiarisation with target technology can lead to the formation of varied standards of habit over time. As a result, the habit may be seen as a personal perceptual construct reflecting the impact of prior experience. Habit is understood as a routinisation of an act which stands as a driving force of the automatic acts of using the technology (Ray and Seo, 2013). Many researchers agree that people start using technology initially to assess its advantages and disadvantages based on conscious thinking and accordingly coordinate using it on purpose to achieve desired goals. The link between achieving a target and its corresponding acts will bind conceptually with repetition. Thus, eventually, the routine usage of technology will become a habit that occurs automatically without conscious thinking when the same target is needed to be reached (Bargh *et al.*, 2001; Jasperson, Carter and Zmud, 2005; Kim and Malhotra, 2005). Therefore, it is expected that habitually using smart transportation mobile applications will be helpful for the users as they will need less cognitive effort to execute a particular behaviour that contributes to achieving their target and goals.

Habit is considered one of the central constructs in the UTAUT2 model (Venkatesh, Thong and Xu, 2012). On the other hand, many previous researchers highlighted that habit influences an individual behavioural intention in adopting a new technology (Sharif and Raza, 2017; Chen, Chang and Hsiao, 2022; Wu *et al.*, 2022). For example, a study was conducted to observe the influence of habit on students' intention to adopt cloud-based e-learning and found that it has a positive effect on students' adoption (Nguyen, Nguyen and Cao, 2014). Moreover, UTAUT2 have been adopted to investigate online consumer behaviour in buying online airline tickets and concluded that habit was critical in influencing behavioural intention (Escobar-Rodríguez and Carvajal-Trujillo, 2013). They also further commented that behavioural intention is an essential indicator of the user behaviour in which consumers will buy online airline tickets. Many other researchers have also found that habit affects the behavioural intention and the actual use of new technologies (Limayem, Hirt and Cheung, 2007; Gupta and Dogra, 2017; Seo and Ray, 2019). In addition, it was found that age and gender moderate the relationship between habit and behaviour intention of adoption, as older people seem more reliable in obtaining information automatically, and therefore, they suppress utilising innovation, especially if it requires learning and training (Ellis, 1991; Lustig, Konkel and Jacoby, 2004). Lustig, Konkel and Jacoby (2004), who stated that once older generations form a habit toward a particular technology, moving to a different technology is not preferable to them. Also, when deciding, women seem more reluctant to change than men. Smart transportation mobile applications involve changes in the citizen's routine experience of travelling. Regarding gender, men are expected to be more motivated by the information and stimuli to decide about utilising the new smart transportation mobile applications while not being bothered about the details. In contrast, women pay more attention to the points while processing information. Women are also more concerned about the changes happening and therefore reduce the effect of habit on their behaviour and intention to use (Venkatesh, Thong and Xu, 2012). Venkatesh, Thong and Xu (2012), and Limayem, Hirt and Cheung (2007) also argued that the length of use is one of the factors that control the main constructs in the UTAUT2 model. As a person ages, their ability to process new information that reaches them weakens. On the other hand, they rely more on the experience they have formed from the length of the period of use of a particular innovation to decide. They focus on this developed experience in making decisions rather than being influenced by their surroundings (Limayem, Hirt and Cheung, 2007).Therefore, citizens with a higher level of expertise due to the prolonged usage period are expected to be affected by their shaped habits due to the reputation of using such technology to perform their tasks.

- **Behavioural Intention (BI)**

Behavioural intention refers to a consumer's intention to adopt a particular technology in the future (Taylor and Todd, 1995; Venkatesh *et al.*, 2003; Venkatesh, Brown and Sullivan, 2013). Most of the research has incorporated behavioural intention to understand the adoption of new technologies (Irani *et al.*, 1999). As many researchers incorporated behavioural intention into their models to investigate the adoption, Venkatesh *et al.* (2003) decided to include it in the UTAUT2 model. Some of the authors suggested that it has a direct impact on the acceptance (Ajzen, 1991). It has been reported that consumers with higher behavioural intention are highly likely to become actual users of new technology (Leong *et al.*, 2013). Many scholars have studied the relationship between behavioural intention and actual behaviour use being taken in the future. Moreover, the behavioural intention has been identified as a factor that directly impacts a person’s usage of a new technology (F. Davis, 1989).

4.6.2 Expansion of The UTAUT2 Model

Most acceptance models (TAM, UTAUT, UTAUT2, DOI, TRA) have been used widely in understanding the adoption of new technologies. As seen from the earlier discussion in this chapter, each model is recognised to be more general and limited to be applied to specific contexts. As there is a strong need to investigate how to implement these smart applications in more successful ways to enhance their acceptance in Oman, building a new, more contextual model to better address the adoption and utilisation of smart transportation mobile applications is recommended. To do so, it was wise to select the most suitable model that has already been used and tested by other researchers in smart technology contexts and confirmed to be important in understanding the smart technology acceptance as a base for the current research. An earlier review of the literature has approved and validated the use of the UTAUT2 model as the most effective model in addressing the current research questions as one of the most influential models. Later, a detailed investigation of each traditional construct of the UTAUT2 model approved that most of the UTAUT2 factors (except hedonic motivation) are valid to provide a practical contribution to addressing the utilisation of smart technologies and mobile applications.

However, other factors critical in understanding the end user's intention to adopt smart transportation mobile applications explored previously in the literature and considered applicable to an Omani context are needed to be incorporated into the UTAUT2 model to better address the research goals and objectives. Incorporating other factors and constructs approved to be critical for technology acceptance in both smart transportation services and the Omani context ensures building a framework that suits the Omani context better. Thus, with proper modifications to the original UTAUT2 model, it is believed that the new proposed model will provide better answers to the research questions. This research first adopts the most suitable model to address the current research questions. Later, to fit this model to the need of this study, some modifications are critical, and they will be presented in the following sections.

The following section will explain the extension of the original UTAUT2 model by incorporating some essential factors to explain better citizens' acceptance of smart transportation mobile applications in Oman. The following paragraphs explain each new contextual factor and its role in understanding the acceptance and adoption of smart transportation's mobile applications. Incorporating the contextual factors in the proposed model is essential to gain a better and more extensive understanding of the other possible factors influencing the acceptance of the new technology. The literature review has highlighted that these constructs are critical in most mobile application adoption.

- **Trust (TR)**

Trust is defined as "*the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party*" (Colesca and Research, 2005, p. 8). User trust has been assigned as a critical factor in the online environment compared to the offline due to the different types of risks involved online (Grabner-Kräuter and Kaluscha, 2003; Lankton and McKnight, 2007; Pengnate and Sarathy, 2017). Recently, researchers have called for more attention to trust. Therefore, the construct has been incorporated into the UTAUT2 model under various contexts, such as the mobile banking (Alalwan, Dwivedi and Rana, 2017), mobile commerce (Lin and Theingi, 2019), mobile marketing (Eneizan *et al.*, 2019), e-learning (El-Masri and Tarhini, 2017) and and digital wallet utilisation (Widodo, Irawan and Sukmono, 2019). In a smart transportation context, Korkmaz *et al.* (2021) extended UTAUT2 by adding a trust factor and approved its significance in adopting the autonomous public transport systems. Also, it has been shown to influence Grab Application acceptance in Philippine (Prasetyo and Vallespin, 2021). Likewise, Lee and Moray (1992) and Ghazizadeh *et al.* (2012) supported the incorporation of the trust factor into the automation context to explain the end users' acceptance of smart transportation services and applications. Therefore, trust has been theorised as one of the direct fundamental variables in determining behavioural intention (Chao, 2019). He reported that the trust factor positively and significantly influences behavioural intention. Bradach and Eccles (1989) investigated the effect of trust in an unfamiliar social setting. They found that it contributes as a significant factor in reducing the uncertainty feeling of the users. It was stated that trust has more to do with situations where a person has limited information and experience about it (Venkatesh *et al.*, 2011). As a result, trust is crucial, especially in information system contexts where users are asked to adopt and utilise new technology.

It was found that the more accurate and updated data, and serving high-quality services, the more trustful the user will be towards the information system (Zhou, 2013). Remarkably, users' prior experience can influence their trust, and if the experience is lacking, then more probably trust will be based on the feedback from their social community (Liébana-Cabanillas, Sánchez-Fernández and Muñoz-Leiva, 2014). Consequently, it can be assumed that trust becomes more vital among people with no experience with the new product or service. Moreover, previous studies discovered that trust becomes essential in an information system context consisting of online transactions, and it influences the adoption (Zhou, 2013; Arvidsson, 2014). Thus, trust will affect the end user's perception of adopting innovations and technologies.

On the other hand, users can sometimes build trust in the technology itself. If they feel that the privacy and security procedures of the system are doubtable, then a concern for adopting will be developed (Venkatesh *et al.*, 2011). For instance, trust becomes more significant with systems that acquire a higher risk of hackers and fraud, such as connecting to the internet, inserting personal information, and putting financial details and other confidential information.

In addition to the technology's safety, online service providers are another component that shapes trust in adopting the new technologies. According to Chen, Xu and Arpan (2017), the adoption of any new technology by a new user depends on their knowledge and trust in the service provider. The reputation of the services providers and their interest in providing services that satisfy the aspirations of their users are among the most important factors that indicate the integrity of the services providers and thus encourage users to adopt their services (Jarvenpaa, Tractinsky and Vitale, 2000). Therefore, many authors considered trust in the innovation services providers to be an essential element influencing end users' attitudes and acceptance (Karlin, 2012). Thus, without knowledge about the new technology, users' trust can be built based on the trust of the organisation providing that services (Slade *et al.*, 2015).

- **Satisfaction (SAF)**

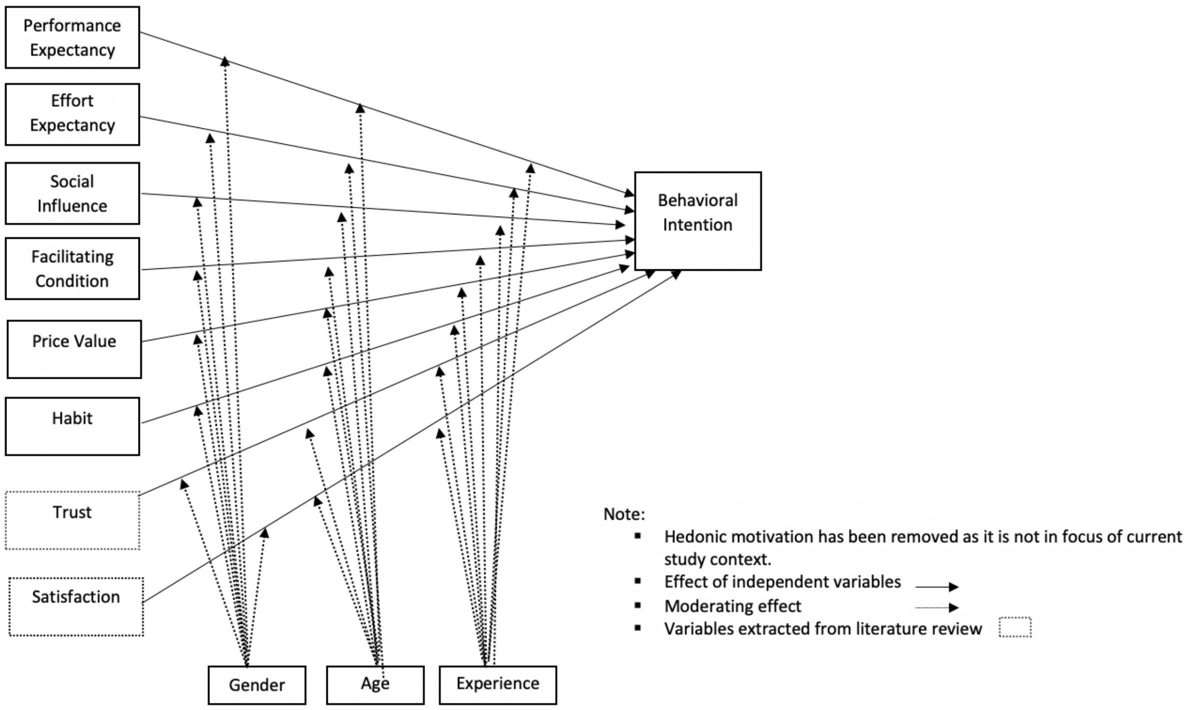
The satisfaction factor is "*if people hold expectations about the outcome of using a particular product and these expectations are confirmed they will feel satisfied*" (Hassenzahl, 2003). It is defined as "*the level of peoples' perception about their necessities, objectives, and desires of the system*" (Sanchez-Franco, 2009). It is also explained as emotional feedback built based on the user's general assessment of the services compared to their expectation (Oliver, 2014). Satisfaction has been reported to have a vital effect on consumers' intention in many studies, such as investigating the acceptance of mobile taxi applications (Siyal, Hongzhuan and Gang, 2021) and the acceptance of the mobile learning (Arain *et al.*, 2019). Satisfaction is accepted to have a momentous effect, either positively or negatively toward attainment of new and existing users (Tandon, Kiran and Sah, 2018). They also argued that it is predicated that the increment in the number of people adopting an online system is referred mainly to the increased value of end-user satisfaction. Chang (2013) claimed that the intention to adopt increases by enhancing people's satisfaction. This is expected to offer significant advantages to the service providers as high satisfaction improves end users' loyalty and consequently increases the user's intention to reuse (Chang, 2013; Kumar, Sachan and Dutta, 2020).

Many prospects contribute to user satisfaction in systems and mobile applications. For example, information quality refers to the ability of the systems to deliver its user instant, useful and critical information in an accurate manner (Zhao, 2019). Citizens access smart transportation mobile applications to get real-time information, and if this information is irrelevant and outdated, they will not be encouraged to use them again. Therefore, information quality is an essential factor influencing citizens' satisfaction. According to DeLone and McLean (2003), information quality affects user satisfaction positively. In related work, Schaupp, Fan and Belanger (2006) discussed the impact of system quality on website user satisfaction and found that system quality, along with information quality, are considered significant and essential factors in predicting end users' satisfaction and, as a result, their behavioural intention to adopt. Also, Hsu, Chang and Chen (2012) confirmed the relationship between website quality and consumer satisfaction and that this link directly affects the end user's behavioural intention to adopt online services. Thus, the quality of the smart transportation mobile applications is predicated to also contribute to public satisfaction. In addition, appearance quality, which refers to the quality of the website presentation, including the design, colour, organisation, layout, the use of multimedia and user-friendly interfaces, is recognised as another element influencing citizens' satisfaction (Aladwani, 2006). As mobile phones are assigned with small screen sizes and limitations of writing and reading abilities, the quality, appearance and accurate information of mobile applications are considered to be more sensitive. It should be addressed very well as they directly impact the end users' satisfaction (Zhou, 2011).

4.6.3 The Modification of the UTAUT2 Model

Since the goal of this study is to explore the different potential factors, including the contextual factors influencing citizens' acceptance of smart transportation mobile applications in Oman from both the services providers' and citizens' understanding, the research adopts the UTAUT2 model as the base for developing the theoretical framework after reviewing the available technology acceptance models. This chapter reviewed and discussed different technology acceptance models which are widely adopted in different studies and ended with the UTAUT2 model selected as a base for the theoretical model of smart transportation mobile applications acceptance in the Oman context. Today UTAUT2 is classified as the latest technology acceptance model, having been built by combining all the main factors of the earlier models. Accordingly, it is expected to be more explanatory in addressing the acceptance and usage of new technologies. Figure 3.8 presents the proposed modified model based on the UTAUT2 model to be investigated in this study. Figure 3.8 shows that most of the factors in the proposed framework are the main traditional factors of the UTAUT2 model, including performance expectancy, effort expectancy, social influence, facilitating conditions, price value, habit, and behavioural intention. Venkatesh, Thong and Xu (2016) claimed that extending a model by including more contextual factors contributes to building more powerful and better predictive models. He also claimed that these contextual factors are crucial in an information system context. Moreover, adding contextual factors to the research context is an important contribution to the UTAUT2 model (Hong *et al.*, 2013; Venkatesh, Thong and Xu, 2016). Therefore, besides the main traditional factors of the UTAUT2 model, two contextual factors extracted from the literature review, namely trust and satisfaction, have been incorporated into the model. The idea behind joining these two external constructs is to provide better explanatory power to the proposed model to address the current research issue better than the original UTAUT2 model. The constructs in the dotted boxes: trust and satisfaction, are the two contextual factors added to the proposed model based on the literature review. These two new factors are displayed in dotted boxes in Figure 3.8. The bottom of the model stands for the individuals' contextual factors involving age, gender, and experience. These are the moderators which influence the main constructs. This proposed model will be used in the empirical study to explore smart transportation services providers' perceptions of the acceptance of the smart transportation mobile applications in Oman and later will be used to investigate citizens' acceptance of such services and applications.

Figure 4.8: The proposed model with new variables and constructs originated from UTAUT2.



4.7 Summary

The main target behind building the proposed model is to explore the utilisation of smart transportation mobile applications by the end users in Oman to better understand the factors influencing their acceptance and enhance their acceptance rate accordingly. In order to reach a successful adoption of smart transportation services and applications in Oman as an example of a developing country, there is a strong need to explore the possible factors influencing the adoption and acceptance of such services. Therefore, this chapter conducted a critical analysis of the literature review related to the utilisation of the new ICT, besides exploring many technology acceptance models to better understand the factors influencing users' acceptance of smart transportation mobile applications. This chapter reviewed, discussed and compared the different technology acceptance models in order to explore the best model to be adopted for the context of the current research. Later, all the constructs of the proposed model were explained in detail to understand the applicability of each construct to the current research setting. At the end of the chapter, a framework based on the UTAUT2 model in conjunction with two contextual factors has been proposed to reduce the resistance to utilising such smart services in Oman. This study is concerned with elements that impact and promote citizen adoption of smart transportation services in the Omani context. It carefully examines the contextual elements, the primary factors directly expected to influence user acceptability, and the problems influencing service providers to enhance Omani user acceptance of smart transportation projects. Both the qualitative and quantitative phases of data collecting, and analysis are carried out in Oman. The Omani setting is therefore explored in the next chapter. To put the researcher into perspective and create a more complete picture of the problem, it primarily studies the Omani context generally, and later, it explores the smart transportation initiatives, challenges, motivations and examples of the smart projects.

Chapter 5: Research Methodology

5.1 Introduction

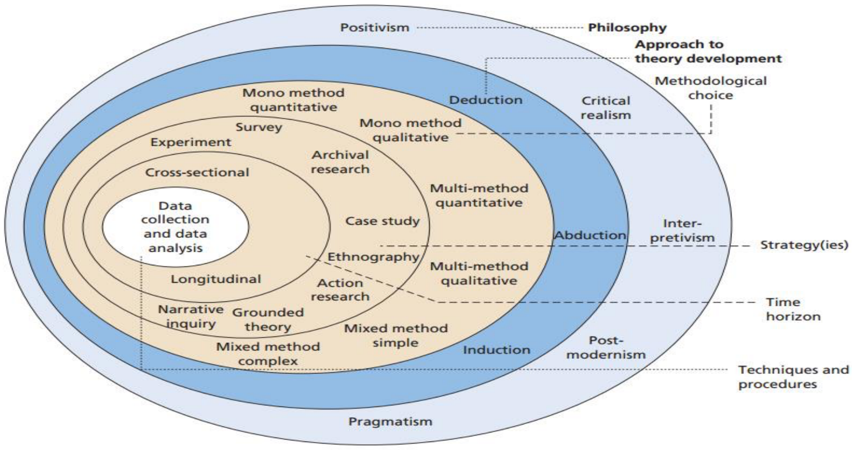
The main objective of this study is to employ the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) after extending it with factors extracted from the literature along with the finding from the qualitative study to work as a framework enabling a better recognition of the behavioural intention associated with the adoption of the smart transportation mobile applications in Oman. According to Greenfield and Greener (2016), choosing and determining the most suitable research methods is critical in order to achieve valid and reasonable results. Therefore, the methodology chapter is concerned with assigning the most suitable designs, approaches to collect data, and the best data analysis methods when designing and conducting research.

This chapter begins by explaining the adopted philosophy of the research, followed by a justification of the reasons behind the selection of the sequential exploratory mixed method approach. Later, this chapter explains the different research methods adopted to answer the research questions to enhance the theoretical and empirical understanding of the topic. The data collection and analysis methods in qualitative and quantitative studies are explained to indicate how they contribute to the research aims and objectives. This involves an in-detail explanation of the validity and reliability behind choosing particular methods and techniques by highlighting and emphasising their main features, advantages, and disadvantages. The ethical concerns related to this specific study are also discussed. The chapter ends with a diagram explaining the different research phases and showing how each phase leads to the next while providing answers to the research questions.

5.2 Research Onion Layers

The research onion presented in Figure 5.1 is adopted from Saunders, Lewis and Thornhill (2009) and used as a guide to design a proper research methodology. It helps to examine the choices of the various data collection tools and analysis processes. Saunders, Lewis and Thornhill (2009) described the complete research approach as an “onion” involving six main distinguished layers: (i) research philosophy; (ii) research approach; (iii) research strategy; (iv) research choices, (v), time horizon; (vi) techniques and procedures. The researchers need to peel the onion from the outer layers to reach the inner core layer, the tools and techniques used to collect data. The following sections explain each layer with regard to the current study.

Figure 5.1: The research 'onion'. Source: (Saunders, Lewis and Thornhill, 2009, p. 109).



5.2.1 First Layer: Research philosophy

Research philosophy is defined as "*a system of beliefs and assumptions about the development of knowledge*" (Saunders, Lewis and Thornhil, 2009, p. 124). The philosophical stance provides a justification for the adopted methods and explains the nature of the knowledge and the criteria by which researchers judge the validity of the conducted study (Shull, Singer and Sjøberg, 2007). Researchers' perceptions, opinions and views of the world influence the ways they design a research's aims and questions and the ways of addressing them (Saunders, Lewis and Thornhill, 2009). Therefore, it is important to spend the appropriate time to assign the most applicable philosophy. The literature is rich with a plethora of various schools and thoughts that include different paths to conduct social studies (Venkatesh, Brown and Sullivan, 2013). Although there is no agreement with regard to the philosophical approach to the research methodologies, there is a range of universal schools of beliefs (Saunders, Lewis and Thornhill, 2009). Namely, there are five main perspectives of philosophical paradigms: positivism, critical realism, interpretivism, postmodernism, and pragmatism (Varey, Wood-Harper and Wood, 2002; Saunder, Lewis and Tornhill, 2016). As the first step in conducting research is to identify the most suitable philosophy for it, the following paragraphs investigate each philosophy to narrow down the most appropriate potential option that fits the current research aim and objectives.

The **positivism research approach** adopts an objective view in which researchers are separated from reality and have no impact on the conducting study (Saunders, Lewis and Thornhill, 2009). It is confirmed that "*positivism assumes that reality exists independently of humans. It is not mediated by our senses and it is governed by immutable laws*" (Rehman and Alharthi, 2016, p. 53). According to Morgan (2007), knowledge in positivism is built through typical scientific ways while avoiding metaphysical estimation. Therefore, it mainly deals with structured quantitative data by building a range of variables by combining social science and logical observation to indicate how these variables interact and link (Mabbot, 2013; Punch, 2013).This approach is mainly related to propositions, quantitative elements, hypotheses and frameworks generated from the population sample (Chen and Hirschheim, 2004). The positivist philosophy is related to quantitative studies and relies on numerical data to generalise answers (Creswell, 2009). It believes that all types of knowledge are developed depending on real reasoning, logical observations, and the logical alignment with the natural phenomenon as primary sources of building valid and authentic knowledge (Klein and Myers, 1999). Thus, it is concerned with building appropriate theories by quantifiable measures of the variables by encompassing a list of assumptions about the social environment and testing the constructed hypotheses from a sample population (Jankowicz, 2013; Balarabe Kura, 2015). One of the main advantages of this approach is that the outcomes can be replicated in future studies in other contexts (Winfield, 1991; Devers, 1999). However, some scientists doubt its adequacy for social science studies as it depends mainly on scientific evidence, and researchers should not dig beyond what is observed (Zinkhan and Hirschheim, 1992). Given this, this approach is unsuited to the qualitative research designed to measure people's thoughts about the social environment where they live. In addition, Burns and Grove (2005) argue that replicable and generalisations of the positivism approach results are suitable mainly for the natural law context where the results are generated objectively and impartially by hypotheses testing and statistical data analysis.

With regards to the current study and from an objective stance, there is evidence that smart technologies and applications contribute to better delivery of transportation services. Therefore, this research seeks quantifiable proof that these smart technologies and applications will empower the transportation sector in Oman. Yet, conducting social research requires "*people use their perceptions to interpret what their senses tell them*", which is an interpretive approach that conflicts with the idea of positivists' certainty (Al-Saadi, 2014, p. 3). Therefore, this method is unsuitable for the current study as it mainly focuses on deductively testing hypotheses. The positivism philosophy is not applicable to the present study context and nature since gaining a comprehensive understanding of the topic being investigated requires an exploration of the smart transportation services providers' perceptions and thoughts so that a profound description of their behaviour is achieved as assigned in various social science kinds of research (Mavs, 2022). Consequently, the researcher will need to conduct a qualitative study with the service providers to understand better their perceptions about the successful adoption of smart transportation services and applications to contribute to better solving the research questions. Thus, the positivism research philosophy focusing mainly on the quantitative study is incompatible with the current research. Collecting opinions and views about the social phenomenon (smart transportation services providers' perceptions about the adoption of smart transportation mobile applications) are valuable to enrich the research with deep insights into the factors impacting the acceptance of smart transportation mobile applications. In addition, the researcher thinks there is no single reality as people have intellectual minds, which may affect how they build reality. Objectivity and physical reality are incompatible with examining changeable social phenomena because comprehension can only be gained via the subjectivity of human perceptions and acts. Based on the above discussion, most authors claim that it is challenging to capture social reality by considering only a positivist approach and the method assigned to it due to its selective nature (Lee, 1991; Mays and Pope, 1995).

In contrast, the **interpretivism research approach** provides different opinions and points of view to provide different ways to reach the reality (Andrade, 2009). The main idea of the interpretivism paradigm is to conduct a deep analysis of the respondents to understand better the reasons and beliefs behind their acts (Nickerson, 2022). The reality in the interpretivism paradigm is obtained through an interpretation of specific people and their observations and understanding; therefore, the reality gained is socially-based, and the chance to be different from one person to another is possible (Saunders, Lewis and Thornhill, 2009). This needs further investigation to understand the truth and beliefs behind their perspectives. As a result, interpretivism applies to qualitative social studies as it explores social phenomena and human behaviour (Pulla and Carter, 2018). Interpretive philosophy is associated with qualitative study and is about creating new and profound understandings and clarifications of the social worlds and contexts (Su and Adams, 2010). In this philosophy, researchers' beliefs and opinions play an essential role in the process. As this approach is mainly about the qualitative method only, it does not apply to the current research, which intended to use a quantitative method to understand citizens' perceptions of adopting smart transportation mobile applications in Oman.

The **critical realism philosophy** is developed in the Frankfurt School and mainly focuses on field political and social issues (Ryan, 2018). Ryan (2018) argued that critical theory aims to critique the different views besides challenging the authority that established them. This philosophy believes in studying history to move ahead; therefore, this paradigm takes a historical perspective (Brenner, 2012). Realism philosophy is about reducing domination and giving more freedom to judge or critique a concept (Kuehn, 1980). This philosophy deals with reality and the independence of the mind. According to Saunders, Lewis and Thornhill (2009), there are two main parts of the realism philosophy: direct realism and critical realism. With direct realism, what is true is associated with the the researcher's senses which present accurate and objective information of the world. On the other hand, in critical realism, what is true is associated with both the researcher's direct sense and how the interpretation of these sensory experiences are viewed (Sekaran and Bougie, 2016). This philosophy is objective in its nature and involves searching for the rules and behaviours in isolation from the human experience as it believes in the independence of human thoughts and beliefs from the natural world (Burrell and Morgan, 1979). In the smart transportation mobile applications context, the assumption is that the structure of the organisations remains the same and the initiatives are adopted to meet this stasis condition. Whether people are aware of social phenomena, perceptions, attitudes, and external factors or not, they are expected to impact the mean by which people perceive the world. Therefore, missing the influence of the phenomenon on the perceptions, motivations, and attitudes of the actors will not help in understanding the extent of whether an initiative will be successful or not (Easton, 2010).

Postmodernist research philosophy is a challenging approach in which knowledge and dominant means of knowing and perspectives viability are questioned by providing alternative silenced views. Therefore, this philosophy offers a chance to create alternative truth rather than simply accepting the voices of a particular dominant view of a specific group of people. The main aim of this philosophy is to question the recognised ways of thinking and knowing by supporting the marginalized means of learning which have been ignored (Saunder, Lewis and Tornhill, 2016). Postmodernism is ambiguous, causes uncertainty, and unnecessarily stirs ideological conflict (Hruby, 2001). According to Spiro (1996), the rejection of the scientific method by postmodernists is in no way credible. He further rejects the claim made by postmodernists that humanities-related fields cannot be referred to be "scientific". Finding the truth is hampered by subjectivity. Spiro (1996) claimed that while the social sciences require different tools than the natural sciences, the need for an objective scientific approach is still valid.

Pragmatic research is well-known in social studies and has been developed due to the clash between truth and reality. The word pragmatic was derived originally from the Greek language and culture in which the phrase “pragma” means action or deed (Ormerod, 2006). This philosophy employs the fact that many factors influence a phenomenon and its contexts, which can only be recognised through socially constructed experience (Creswell and Clark, 2011). c (Creswell, 2003). It is defined as solving problems and finding practical solutions to complex human problems based on their practical requirements and consequences (Ormerod, 2006). Accordingly, pragmatic research is usually initiated with practical issues and is carried out to contribute practical solutions to be used as a future practice (Giddings, 2006). Therefore, undertaking pragmatic research means that abstract solutions are not exciting; instead, practical answers are pragmatists' primary target.

The pragmatic approaches to studies “*do not take a particular position on what makes good research. They feel that research on both objective, observable phenomena and subjective meanings can produce useful knowledge, depending on the problem that initiated the study*.” (Sekaran and Bougie, 2016, p. 24). It puts ontological and epistemological judgement about the social world aside, and instead, it tries to perform flexible and responsive studies as the research unfolds (Johnson and Onwuegbuzie, 2004). Thus, this type of research begins in reverse, where the researcher first begins to suspect that an error or something abnormal occurs and leads to the creation of a belief after the problem is solved. In this way, the pragmatic approach "*holds the research problem at the centre of the inquiry and allows the application of all available approaches to address the research problem in the most appropriate way*" (Shah *et al.*, 2019, p. 96). In favour of this argument, the pragmatism approach appears best suited to the current research problem as it enables putting the research questions in the centre and complementary recognising strategies to address them.

Moreover, the pragmatic approach supports combining both principles of qualitative and quantitative studies in a manner that develops a rich explanation of the contextual nature of the tested phenomenon (Feilzer, 2010). The pragmatism approach overcomes the limitations and dogmatism of each previous approach by emphasising the complementarity and inclusivity of the various research methods (Creswell *et al.*, 2006; Queirós, Faria and Almeida., 2017). Thus, it provides more persuasive and realistic findings by correlating the data collected over qualitative and quantitative methods (Queirós, Faria and Almeida., 2017). This approach does not limit the researcher to only one method, and accordingly, it ensures addressing the research questions in a more comprehensive way (Creswell and Pioano Clark, 2007). The pragmatic paradigm permits the adoption of qualitative and quantitative methods to enhance understating of the contextual nature of the investigated issue (Creswell, 2003). The current research employs a quantitative study to address the research questions and examine the proposed hypotheses using a questionnaire survey. The quantitative method allows for investigating and exploring the relationships between the constructs and testing the formed hypotheses (Gall, Borg and Gall, 1996). Besides, the researcher decided to utilise the qualitative method by conducting interviews to understand the smart transportation services providers' perceptions on the main factors affecting the successful delivery of smart transportation services to obtain better answers to the research questions. Combining these two methods enables the researcher to get valid and reliable outcomes. Therefore, the pragmatic approach suits this study the most as it allows for collecting data from various sources by combining both methods.

The current research investigates the successful implementation of smart transportation mobile applications by exploring the factors affecting their acceptance and adoption. By identifying the prominent influencers, this research is intended to provide an understanding to the smart transportation service providers to introduce smart transportation mobile applications in Oman successfully. Consequently, the pragmatic paradigm is aligned well with this study as it first promotes practical solutions. Secondly, pragmatism "stresses the relationship between theory and practice. For a pragmatist, a theory is derived from the practice and "then applied back to practice to achieve intelligent practice" (Bougie and Sekaran, 2019, p. 24). The author believes in combining theories with practical cases to address the real world. This research adopts one of the technology acceptance theories to suggest practical recommendations to the services providers to manage better the successful implementation of their smart transportation services and mobile applications. Yet, smart transportation mobile applications involve various factors affecting the successful delivery of such services. For example, in addition to technological concerns, citizens are another factor influencing the success or failure of smart transportation services. This research adopts the most suitable technology acceptance theories to the context of the current research to promote the acceptance of smart transportation mobile applications. Then it investigates the other factors influencing the acceptance from the experience of the services providers and other studies related to the current context. Later, it applies the framework back to reality by investigating the actual users' perceptions of the factors influencing their acceptance. The pragmatic approach is raised from the fact that various realities may affect a phenomenon observed mainly in social settings through the human experience (Creswell and Clark, 2011). It also supports the idea that there is a divergence between truth and reality (Creswell and Clark, 2011). Accordingly, pragmatics is the best to address the current research problem.

Technology acceptance theories are assigned as a tool to allow the service providers to enhance managing the implementation of smart transportation services and encourage citizens' acceptance. The research is also concerned with new knowledge creation as it involves successfully implementing smart transportation mobile applications besides properly understanding the participants' different views and perceptions.

In light of the above, the pragmatic paradigm offers the researcher a wide range of advantages to better address the current research questions and objectives.

5.2.2 Second layer: Research Approach

Three approaches are assigned to this layer of the research onion: deductive, inductive and abductive (Saunders, Lewis and Thornhil, 2009; Hunter, Saunders and Constance, 2016). The researcher explored these three approaches to identify the best approach for the current research. The **deductive approach** is similar to the scientific rules in which hypotheses are built based on the existing theories (Mantere, 2010). It focuses on a structured approach in which the author is independent and adopts a suitable sample to provide generality of the project findings (Saunders, Lewis and Thornhill, 2009). Therefore, it focuses on quantitative research and best suits the positivism projects (Decrop, 1999). Deductive reasoning works from more general rules to specific applications; therefore, it is explained as a top-down approach (Torres, 2020). Saunders, Lewis and Thornhil (2009) and Blaikie and Priest (2019) described the six steps involved in the deductive approach: identifying an existing theory, forming hypotheses to work as a testable proposition, collecting data to compare the hypotheses against existing research, analysing the collected data statistically to approve or reject them, and finally evaluating if the findings contribute in demonstrating a new knowledge. In contrast, **the inductive approach** begins with acquiring a broad knowledge of the research topic or phenomena, assessing the themes, building linkages and formulating new theories

(Cavana, Delahaye and Sekeran, 2001). This approach is called the bottom-up approach as it acquires general knowledge of the issue, and theories are developed at the end of the research based on the investigated field results (Orgun, 1996). Thus, it is classified as a bottom-up reasoning approach because it involves widening a specific observation into a broad generalisation (Draper, 2004). It is associated the best with the interpretivism philosophy research (Gasson, 2004). Moreover, it provides reliable and valid results of qualitative research data analysis (Thomas, 2006).

The abductive approach is developed from the fact that the significant advances in science have neither followed the pure deductive reasoning nor pure of inductive approach (Taylor, Fisher and Dufresne, 2002) but instead, abductive researching is a more flexible approach to the research needs as proceeding the study (Sinkovics and Alfoldi, 2012). The abductive approach is a combination of both qualitative and quantitative methods in which instead of moving from a general rule to a specific conclusion (deductive reasoning) or a specific observation to the general conclusion (inductive reasoning), the researcher is free to move back and forth from one reasoning to another based on the research needs (Collis and Hussey, 1997; Morgan, 2007; Saunders, Lewis and Thornhil, 2009). Thus, abductive research starts with an observation or available data used to understand a phenomenon and develop themes later to modify an exciting theory or demonstrative of a new theory which is further investigated by collecting more data (Dubois and Gadde, 2002). It involves utilising the available information and theories to extract conclusions and address the surprising patterns by amending the existing theories to identify the most practical approach to understanding what is happening. Therefore, it is aligned very well with the pragmatic research approach (Bringer, Johnston and Brackenridge, 2004; Locke, Golden Biddle and Feldman, 2008). Therefore, it supports combining qualitative and quantitative methods to overcome the weaknesses associated with each method (Żelechowska, Żyluk and Urbański, 2020).

Concerning the current study, the abductive approach allows the researcher to combine deductive and inductive approaches in the same research. Saunders, Lewis and Thornhill (2007, p. 157) stated that with the abductive approach, "*It is possible to combine deduction and induction within the same piece of research*". Thus, it seemed that the abductive approach is the most practical approach to the nature of the current project as it supports explaining, developing and modifying the theoretical model before, after and during the research process (Dubois and Gadde, 2002). Moreover, this approach allows the researcher to combine deductive and inductive reasoning to handle the research problem. This research has embraced the abductive approach to reasoning since it has chosen pragmatism as its philosophy, which takes a mixed methods approach to data collecting and analysis.

The researcher needs to consider specific knowledge in a particular area and theoretical knowledge associated with the selected domain. Acceptance has been chosen as a key concept to be investigated. The researcher adopted the UTAUT2 model as a theoretical base to explore the actual meaning of acceptance in the context of smart transportation mobile applications. Further, an intensive literature review of the acceptance in the context of smart cities and smart transportation services was conducted to construct a theoretical knowledge of the topic and revise the proposed acceptance model. Utilising the abductive reasoning to the current research on the factors influencing the successful implementation and acceptance of smart transportation mobile applications would mean gaining data that are appropriate and rich to the extent of allowing exploration of the phenomenon and explaining the themes and issues affecting citizens' acceptance of smart transportation mobile applications. Next, the researcher will try to incorporate the extracted knowledge into the proposed framework and thereby administrate a theory of the factors influencing citizens' acceptance of smart transportation mobile applications. The researcher later deduces and proposes hypotheses to measure the relationships among the variables. Later, the study collects data to evaluate the proposed hypotheses to confirm or reject them. This is tested by using justification extracted from the existing data and the new data observed from the qualitative and quantitative studies and amending them accordingly. Finally, the theory and proposed model will be adopted and modified concerning the data collected in the smart transportation mobile applications context.

5.2.3 Third layer: Methodological Choice

According to Saunders, Lewis and Thornhill (2009), there are three main methods assigned to this layer of the onion: mono-method, mixed method and multi-method. Mono-method comprises only one method, either qualitative or quantitative. With regards to the mixed method, it involves collecting data from both qualitative and quantitative data (Creswell, 1999). Multi-method combines two or more qualitative or quantitative methodologies in a single research (McKendrick, 1999). The main difference between multi-method and mono-method is the dataset in which mono-method relies on a single dataset, whereas multi-method research is associated with segments in which each has a unique dataset (Feilzer, 2010).

Qualitative research methodology is widely used in different academic fields such as social, education, science, health, and criminology (Denzin, Lincoln and Giardina, 2006; Holland, Thomson and Henderson, 2006). Qualitative research methodology is *"a form of social action that stresses on the way of people interpret, and make sense of their experiences to understand the social reality of individuals"* (Mohajan, 2018, p. 2). It is commonly used where human interpretation and understanding are needed to be studied and does not involve numerical data (Fitzpatrick and Boulton, 1994). The qualitative method helps obtain a deeper understanding of the social aspects by offering better observations (Earl R Babbie, 2020). This further enhances producing descriptive information by utilising the researcher to collect data from participants to understand their social views (Merriam, 1998). Consequently, such a method enables a better investigation of the phenomenon and handles a wide range of evidence (Matthew B Miles and Huberman, 1994).

On the other hand, Punch (2013, p. 4) defined the quantitative method as "*empirical research where the data are in the form of numbers*". It is used in natural sciences studies (Kleining and Witt, 2001). It adopts different statistical tools to analyse numerical data collected on a topic or a phenomenon to understand the other variables affecting them (Sorensen, Gianola and Gianola., 2002). It also seeks to quantify a large population's perceptions, points of view, attitudes and behaviours to make general outcomes (Pavilikakis and Tsihrintzis, 2003).

In the current research, the research's questions and objectives demand deep knowledge of the experiences of the smart transportation services providers besides the perceptions of the citizens in Oman to acquire a rich contextual understanding of the issues and factors affecting the acceptance of these smart mobile applications. The study aims to generate an improved understanding of the acceptance of smart transportation mobile applications besides exploring the factors that impact their acceptance. Therefore, utilising the benefits of qualitative and quantitative methods helps enhance the knowledge of exploring the factors influencing the acceptance of smart transportation mobile applications among Oman citizens. Besides, the smart city concept is considered a complex and dynamic approach implemented to improve cities' performance, enhance making informed decisions, and solve different urban environmental, political, health, educational and economic challenges current cities face (Bibri, 2019). Thus, with such complicity in the research area, this study adopts a mixed research method to ensure the qualified addressing of all research questions. Different research within smart city domains has been conducted following this approach, such as (Sandoval-Almazan *et al.*, 2015;Bernardi and Diamantini, 2018; Danquah, Marful and Duah, 2020).

Given the above discussion, the mixed method is considered the right choice as it matches well with the research aim and enables the collection of reliable and valid data that promotes better answers to the research questions. This method is well-known and has been used widely in other research, and it combines the qualitative and quantitative methods (Greene, Caracelli and Graham, 1989). According to Greene, Caracelli and Graham (1989, p. 258), "*mixed-method study, qualitative and quantitative methods are used to measure overlapping but also different facets of a phenomenon, yielding an enriched, elaborated understanding of that phenomenon*". Moreover, the mixed method enables obtaining more accuracy as each method increases the depth and wide of the data required (Malkus and Hughes, 1978). For example, an improvement can be gained by comparing the data collected from one method to the data collected from the other method (Thomas, 2017). The mixed approach enhances the researcher's confidence in the research results (Creswell, 2014). Also, the mixed method allows a researcher to better address the research questions by providing an alternative but complementary method to understand better the phenomenon of the study (Creswell and Pioano Clark, 2007).

This study starts with a qualitative method of semi-structured interviews conducted among four organisations of smart transportation service providers in Oman to gain a deep understanding of their perceptions of the smart transportation mobile applications' acceptance in Oman. This enables a better understanding of the factors influencing the acceptance of smart transportation services by Oman citizens from a managerial perspective. These interviews also contribute to the testing and validating of the proposed model and explore the missing factors related to the Omani context affecting the acceptance. In addition, the results of the interviews work as a base for constructing the final survey questionnaire. The qualitative method is utilised for investigating how the participants make sense of their world and their reality which is vital for the researchers to avoid imposing their thoughts about the investigated social phenomena upon (Banister *et al.*, 2011; Bell, Bryman and Harley, 2022).

Later, a quantitative method through survey questionnaires is conducted within a random population of smart transportation mobile applications expected users in Oman. The researcher conducted an intensive literature review of smart transportation, smart cities, and the acceptance technologies models to construct the theoretical model and form hypotheses to answer the research questions. The quantitative study tests the linkages between the research-proposed model variables and provides evidence to accept or reject the different research hypotheses (Goddard and Melville, 2004; Lee, Tan and Trimi, 2005; Bélanger and Carter, 2008). This method is the best when the research considers a large number of participants. It also enables the researcher to collect the data with a quantitative tool and analyse them using statistical techniques (May and Perry, 2022). As this research begins with a preliminary qualitative investigation to refine and validate the proposed theoretical model and is later followed by a quantitative study to validate the modified framework, this study follows a sequential mixed method.

5.2.4 Fourth layer: Strategies

The research onion suggests a range of strategies to select from (i) action research, (ii) experimental research, (iii) surveys, (iv) case study research or a systematic literature review, (v) archival research, (vi) ground theory and (vii) natural inquiry research (Saunders, Lewis and Thornhill., 2016). The experiment and survey strategies are the best for quantitative projects. Archival research and case studies are entirely associated with mixed-methods research. Action research, natural inquiry and ground theory are aligned with qualitative studies (Tremblay *et al.*, 2016).

A case study strategy is "*an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident*" (Yin, 2009, p. 19). It is a strategy designed to explore an event over time within its natural setting, such as a specific group, place, and organisation, to determine the reasons behind the investigated issue (Dempsey and Dempsey, 2000; Zainal, 2007). Robson (1993, p. 146) also expressed a case study as "*a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real-life context using multiple sources of evidence*". Case studies enable researchers to be more foregrounded with a particular social context to capture a more vivid picture of the issue under investigation than other research strategies (Zach, 2006). It is the most common strategy adopted in Information System (IS) research as it also allows addressing the questions like how and why incorporated in most studies and even questions related to how and what may also be integrated with it (Orlikowski and Baroudi, 1991; Yin, 2009). Therefore, this method is well-associated with both exploratory and explanatory research (Saunders, Lewis and Thornhill, 2009). In addition, this strategy is compatible with both qualitative and quantitative research. According to Byrne, (2009, p. 9), "*Case-based methods are useful and represent, among other things, a way of moving beyond a useless and destructive tradition in the social sciences that have set quantitative and qualitative modes of exploration, interpretation, and explanation against each other* ".

Regarding the current study, the researcher believes that the case study is the most appropriate strategy because it focuses on smart transportation mobile applications acceptance in the Omani context by exploring the factors that impact smart transportation service providers to facilitate citizens' acceptance. Moreover, this strategy is adopted as it contributes to exploring the 'how' questions of the research. Additionally, the case study supports conducting qualitative and quantitative studies adopted as research methods for the current project. As a result, the case study provides a better explanation of the factors and complex links that govern the welfare of smart transportation mobile applications in the Omani setting.

There are two main types of case studies: single and multiple case studies (Gustafsson, 2017). Researchers need to decide whether to make single or multiple case studies depending on the research context, the problem being addressed and the boundaries of the conducted research (Gustafsson, 2017). The single case study helps in generating a nuanced, comprehensive, productive empirical account of a particular issue (Willis, 2014). According to Maeseneer (1990) and Yin (2009), it is well applied to investigate a phenomenon that was not reachable or hardly been considered earlier, when research has limited resources, and when addressing a practical and actual case. Additionally, it is mainly implemented when a single case tested can represent other representative cases and when research explores two distinct issues within similar case (Stuart *et al.*, 2002). In contrast, multiple case studies are classified by many researchers as the most helpful strategy to conduct a comparison of different prospects of cases (Gustafsson, 2017). It requires a lot of time and resources, and findings from multiple case studies are considered more convincing (Ponelis, 2015).

This research adopted a single case study to understand smart transportation mobile applications acceptance in Oman, specifically a single case study attempting to explore the contextual factors influencing the acceptance of smart transportation mobile applications, mainly in the capital Muscat. According to Tellis (1997), case studies are not expected to be representative but instead to shed light on what can be learnt from a single case study. Single case studies are essential in improving the quality of the knowledge associated with the relevant knowledge field (Baker, 2011). The main concept associated with a single case study is " *not to prove but to improve*" (Stufflebeam, Madau and Kellaghan, 2006, p. 283). The current study seeks to enhance the acceptance of smart technologies within the smart transportation sector in Muscat by developing a model that might be applied to other cities within Oman and other countries with similar conditions. This is unlike the multiple case studies targeting to "*establish whether the findings of the first case occur in other cases and, as a consequence, the need to generalise from these findings*" (Saunders, Lewis and Thornhill, 2009, 140).

Three main types of research strategies have been identified by Yin (2011): exploratory, explanatory, and descriptive. The exploratory study investigates a topic that has yet to be defined to understand better and answer the unanswered questions. This kind of research involves identifying the nature of the problem investigated and provides a better understanding of it, especially the issues which lack a clear understanding of the reasons behind the problem (Saunders, Lewis and Thornhil, 2009). This approach starts with qualitative data collection followed by quantitative data design (Creswell, 2003). Explanatory research design is where quantitative data collection is followed by the qualitative data analysis (Creswell *et al.*, 2006). The primary purpose of implementing it is to use qualitative data to help explain the quantitative results (Creswell, 2003). Descriptive research aims to precisely measure and document the attributes of the studied phenomena or group.

A sequential mixed exploratory design is the most appropriate for the present investigation because the current research design calls for performing the qualitative study and then following it with a quantitative study. The researcher will gather and analyse the qualitative data as a foundation to inform and shape the quantitative study. The researcher will use qualitative research to explore the factors and themes influencing the acceptance of smart transportation mobile applications from the service providers' perception in the qualitative phase. Then this will be associated with the variable and data collection in the quantitative phase to check if they can be generalised to population perceptions. As the current research design involves implementing the qualitative study and later following it with a quantitative study, a sequential mixed exploratory design best fits the ongoing research. The researcher will collect and analyse the qualitative data and then use the results of the qualitative data analysis to be the foundation and influence the quantitative study, so whatever results from the qualitative data analysis are used for the quantitative data.

5.2.5 Fifth layer: Time Horizon

The fifth layer of the research onion is the time horizon. Saunders, Lewis and Thornhill (2009) identified this layer with two prospective: cross-sectional and longitudinal. Cross-sectional studies are carried out one time only; therefore, the time is considered fixed and predetermined, whereas longitudinal research is carried out over a lengthy period. Accordingly, time is not considered a constraint. Because this research is academic that is anticipated to be finished within a specific time frame, the proper time horizon for this study is cross-sectional.

5.2.6 Sixth layer: Data Collection Techniques and Procedures

5.2.6.1 The Qualitative Study

5.2.6.1.1 Semi-Structured Interviews Objectives

The two main objectives of the semi-structured interviews are:

- To provide an understanding of the smart transportation services providers' perceptions of both the traditional UTAUT2 factors and the extended contextual factors extracted from the literature review chapter in influencing citizens' acceptance of the smart transportation’s mobile applications in Oman to facilitate their acceptance better.
- To use the enriched understanding generated from the interviews to validate and refine the theoretical model of smart transportation mobile applications acceptance in the Omani context to be used later for the quantitative study.

5.2.6.1.2 Interview Method: Semi-Structured Interviews

As has been identified by many authors, interviews are classified as the most common data-collecting technique in the qualitative research (DiCicco-Bloom and Crabtree, 2006). Interviews are a qualitative method that allows researchers to collect data to understand how people think about their experiences, understanding and expectations (Nunkoosing, 2005; Lambert and Loiselle, 2008). Kvale (1994) also defined qualitative interviews as the exchange of beliefs between people involved in a discussion on a particular topic of common interest to create knowledge and underline the social position of the research collected data. An interview can be defined as an interchange of ideas and opinions on a specific issue between the interviewer (the researcher), who is assigned to coordinate the interviews and asks questions and the interviewee, who answers and comments on these questions. According to Rubin and Rubin (2011), interviews depend not only on the interviewer's skills but also on respecting what people say while also putting effort into hearing what they say to understand them better. Interviews can be formed differently based on the purpose being designed for and the type of information needed to be collected (Jamshed, 2014). There are three main designs of interviews: structured, semi-structured and unstructured interviews (Britten, 1995; Bryman, 2012):

- Structured interviews: this form of an interview is the most rigid one where the researcher must strictly adhere to the interview protocol. All the questions should be prepared ahead in that researchers never deviate from the wording or try to interpret the meaning by using their own wording during the interview (Given, 2008).
- Semi-structured interviews: this form is a combination of both structured and unstructured forms of interview. In addition to the predesigned questions, this form also involves questions that are not necessarily pre-decided. Also, the ways and orders of the interview questions are not absolutely decided in advance. Therefore, this interview form allows researchers to ask more open-ended questions enabling an objective comparison of participants in addition to providing chances to investigate subjects related to a specific participant spontaneously.
- Unstructured interviews: in this form, researchers ask questions which have not been decided in advance, and instead, an informal conversation is created where questions arise, and accordingly, different participants may be asked different questions.

As this research aims to collect in-depth and specific data about the research issues from the interviewees, in-depth semi-structured interviews were adopted to explore and gain as much information as possible to throw light on the research questions. Semi-structured interviews are expected to help elicit the interviewee's opinions to address better the research questions (Harrell and Bradley, 2009). Moreover, the semi-structured interviews allow discussion with the interviewees, enhancing the elaboration and further clarification of the feedback received (Dearnley, 2005). The researcher has adopted semi-structured interviews to motivate the participants to provide detailed information. Assigning closed fixed response interviews, which have determined responses, limits respondents' ability to explore besides also limiting their choice of answers. On the other hand, informal conversational interviews involve the challenge of losing focus and missing relevant topics (Patton, 1990). Therefore, the semi-structured interview approach is the best for the current research as it enables the researcher to be more flexible by asking additional questions to facilitate a better understanding (Patton, 1990).

Semi-structured interviews are employed as they allow for collecting qualitative data from the selected people directly involved with implementing smart transportation services in Oman. In addition, they also allow for gaining contextual data by asking open-ended questions, which promotes providing more detailed answers (Mack *et al.*, 2005), besides enabling themes to develop from their responses to facilitate a broad understating of the investigated issue smoothly. The data about the acceptance and use of smart transportation mobile applications to be obtained from the responses to the detailed interview questions will complement the quantitative study. This is expected to produce an enriched understanding to build a better theoretical model of the phenomenon under investigation (Brewer and Hunter, 1989; Creswell, 1999). Therefore, interviews are an effective tool for revealing contextual data about services providers' perspectives, experiences and opinions when studying a relatively new topic such as smart transportation mobile applications acceptance in Oman. Interviews enable the author to explore the issue under investigation from the eyes of the participants' (Meulemann and Hagenah, 2009). Patton (1990, p. 278) stated that "*the purpose of interviewing is to find out what is in and on someone else's mind*"; therefore, interviews fit the aim of this project. Also, semi-structured interviews were expected to help explore the interviewee's opinions to address better the research questions (Harrell and Bradley, 2009).

5.2.6.1.3 Interview Design

At this stage, the researcher has already gained a broad knowledge of the issue and proposed an initial acceptance model for the research context. Most of the questions are worded before conducting the interviews in an open-ended form to allow the interviewees to freely express their experiences instead of choosing from a list limited to the researchers' assumptions (Qu and Dumay, 2011). The interview questions were divided into two main parts in which the first part is to collect general information about the interviewee's backgrounds to understand their roles in the smart transportation projects, their positions, and the perceptions they hold about the issue under investigation. The second part of the interview is designed to explore the acceptance issues. Two types of questions were involved in this part: initiating and follow-up questions, which helped gain more insights into the participants' perceptions of the investigated issue. The initiating questions were designed to mainly address challenges or problems while implementing the smart transportation mobile applications, the kind of resistance recognised from the main potential users of these smart applications, the kind of activities designed to address the resistance and how they have planned to convince citizens to utilise these smart applications. On the other hand, follow-up questions were included to encourage participants to continue talking to elicit more information required to understand better the issue (DeJonckheere and Vaughn, 2019).

The researcher adopted the Arabic language to conduct the interviews as it is the mother language of most of the participants unless there was a preference for the English language by the interviewee. This further allowed the participants more flexibility in expressing their opinions and thoughts without having difficulty saying what they wanted. The interview questions were initially written in English and later have been translated into Arabic, as all of the participants were Omanis. Moreover, the researcher explains any questions that must be clarified to the participants. Therefore, the risks assigned to the interview questions translation are less critical than the translation of the questionnaire survey items.

The interview method has been adopted to gain a deeper understanding of the potential facilitators and influencers to the acceptance of smart transportation mobile applications in

Oman. The UTAUT2 model was adopted and combined with the finding extracted from the literature review to advise in-depth semi-structured qualitative interviews to fulfil this aim. Thus, the insight from conducting interviews was to obtain contextual themes raised by the smart transportation services providers that were not included in UTAUT2 or the literature review. Besides, refining the proposed model by investigating more the factors explored and incorporated into the model from the literature and the traditional UTAUT2 model. The interview questions are derived to explore the interviewees' experiences of executing smart transportation services in Oman. As a result, the purpose of this method was to discuss the topic with service providers to get a more comprehensive understanding of their perspectives and experiences to construct a comprehensive theoretical framework of the factors believed to influence the acceptance. The qualitative interviews are also essential in developing the questionnaire survey for the subsequent quantitative study employed to validate the proposed model. Hence, this phase contributed to confirming the importance of each proposed factor, adding new elements and sharpening the proposed hypothesis. It also contributes to exploring the contextual issues that facilitate or prohibit the adoption.

The primary objective of the interviews is to look into unexplored elements that may play a role in the acceptance of smart transportation mobile applications in the Omani context, besides also seeking to confirm the impact of the factors explored previously from the literature review and the UTAUT2 model. Hence, interview questions are designed to ask open-ended questions to encourage interviewees to share their ideas, thoughts, and opinions about the explored factors while also revealing the hidden factors to acquire an understanding of the factors influencing acceptance. The interviews comprise eleven primary questions, each targeting either exploring a new element or approving factors that have been already involved in the model. The first question, “What improvements do you think your smart mobile application is providing to consumers' mobility and travel?” aims to explore the performance expectancy and the value that citizens can gain by adopting smart transportation mobile applications. The second question, “How easy or difficult do your users find learning to use your smart mobile applications for transportation and information-seeking or travelling?” helps assess effort expectancy by understanding how easy or difficult it is to learn to use the smart transportation mobile application. The third question, “Have you studied the readiness of the technical infrastructure to suit your smart services and smart transportation mobile application?” investigates the factor of facilitating conditions by exploring the readiness of Oman’s infrastructure for delivering smart transportation services. The fourth question, “Did you support the end user by providing them with assistance?” helps investigate the level of assistance offered to the citizens, which can enhance their understanding and acceptance. The fifth question, “Do you think that you have involved all the concerned parties in implementing the smart mobile application?” examines the extent of all related party’s involvement in the design and implementation of smart transportation mobile applications, which is expected to enhance the acceptance further as they are the key players. The sixth question, “Do you think that your target customers will intend to use your smart transportation mobile application in commuting, and why?” aims to understand the end user’s behavioural intention to use the smart transportation mobile applications. The seventh question, “What activities did you do to assess user satisfaction?” intended to investigate the satisfaction factor, the new factor explored from the literature review, to assess its positive and negative effects on acceptance. The eighth question, “What activities have you undertaken to promote user acceptance?” is also designed to explore the new factor awareness impact on acceptance as a new factor incorporated from the literature review. It aims to explore the strategies for promoting acceptance to enhance awareness and usage among the end users. The ninth question “What are the criteria you have decided to rely on while deciding the technology to be used in building your smart mobile application? It helps to explore factors such as compatibility and understanding the end users’ abilities and skills in adoption. Question number ten, “Have you encountered any kind of resistance from the end user to adopt your new smart application?” helps to identify any other potential factors affecting the acceptance which have not yet been involved in the model. The last question, “What types of incentives have you provided to users to encourage them to use these smart services?” encourages interviewees to explore other factors. The main objective of both the interviews and the survey is to validate the factors incorporated in the UTAUT2 model to the acceptance of the smart transportation mobile applications in the Omani context. Thus, the interviews and survey questions were designed with the same aim, which is to confirm and explore the impact of each factor in the UTAUT2 model on the acceptance of smart transportation mobile applications in the Omani context.

The main difference is that the interview questions primarily focus on the service providers' perspectives regarding the factors contributing to the acceptance of smart transportation mobile applications. On the other hand, the survey is designed to comprehend the end users' perspective regarding the factors that enhance acceptance from the citizens' point of view. While most survey questions are formulated based on the literature review and the UTAUT2 model, the interview questions are developed to explore the service providers' perceptions regarding the factors contributing to the acceptance of smart transportation mobile applications. While most survey questions are based on a literature review and the UTUT2 model, the researcher has developed the interview questions to investigate the service providers' perspectives on the factors that impact the acceptance of smart transportation in Oman specifically.

5.2.6.1.4 Selection of Participants

The Covid-19 pandemic has affected the way of learning, and many have been forced to work more remotely. This pandemic has also changed the way of undertaking studies (Haleem *et al.*, 2020). Most qualitative studies depend on face-to-face interaction to collect the data through interviews, focus groups, and sometimes field works (Sutton and Austin, 2015). However, there are numerous methods for researchers to gather qualitative data. This research was designed before the Covid-19 pandemic outbreak and was planned to involve representatives from service providers of smart transportation projects in Oman. The original study was designed depending on face-to-face semi-structured interviews; however, the outbreak of Covid-19 across the world, including the different regions in Oman, has made face-to-face interviews impossible. All the travel restrictions from the World Tourism Organization (WTO), Public health guidelines assigned by the World Health Organization (WHO), and physical and social distancing rules made conducting face-to-face interviews challenging and impossible. Recruiting the sample is hard under normal conditions, but during Covid-19, it became even more difficult as the researchers were not recommended to pursue face-to-face interviews in any country. As interviews are the primary approach in collecting qualitative data and contribute to collecting different opinions and perceptions, they were integral to the current study. Therefore, the researcher was forced to rethink a way to conduct the interviews safely and operationally feasible manner. Consequently, the researcher decided to recruit the sample through the help of the selected governmental and private organisations by sending a request to them to advertise the study and send emails to their employees on the author's behalf as this way is safer than recruiting people face to face.

As a result, the study is designed to conduct semi-structured interviews online. Zoom, Google Meet, and Microsoft Teams tools turned out to be the most convenient as they were the most famous and preferred based on the participants' preferences. The online semi-structured interviews were based on the previously created interview guide, mainly on the research questions and the theoretical framework developed earlier in the literature review chapter.

Although the researcher tried to communicate and convince most of the selected private and governmental organisations in different ways, the respondents were limited to those organizations who replied to the researcher's emails and phone calls and agreed to distribute the research among their staff. The research adopted the data saturation strategy suggested by (Saunders *et al.*, 2018). Therefore, the researcher stopped with participant number 20 when no new information or themes emerged from the interviews (Fusch and Ness, 2015). As the researcher goal is to obtain a comprehensive and exhaustive data collection with regards to exploring the factors influencing Omani citizens acceptance of the smart transportation mobile application, the thesis adopted saturation strategy in which the focus is on stop the interviews whenever there are no new themes emerging and the information collected become redundant and repetitive.

As most researchers lack the resources and time to involve the entire population, adopting a sampling technique is crucial to reduce the number of cases and locate the appropriate population (Taherdoost, 2016). It is vital for researchers to identify the best sampling method applicable to their study to control biases and select the population that best meets research goals and objectives. Also, the sampling method should be suitable for the research nature and is cost-effective (Starks and Trinidad, 2007; Etikan, Alkassim and Abubakar, 2016). Different methods are used to efficiently locate and recruit a representative sample of participants (Arcury and Quandt, 1999).

Non-probability sampling is considered faster and more cost-effective than probability sampling, where the sample is known to the researcher (Dever and Valliant, 2014). Moreover, it is more appropriate, especially when the research population is small and specific and the researcher is willing to learn detailed knowledge about a particular issue rather than making statistical inferences (Acharya *et al.*, 2013; Taherdoost, 2016). Compared to probability sampling, in purposive sampling, the respondents respond faster as they are more motivated to participate, and accordingly, it is easier to reach the designed number of participants. Since the current research depends on collecting knowledge from a specific and limited group of people, the purposive non-probability method fits it very well as it enables the researcher to maintain focus and collect the necessary data needed to answer the research questions from the participants. Thus, researchers get the chance to select only those participants who can contribute to answering the study questions (Matthews and Ross, 2010). According to Tashakkori and Teddlie (2003), non-probability sampling enables the researcher to select specific cases related to the exact aims and goals rather than a random sampling that may not represent the actual population.

Most smart transportation projects involve massive investments with many employees, each with different roles and responsibilities. Within each smart transportation project, there are different teams of experts in different process, including planning, designing, construction, development, and evaluation, to ensure the successful delivery of these smart transportation projects. The researcher was very careful to include participants from different levels and departments with different tasks to gain a complete picture of the smart transportation services providers' perceptions on facilitating the acceptance and adoption of these smart services. Accordingly, the potential participants must have engaged actively in any processes of smart transportation projects implemented in Oman to participate and be included in the selected sample to be interviewed. After studying the Omani transportation sector, the researcher found a group of organisations and entities that participated in the various processes of implementing smart transportation projects in Oman. Some of these organisations and institutions are governmental, whereas individuals own others privately. Some of these organizations are intended to do feasibility studies and planning and later pass them to special companies and organisations to implement. Therefore, the sample of this qualitative study includes participants from both government and private sectors who contributed directly to the implementation of smart transportation projects in Oman. This was important to ensure exploring the full image of their perceptions and interpretation of end users' acceptance and utilisation, which leads to a comprehensive answer to the research questions. This resulted in 20 participants being interviewed, representing a sufficient number in exploratory research.

Four major organisations have been selected to be involved in this study as they are classified as the most active and responsible organisations in implementing smart transportation mobile applications in Oman. These four organisations have been given a code name to maintain their privacy and anonymity. The four organisations' coding is explained in detail in section 6.2.

5.2.6.1.5 Conducting the Interviews

The application to conduct the interviews was sent for consideration to the Brunel University research ethics committee. By getting the approval, the researcher guarantees meeting the human subject issues such as confidentially, consent and risk assessments. The qualitative study was designed under the supervision of professional supervisors. As a first step, the researcher seeks approval from the head of the human resources department within each selected organisation. Upon the agreement, the researcher contacted the responsible departments. Each interviewee was sent an email to clarify their availability and willingness to participate in the study. Along with this email, a copy of the consent form was sent to be signed and returned. Also, the researcher was keen to send a document to all participants explaining: the length of the interview, an introduction to the investigated topic, the type of questions involved, the use of the collected data, the process followed to ensure their confidentiality and anonymity, the aim, nature, and purpose of the research.

The interviews commenced in July 2021 in Oman. The study is designed to conduct semi-structured interviews online. Semi-structured interviews in the current study were conducted via the utilisation of technological resources, for example, online platforms such as Google meet and Microsoft Teams. Video semi-structured interviews are adopted as they are the most applicable for the outbreak of Covid-19. Zoom, Google Meet, and Microsoft Teams turned out to be the most convenient media as they are the most famous and preferred media based on the participants' preferences. Furthermore, such online interview modes prove a range of advantages, from the ease of scheduling, improving the pool of hiring, cost saving, and more convenience to eliminating face-to-face interviews stress (Christina, 2021).

The participants' involvement in the current research was voluntary, and the researcher did not use any inducement methods of encouraging persuasion. Each interview took place online separately on working days based on a one-to-one with services providers who have contributed to implementing smart transportation services and applications in Oman. Each interview was conducted online in a quiet room to ensure privacy and let each participant feel relaxed and freely share valuable information. The interviews ranged from one hour to one hour and a half, and up to two interviews only were conducted daily to enable the researcher to organise each interview's ideas and content. It is very important to gain detailed information to explore the investigated issue accurately; therefore, the researcher should be very curious to refrain from controlling the interviews to the level prohibiting extracting such details (Orlikowski and Baroudi, 1991).

The participants were informed that the gathered data would be used for the benefit of the research. They were also told that their identity would remain anonymous throughout the study. The participants would agree to participate in the research by signing a consent form sent to their email addresses. The participants' details and recorded interviews will be saved in a password-protected file, and only the researcher and the supervisors can access them. Also, while presenting the data in the research, they are anonymised, and the participants ' feedback will be destroyed after analysis. All data, such as any audio records of interviews and interview transcripts, will be locked away securely and stored on a secure password-protected file on the Brunel Network Server and deleted following the research completion. All this information will be conveyed to the participants by giving them an information sheet and consent statement as part of the ethical considerations. Moreover, the researcher will not ask participants to disclose their names or any private information, such as addresses and phone numbers, to ensure that respondents are protected from any future harm from the interview.

5.2.6.1.6 Piloting the Interview

The researcher decided to conduct the pilot study with a group of service providers from the target population who were not involved in the main study. The pilot study was undertaken to ensure that the interview questions covered the research aims and objectives and ensured the questions' clarity. Also, it enables the researcher to decide whether the open-ended questions are well organised, are in the right order, besides gaining ideas about the expected answers and the kinds of responses to be obtained from the participant (Beebe, 2007). The pilot study was conducted under the same condition as the main study. Therefore, an email was sent with all required documents along with the consent form, the researcher details, the aim of the study, invitation letters, and the information sheet. The number of participants involved was only 2, representing 10% of the total participants. This pilot study demonstrated different outcomes discussed in the following paragraph.

Firstly, the piloting of the interview conducted approved that interviews can be executed in the same way as it is planned and that online interviews are possible with the current infrastructure available in Oman. The two participants gave the researcher an opportunity to understand the best way to aid an academic exchange interview. Moreover, the researcher has built interpersonal skills to keep a discussion focused on the research's main goals and aims while maintaining participant-free expression.

5.2.6.1.7 Interviews Data Analysis

The researcher selected the thematic analysis technique as the main approach for analysing the qualitative data collected through semi-structured interviews. To address the research question about citizens' acceptance and willingness to adopt smart transportation mobile applications in Oman, it was important to adopt thematic analysis to introduce patterns from the collected data. Thematic Analysis (TA) is defined as "*a method for systematically identifying, organising, and offering insight into patterns of meaning (themes) across a data set. Through focusing on meaning across a data set, TA allows the researcher to see and make sense of collective or shared meanings and experiences*" (Braun and Clarke, 2012a, p. 57). The researcher decided to adopt the top-down approach of thematic analysis mentioned by Braun and Clarke (2012), in which the researcher is allowed to create codes and themes before analysing the data. This allows the researcher to explore how citizens understand and accept smart services and smart transportation mobile applications in Oman. It also helps to identify whether their opinions and feedback are relevant to the framework designed in the literature review chapter. It also helped identify the availability of useful information outside the designed framework, which could further help revise the built framework. Peterson and Gaugler (2021) proposed using thematic analysis for either exploration or confirmation reasons. With regards to this study, it is used to explore the relationship between the smart transportation service providers' perceptions and the successful implementation of the smart transportation mobile applications as well as to confirm the factors already involved from the traditional UTAUT2 model and literature.

5.2.6.1.8 The Processes Thematic Analysis

Braun and Clarke (2006) assigned six thematic analysis steps. These steps are not linear processes in which the researcher moves from one step to another. Instead, it is a recursive process (Anderson *et al.*, 2014). The six steps of thematic analysis assigned by Braun and Clarke (2006) are discussed in the following paragraphs:

- **Step1: Familiarizing Yourself With Your Data**

According to Braun and Clarke (2006), at this step, the researcher focuses on organising and managing the collocated data to become familiar with it. Thus, it is critical for the researcher to hold prior knowledge and an overall understanding of the obtained data. This step starts by transcribing the verbal data collected from each interview record and starting to actively read and reread the data to gain an understanding and form initial key analytical ideas within the collected data. Later, the researcher can take notes about general observations and build initial thoughts that might later contribute to theme development (Braun and Clarke, 2006). As this step involve transcribing, translating, reading, rereading, and understanding the collected data, it is considered a very time-consuming step (Bryman, 2016). Riessman (1993) also claimed that this stage is boring and requires sufficient time to be accomplished. However, scientists claim that it is worthy as it enables a complete understanding of the collected data and "*it informs the early stages of analysis, and you will develop a far more thorough understanding of your data through having transcribed it*" (Braun and Clarke, 2006, p.88).

Regarding the current study, the transcribing was done by the researcher personally since all the interviews were done by herself. Accordingly, this will ensure the generation of more focused data. This also further promotes linking between the notes taken while conducting the interviews and the interviews' content efficiently. The transcribing process took considerable time with the first few interviews; however, the process became faster later as the researcher became more expert at transcribing.

With regards to the interview transcript translation and due to the significant interview transcripts content, translating qualitative data is a more involved and challenging procedure than translating interview questions. Accordingly, Temple and Young (2004) recommended paying more attention to the process followed in interview transcripts translation. One of the ways identified in translating interview transcripts is transcribing the entire interview transcript into English. Yet, this involves many risks, such as being time-consuming, losing significant materials and difficulty communicating the actual meanings from the Arabic language to the English language (Twinn, 2000). Additionally, throughout the translation process, researchers may involve their subjective interpretations and justifications for the original meaning of the interview data (Twinn, 2000). Also, this might impact how suitable codes are created throughout the data analysis. Thus, rather than translating the entire interview transcripts from Arabic to English, the analysis was initially conducted in Arabic, the original language of the transcripts. Later, all the generated codes with the texts were later translated into English. This contributed to minimising the risks have been mentioned earlier.

- **Step 2: Generating Initial Codes**

Braun and Clarke (2006) advise researchers to evaluate the collected data systematically by paying serious attention to each data item to extract important prospects that may work as foundations for themes. At this stage, the researcher extracts initial codes from the collected data. Interesting data can be coded manually or by using special software packages such as NVivo (Zamawe, 2015). Codes are "*tags or labels for assigning units of meaning to the descriptive or inferential information compiled during a study*" (Miles and Huberman, 1994, p. 56). Therefore, this step is about highlighting the critical parts of the data being analysed to identify the crucial sections of the text into codes which may be related to the research aims and objectives (King, 2004). Proper codes have explicit boundaries assuring that they are not interchangeable or redundant (Boyatzis, 1998; Attride-Stirling, 2001). Different researchers recommended shaping as many codes as possible as they may become critical in later stages (King, 2004; Braun and Clarke, 2012). Later, it is essential to ensure that each chuck of the data is fitted to its correct code (Braun and Clarke, 2006). Regarding the current study, the researcher decided to adopt the NVivo software package for coding as hand coding takes much more time than the software (Ozkan, 2004; Dollah, Abduh and Rosmaladewi, 2017). NVivo software assists in drilling down into the transcript, in which a better analysis of the interview's transcripts is achieved by coding each response into relevant codes to get a general feeling of all possible themes (Braun and Clarke, 2006). However, after downloading the NVivo software the researcher realised that learning how to use it is time consuming and interpreting data through it was not convenient. According to Dollah, Abduh and Rosmaladewi (2017), Nvivo is found to be "*time consuming in learning to use application, expensive for individual use and can't interpret data*". Therefore, later the researcher decided to adopt manual data analysis technique as it was more convenient and easier to accomplish. The researcher has created a codebook to briefly describe each code, allowing keeping track of coded data to avoid developing repeated codes (Mihas, 2019). The codebook presented in Appendix D includes the code names and the extracted texts from interviews of each code. The initial list of codes was generated by reaching the raw data many times. These initial codes were created about the service providers' perceptions of the acceptance and challenges of implementing smart transportation mobile applications. Keeping the aims and objectives of the research in mind is very important while generating the codes, which is, in this case, the services providers' understanding and perception of the various factors affecting smart transportation mobile application acceptance in Oman to ensure extracting meaningful initial codes related to the investigated topic (Nowell *et al.*, 2017). This is critical as the generated codes in this step will be used in the next step to produce themes. This step of thematic analysis involved multiple cycles of code's creation. In the first cycle, the researcher generated over 200 codes due to the richness of the data. During the second round of coding, the interviews transcript was revisited to enhance the understanding of the participant perception and additional codes such as "real-time transportation data", "user data protection", "safety and security", "limited knowledge of existing smart transportation applications", "integration with other smart transportation services or platforms" and "trust in application's updates and maintenance". Later, the researcher reviewed the latent and semantic meaning of each generated code and the texts assigned to them and found that some pieces of texts were belonging to more than one code. The researcher also, noticed that some codes were substantially overlapping with other codes while some codes were not in the interest of the current study. For example, the researcher has assigned the code "users' preferences" under the facilitating conditions construct and later it has been moved to effort expectancy construct. Also, some of the issues in the text were not covered by any code, so new codes have been added. Some codes were merged, while others were wide codes; therefore, they were split into more specific codes. For example, the researcher split the code “issues related to services providers” into “services providers reputation” and “services providers understanding of citizens needs and preferences”. Moreover, the researcher realised that some codes were not in the interest of the ongoing investigation such as “smart homes” and “medical portable watches” and accordingly they were removed.

Step3: Connecting Codes and Identifying Themes

This step uses the various codes generated from the previous stage, in which the researcher moves the codes back and forth to sort them into potential themes. It started by screening the developed codes and their description to collect them into themes that interpret exciting ideas of the data. Braun and Clarke (2006, p. 82) describe a theme as “*something important about the data concerning the research question and represents some level of patterned response or meaning within the data set*”. Different tools, such as mind maps, tables, and flashcards, can facilitate this process. Utilising the concept of mapping enables the researcher to map the codes into main themes and subthemes by visualising the relationships between generated codes. According to Babbie (2020, p. 395), mapping is “the graphic display of concepts and their interrelations, useful in the formulation of theory”. King (2004) states that various changes will be involved in this step depending on the quality of the initial coding process.

With regards to the current study, the researcher built the theoretical model based on the UTAUT2 model along with the findings from the literature review chapter; therefore, the factors of the UTAUT2 model coupled with the elements from the literature represented the base of the collation processes of the codes assigned with this step. As a result, a bunch of initial codes were collated into themes and subthemes. To design the interview instrument questions, it was critical to identify the various expected themes and prospects to be explored. From the earlier discussion, it can be recognised that the main theme associated with the current study is acceptance. According to the UTAUT2 model, this acceptance is identified mainly by behavioural intention. Later all other constructs, such as effort expectancy and performance expectancy, habit, price value, facilitating conditions and social influence, are included as factors affecting the behavioural intention construct. In addition, two new themes were recognised from the literature review: trust and satisfaction. Most interviewees raised information dealing with these two factors, and accordingly, the researcher decided to keep them in two separate themes. Subsequently, the researcher was able to collate many other codes into these themes. For instance, “personal data protection”, “transparency”, “minimising data sharing”, “reliable data”, and “happy with features and facilities” are some of the codes used to construct these new themes.

However, some codes were extracted from the interviews that the researcher could not sort under any main and subcategory themes. For example, “lack of previous usage”, “advertisements and campaigns”, and “offering tail period” did not fit in any themes. Therefore, the researcher kept going back and forth within these codes to check the possibility of incorporating them within exciting themes, or whether they needed to be grouped into new themes. Since most of these codes were relative to the end user acceptance of the smart transportation mobile applications and, at the same time, they were not related to any generated themes, the researcher decided to add two new themes: awareness and former practice. This is aligned with the thematic analysis purpose of exploring new knowledge of the investigated topic (Peel, 2020). These two new factors were further incorporated into the proposed model and investigated in the quantitative research to confirm them.

Step 4: Reviewing Themes

After exploring a range of themes, the thematic analysis is moved to the fourth stage, refining the formed themes (Braun and Clarke, 2006). This stage involves two levels: reviewing and refining the developed themes (Clarke and Braun, 2016). Regarding the first level, a review of all generated nodes is conducted to check whether each extracted theme and subtheme fits and forms a coherent pattern (Nowell *et al.*, 2017). Themes that do not meet this requirement are reconsidered by rethinking and rearranging them by either creating new themes or deleting them and replacing them with contemporary themes (Braun and Clarke, 2006). At this level, the coherence of each theme is rechecked by validating each identified code to its corresponding extracted text. Also, the researcher ensures a clear distinction between formed themes by modifying the built themes and their collected data, dividing themes with different meanings into new themes or subthemes, and merging themes with the same purpose into one (L. Given, 2008). For example, two themes under effort expectancy construct namely “assumed difficulty” and "perceived complexity” have been combined under one theme named “user friendly” to better enhance the understanding. Those themes that pass the review at this level are moved to the next level, which is about building a thematic map of the identified themes, their subtheme, and their corresponding codes. The main output of this stage is generating a thematic map. The concept map's main advantage is “*facilitated conceptualisation, analytic clarity, and intellectual rigour. The maps became representations of the researchers’ understandings, and interpretations of the data issued from it*” (Baugh, McNallen and Frazelle, 2014, p. 4). The thematic map of this study is presented in Chapter 6 in Figure 6.1.

- **Step 5: Defining and Naming Themes**

This step identifies what each theme represents and what aspect of the data each theme captures (Braun and Clarke, 2006). They stated that researchers need to perform a detailed analysis of each formed theme to identify the individual narrative assigned within each theme. After that, the researcher will be able to assign concise names that give the readers a sense of what each theme represents (Braun and Clarke, 2012a). At this step, the researcher needs to identify how each theme matches the overall story of the whole data set concerning the research questions (Braun and Clarke, 2012). Once able to clearly explain and describe the content and story behind each theme, the refinement process will not be needed anymore (Braun and Clarke, 2012a). Therefore, the researcher spent sufficient time in naming and refining each theme by providing a detailed explanation of each theme's meaning, identifying its importance in explaining the whole story needed for the qualitative data analysis and how it is significant in supporting answering research questions (Braun and Clarke, 2012a).

Thus, during this stage, all themes and subthemes have been assigned a name and labelled regarding their meaning and what they reflect. All themes were collated into ten main themes. Seven themes, including performance acceptancy, effort expectancy, social influence, facilitation conditions, habit, trust, and satisfaction, carry the same meaning as identified in the literature review. Most of these themes' definitions matched very well with their corresponding theoretical purpose, and the researcher needed only to amend them to suit the smart city context. However, only one theme from the traditional UTAUT2 factors, which is price value, the researcher needed to modify into another meaning based on the context of the current research. The price value factor in the UTAUT2 model refers to the trade-off between the monetary cost and the benefits consumers perceived from the application's adoption. However, regarding the current study context, in addition to representing the monetary trade-off, it also refers to the non-monetary benefits of smart transportation mobile applications to encourage citizens' utilisation and adoption. In addition, awareness and former practice themes are incorporated based on the understanding captured by the service providers.

- **Step 6: Producing the Report**

The final step of thematic analysis is about writing up the final report. According to Braun and Clarke (2012), the report generation process should involve providing valid, concrete, constant comparative, logical, non-repetitive, and exciting data across the themes. In this step, the researcher synthesize the data, conduct analysis and connects them to the scholarly to produce a report answering the research questions and producing a bigger picture of the overall report (Guest, MacQueen and Namey, 2014; Vaismoradi *et al.*, 2016). Also, the researcher must choose attractive codes for the final report, which can be used as evidence to support each identified theme compared to the whole data set. This stage plays a critical role in the current study as the finding identified from this report works as a base to extend the quantitative study to the next stage.

5.2.6.1.9 Validity of Interviews

The researcher worked on providing each participant with a copy of the interview questions and consent form along with other documents before the interview data. Also, the researcher checked the internet connection, the meeting tool efficiency, and the recording software in advance. The interviews were conducted on a mutually convenient date and time for both the candidate and the interviewer to guarantee a relaxed environment with enough time for further discussions.

Moreover, for the validity of the qualitative interviews, it was essential to match the interview questions to the primary research objectives. The current research is designed to investigate the smart transportation services providers' perceptions of the end user acceptance besides exploring the constraints incorporated with improving user behavioural intention to use these applications. Thus, interview questions were developed to achieve this purpose, and the interviews were focused on the research area.

In addition, it is also essential to plan a valid method for hiring and recruiting candidates who are not forced to participate in the study (Stenbacka, 2001). The expected participants of the current study are officials involved in any activities, including designing, planning, and implementing smart transportation services and projects in Oman. By this, the researcher guaranteed the involvement of those aware of the investigated topic. Purposive sampling was adopted, as has been discussed earlier in this chapter. The researcher called the four organisations who agreed to be part of this study to explain and reveal the factors affecting Omani citizens' acceptance and adoption in the smart city era.

5.2.6.2 Quantitative Study

5.2.6.2.1 Questionnaire Objectives

The main objectives of the survey questionnaire are:

- To validate the theoretical framework constructed from the literature review and the qualitative study.
- To explore the various factors perceived by the citizens to affect their acceptance of smart transportation mobile applications in the Omani context.
- To assess the similarities and differences between smart transportation service providers' understanding and citizens' perceptions of the various factors influencing the acceptance of smart transportation mobile applications in the Omani context.

5.2.6.2.2 Quantitative Data Collection Method: Questionnaire

According to Rattray and Jones (2007), the questionnaire is a powerful technique allowing researchers to collect perceptions from a wide range of participants. The questionnaire tool enables researchers to understand public thinking and get useful data about a specific matter (Krosnick, 2017). It has been employed successfully in other research to validate hypotheses, construct theoretical models, and develop measurement scales (Easterby-Smith, Thorpe and Jackson, 2012). Moreover, the questionnaire is one of the most popular research approaches that empower researchers to study multilabel variables (Saunders, Lewis and Thornhill, 2009). In other words, a survey enables researchers to collect sufficient data to provide possible reasons for particular connections within different factors to build a model based on their links (Bryman, 2004; Earl R. Babbie, 2020). Also, it has been utilised in various studies that employed the UTAUT2 model as its theoretical framework (Venkatesh, Thong and Xu, 2012). This method is also realised as one of the most economical methods to collect a large quantity of data (Saunders, Lewis and Thornhil, 2009). Saunders, Lewis and Thornhil (2009) further stated that a questionnaire enables the generation of results that can represent the whole population without the need to collect data from the entire population. Although questionnaires are usually conducted within a sample, they are standardised, enabling researchers to easily make comparisons (Trochim and Donnelly, 2001). The questionnaire tool is accepted as a practical method of getting a large amount of data to provide a broader understanding of the issue under investigation. Compared with other data collection strategies, a survey enables collecting data simply and persuasively, especially in studies with limited time, resources, and logistical challenges. The questionnaire is defined as a document filled out by the participants in either written or electronic forms (Wray and Bloomer, 2013). In line with this, a questionnaire tool will be adopted to collect data for the current research to explore the possible reasons for the relationship between the dependent variable to understand the intention to adopt smart transportation mobile applications and the other independent variables.

5.2.6.2.3 Questionnaire Design

The quality of the collected data and the type of responses strongly affect the strength of the analysis, so designing a well-developed questionnaire is crucial (Burgess, 2001). Thus, it is essential to focus on different aspects while designing a questionnaire, such as its contents, length, wording, pre-testing, questions order and meanings (Sreejesh, Mohapatra and Anusree, 2014). Researchers conduct surveys to collect data to be used to solve the research questions. Usually, the questions are extracted from an established framework or earlier studies related to the ongoing investigation (Robson, 2002). As questionnaires are developed to help answer the research questions, their questions should be mostly designed based on findings from earlier studies or evaluated theories related to the research context (Gibbins and Qu, 2005; Yaddanapudi and Yaddanapudi., 2019). As the researcher was not able to identify a comprehensive or appropriate survey suitable for the context of Oman, a decision has been made to build a related survey meeting the contextual requirement of the ongoing investigation with extended factors incorporated from both the qualitative study findings along with the constructs explored from the literature review.

The main part of the questionnaire was developed based on the various constructs of the traditional UTAUT2 model, which later was modified to the context of the current study of smart transportation services and applications. The proposed model in this study is built based on some mature elements tested in previous studies in other settings and backgrounds. Thus, the questionnaire is based mainly on the components of the UTAUT2 model, and the statements will be modified to the context of smart transportation mobile applications. The survey is primarily developed on the instrument and items found in Venkatesh, Thong and Xu (2012) and Venkatesh *et al.* (2003). Also, studies that have adopted the UTAUT2 model in other contexts, including smart cities and smart transportation settings, were also reviewed to build a proper survey instrument suitable to the context of the current research. As a result, the author also incorporated some items in the previously developed surveys available in the literature in designing the current research questionnaire, as most of them had acceptable validity and reliability tests (Holland, Thomson and Henderson, 2006). Thus, the survey in this study is also built based on some mature items tested in many studies previously in other settings and backgrounds. The findings from the preliminary qualitative study are also used to add to the questionnaire of the current study, as some questions and items were extracted from the results of the preliminary qualitative study and used as bases for the questionnaire of the present study. Around ten constructs are expected to influence the behavioural intention to use smart transportation mobile applications in the Omani context, including performance expectancy, effort expectancy, social influence, facilitating conditions, price value, habit, trust, satisfaction, awareness, and formal practice. Table 6.4 in chapter 6 shows the questions about each factor besides indicating each item within a construct and its sources. The survey is designed into two main sections, as explained below:

- Section one: This section is solicited to collect demographic information and the relevant background characteristics of the participants. The data collected from this section are used mainly for two main purposes. Firstly, to obtain the demographic information of the participants. Secondly, most of the information gathered is classified as moderators within the UTAUT2 model and considered critical to answer research questions. These moderators include age, gender, and experience.
- Section two: This section focuses on capturing citizens' perceptions regarding the adoption of smart transportation mobile applications to gauge the extent of agreement and disagreement with each item about the variables impacting their acceptance of the smart transportation mobile applications. The participants are provided with a list of items based on the UTAUT2 model, literature review and qualitative study. All items under each factor use a five-point Likert scale ranging from strongly disagree to strongly agree, and citizens are requested to indicate their level of agreement with various items given under each construct.

A copy of the questionnaire and the consent form are attached in Appendix B. A consent form is attached as the first page of the questionnaire to inform participants that agreeing to its term will be considered an agreement to participate in the research. In addition, an extra information sheet is also attached to the introduction part of the questionnaire to help participants understand the research aims. It also clearly states that all participants' personal information is kept hidden and considered confidential to ensure their anonymity. The questions are formed to be answered by both genders with different disciplines, backgrounds, and qualifications.

5.2.6.2.4 Development of Measurement Scale

The Likert scale is considered one of the most powerful tools used in studying and measuring participants' perceptions, opinions and attitudes (Kaptein, Nass and Markopoulos, 2010). According to Joshi *et al.* (2015, p. 398), the Likert scale is about "*the presentation of item on scale are such that, to allow the participants to choose clearly opposed alternative*s". The Likert scale can be easily made, showing the responses from extremely important to extremely unimportant with a neutral option which occupies the midpoint of the Likert response scale (Garland, 1991). The Likert scale is simple and easy to use, and the reliability of the data produced by using it is usually greatly valued (Djamba and Neuman, 2002). Various points of the Likert scale have been developed; however, a 5 and 7 points Likert scale are the two most widely used (Dawes, 2008). Leung (2011) argued that a 5-point Likert scale is much easier to read, scale, and helps improve the response rate.

The Likert scale is evaluated as one of the main tools used in social science studies (Croasmun and Lee Ostrom, 2011; Byrne, 2013). The Likert scale has been widely used in smart city research; for instance, Rana et al. (2019) have used a five-point Likert scale to test the smart city barriers in the Indian context. Guedes *et al.* (2018) have also employed a 5-point Likert scale to identify the contribution of each factor in making cities smarter. Also, Charalabidis *et al.* (2019) used the same scale to prioritise smart city initiatives from different points of view, such as municipal officials, citizens and experts. Therefore, the decision has been made to utilize a 5-point Likert scale ranging from strongly disagree to strongly agree as it allows participants to clearly express their opinions about the agreement of each factor in smart transportation mobile applications adoption in the Omani context.

5.2.6.2.5 Translation of The Questionnaire

As Arabic is the primary language of communication in Oman and because several Omanis understand only the Arabic language or may have limited English language abilities, survey questions in both the pilot and main study were conducted in the Arabic language. The questionnaire questions were first written in English and then translated into Arabic. The questions were translated into Arabic through a back translation process to confirm a complete understanding of the relevance, acceptability, comprehensibility and completeness of the translated questions (Brislin, 1986). This procedure is classified as one of the most common and highly recommended to be implemented to ensure the accuracy and validity of the translations (Chen and Boore, 2010).

The word back translation in this context means translating a translated item back into its source language (Harkness, Vijver and Mohler, 2003; Tyupa, 2011). To eliminate any possible error, ensure the accuracy of the translation process and approve that both the Arabic and English versions of the questionnaire are asking the same questions, two different authorised Arabic translators were hired to translate the interview questions independently from English to Arabic. The Arabic version of the survey questions, obtained from the first translator, has been translated back into English by the second translator. The exact process was repeated in the second version of the translated survey questions. Later the researcher compared the two versions in both Arabic and English to each other by a native speaker of Arabic and fluent in English to reveal any differences until an agreement was formed on the final version of the questions. The two versions of the translation were combined to write the best version of the translated questions. Moreover, the researcher paid special attention while translating the technical terminologies. Therefore, the translation was guided by an Omani professional with considerable experience in Information System vocabulary to ensure the accuracy and clarity of technical terminologies by rephrasing them to their appropriate wording.

5.2.6.2.6 Sampling Approach

Sampling is considered one of the essential preliminary tasks when undertaking research as it reflects the accuracy of the collected data (Kothari, 2004). Hence, it is especially critical to choose a sample representing the population to allow accurate inferences that represent the whole population (Bartlett, Kotrlik and Higgins, 2001). According to Malhorta and Birks (2006), at the outset, the researchers are requested to define the research population, which is described as all people, groups, organisations or items with common characteristics that the researcher seeks to investigate a specific problem through and from which a generalization can be made. In actual practice studying the entire population is not feasible due to the time and resources limitation (Etikan, 2016). Thus, the research is carried out on a specific sample rather than the entire population to which the study results will be generalised (Naing, 2003). A sample is "*the smaller number of cases, units or sites selected from a much larger population. Some samples are assumed to be representative of wider population*" (Hammond and Wellington., 2013, p. 174). Likewise Kumar (2018) states that sampling means selecting a group of people from a large group to represent the entire population. Thus, sampling can reduce the volume of data a researcher needs to collect by studying data from a subgroup instead of including all cases (Saunders and Tosey, 2013; Kumar, 2018). As a result, the research finding can represent the whole population (Kumekpor, 2002).

There are around five main steps involved in the sampling process: identifying the target population, identifying the sampling frame, choosing the sampling tool, deciding on the sample size, and finally, implementing the sampling plan (Akhouri, 2018). Concerning the target sample, the study targets Omani citizens who have yet to utilise any smart transportation mobile applications in Oman. Participants will be asked at the beginning of the survey if they have used any smart transportation mobile applications in Oman; if yes, they will not be allowed to carry on with the main acceptance questions. Therefore, the sample frame for the current research is people living across the capital Muscat including all citizens above 18 years old who are yet to adopt smart transportations mobile applications.

As explained earlier in Section 5.2.6.1.4 and declared by Saunders and Tosey (2013), there are two possible ways to gather data from the public: probability and non-probability sampling. With probability sampling, all population members have an equal chance to be selected. In contrast, in the nonprobability sample, every person in the population does not have an equal chance of being selected (Etikan, Alkassim and Abubakar, 2016). Each method contains a range of sub-methods for achieving the target sample. For example, probability sampling includes simple random sampling, stratified random sampling, systematic random sampling, cluster random sampling, and multi-stage sampling (Etikan and Bala, 2017). Random sampling is utilised widely as it involves giving an equal chance for each member in the target sample to be selected to participate, yet it is more applicable for a controlled sample such as an experiment group (Zikmund *et al.*, 1967). The non-probability sampling includes convenience sampling, snowball sampling, voluntary response sampling, quota sampling, purposive sampling and self-selection sampling (Sarstedt *et al.*, 2017).

The researcher decided to employ the non-probability sampling method to collect data for the quantitative study of the current research. Specifically, the self-selection sampling technique has been utilised for the current research as it allows individuals to decide whether they want to participate. The present study sample is considered too large to use random sampling to give every member in Oman an equal opportunity to participate; therefore, self-selection sampling is more valid for the current study to enable the researcher to collect more data.

The decision on sample size is critical as it directly affects the outcomes (MacCallum, Browne and Sugawara, 1996). There is no definitive answer regarding the adequate sample size in research, and the decision is complicated and not always a simple task. Yet there is usually a range of factors to be considered before making the decision (Bryman, 2016). For example, Maxwell (2008) recommended alignment of the sampling with the research designs and that it should not be decided in isolation from the study setting. He also advised that it should be based on what works best for the current study. In addition, Westover (2010) stated that the backbone of the research sampling size should be determined based on the time, cost, accuracy and relevance aspects. According to Sarantakos (2017), assigning a better representative sample will enable the generalisability of the results and consequently enhance the quality of the outcomes. On the other hand, setting a proper and representative sampling technique depends on many elements such as resources, time, population, nature of the study and accessibility (Saunders, Lewis and Thornhill, 2009). Saunders, Lewis and Thornhill (2009) argued that the sample size in the non-probability method depends very much on the research aims and objectives and is open to interpretation with no standardised rules.

This study is focused on a single case study as this method offers to collect in-depth and detailed information besides allowing diversification in terms of the methods that can be used in data collection, such as incorporating surveys and interviews, which provide several layers of analysis to understand better various perspectives (Kratochwill *et al.*, 2010). The researcher has selected the Sultanate of Oman and, more specifically, the capital Muscat as a case study to conduct the investigation based on her experience and knowledge of the country. Therefore, the study is restricted and bounded by different factors, such as the location of the physical participants and people's knowledge. The research's sample size is restricted to those citizens who have yet to experience smart transportation mobile applications in Oman. Moreover, one has to assign a sufficiently large sample size to draw a precious and accurate conclusion. Like the sample tool, the sample size is also restricted to different constraints such as time, resources and money that dictate the size and the structure of the selected sample. It is advisable to assign a sufficiently large sample size to draw precious and accurate conclusions (Bartlett, Kotrlik and Higgins, 2001). On the other hand, it is also important to recruit a manageable sample that still establishes a clear picture and understanding of the position in the other hand (MacCallum *et al.*, 1999). This study employs a non-probability self-selecting sampling tool for collecting the quantitative data. This research involves 11 constructs and employs the SEM technique to analyse the collected data, which will be discussed later in this chapter. Accordingly, special consideration to the sample size is very critical as the SEM technique to generate accurate results needs at least 200 participants. The Sultanate of Oman is a large country but small in terms of population size, with only 5,106,626 million people in 2020 (Worldometers, 2020). The sample size of the current research is discussed more in Section 5.2.6.2.9.

5.2.6.2.7 Pre-testing and Expert Vetting of The Questionnaire

In specific cases, such as this research, where the theoretical model is built based on adopting a technology acceptance model, researchers need to pay special attention to the content validity of the various scales and the internal consistency of the questionnaire’s items. Although most of the questions adopted in the current research’s questionnaire are extracted from Venkatesh, Thong and Xu (2012) and Venkatesh *et al.* (2003), which are widely employed and validated in many previous studies, new items under some constructs have been incorporated based on the interviews finding and literature review. The model has been extended by adding new factors related to the current research context. The draft instrument included 11 factors and 39 items to measure them. These items were validated by an expert panel and adjusted accordingly. These new items and changes must be content validated to guarantee that the instrument is built correctly. Therefore, before distributing the current questionnaire for the pilot study, it was essential to test it by experts to refine it to avoid any issues that may be faced regarding invalid reliability and validity. According to Hair, Babin and Anderson (2010, p. 543), content validity is the "*extent to which a set of measured variables actually represent the theoretical latent construct they are designed to measure*". Content reliability is "*concerned with whether the findings are really about what they appear to be*" (Saunders, Lewis and Thornhill, 2009, p. 57).

With regards to the current research, in order to ensure that each factor and the items under it are correctly constructed, advice has been taken from various instructors from various educational institutions in Oman, along with some other experts who have knowledge and experience with the technology acceptance models. This step is critical to assess the instrument's content validity. Given the research interest in investigating the factors influencing citizens' acceptance of smart transportation mobile applications in Oman by adopting the UTAUT2 model, the researcher has tried to include as many questions as possible to measure each construct from different sources. The survey involved a combination of questions from three primary sources literature review, the UTAUT2 model and the findings of the interviews. The researcher decided to contact experts and academics with specialists in technology acceptance theories, particularly the UTAUT2 model, to evaluate the validity of the questionnaire by employing an expert panel composed of academics who have adopted technology acceptance models in their previous research. Also, the participants involved in the pre-testing stage had to have some publications related to the acceptance models and must have at least a doctorate degree to ensure valuable input. A panel of 7 experts agreed to participate, and the selection was purposive rather than random. The reason is to ensure in-depth information about the validity of the constructed factors and their items. The panel of experts includes professionals from various institutions such as Sultan Qaboos University (SQU), Princess Sumaya University of Technology, Sohar University, AlBuraimi College and the University of Technology and Applied Science. The academics were asked to answer the questionnaire and provide feedback on whether each item accurately measures the designed construct, especially the newly added items and factors. They were also asked to check the questions' clarity, understanding, and the possibility of contradiction among the items. They were also required to check if the items were reliable and valid.

The feedback from the expert panel allowed the researcher to improve the questionnaire in many ways. Based on the input from the academic faculty on the draft questionnaire, some items were reworded to enhance clarity and validity; however, many have been changed, and some have been dropped. The researcher has rephrased some of the questions where the meanings were not precise; in some cases, new questions were added while others were dropped. Experts involved in this phase commented on the design, length, redundant questions, contradicting questions, misunderstanding questions, and addition of some new questions they felt were important in improving each construct's measurement. As a result, the questionnaire was further updated to reflect the feedback received from the panel.

To sum up, it is essential to know that these changes were based on the cognitive feedback from the expert in the technology acceptance models. The elimination of irrelevant items and adjusting the existing questions led to 39 items used to measure 11 factors in the proposed extended model of acceptance of smart transportation mobile applications in Oman.

5.2.6.2.8 Piloting Questionnaire

A pilot study is implemented to enable researchers to conduct a small-scale test of the methods, tools and techniques adopted for the actual research (Van Teijlingen and Hundley, 2001). To collect high-quality desired information, Saunders, Lewis and Thornhill (2007) argued the importance of the questionnaire design and recommended undertaking a pilot study to guarantee the adoption of the best design in terms of clarity and acceptability. This process enables researchers to identify the actual and potential problems of the questionnaire before the actual implementation of the final one (Fraser *et al.*, 2018). It also facilitates testing adequacy and feasibility, predicting success, discovering local politics, determining the time needed to complete the questionnaire, and testing the question's validity (Van Teijlingen and Hundley, 2001). Therefore, pilot testing is considered an important tool to utilise better the research money, time and effort in the most effective way (Desimone and Le Floch, 2004). The pilot test usually incorporates a small sample of participants with similar characteristics to target participants who are asked to complete the questionnaire to provide feedback. This allows the researcher to ensure the feasibility of the questionnaire by allowing to revise the questionnaire's instrument based on the feedback received from the pilot test (Bryman, 2004; Chenail, 2011).

Concerning this study, the researcher prepared a draft questionnaire based on the traditional UTAUT 2 model, the literature review findings and the preliminary qualitative study. An initial pilot study is conducted with 4 participants from different backgrounds from the researcher's network. The participants can comment on the research questionnaire length, clarity, design, and, most importantly, the level of understanding of the different questionnaire elements and questions. The findings from this pilot study are used to amend, adjust, construct, and improve the quality of the final questionnaire. This stage was conducted mainly to investigate whether the Arabic version of the questionnaire was clear. A few changes were made to the questionnaire based on this pilot test feedback. This stage revealed a few simple changes, including some spelling and a few inappropriate words to be replaced. The author amended and rephrased some of the statements based on the issues that emerged in the pilot study. For example, a few amendments were made to some questions in which they were rephrased in terms of the language and questions' structure. Moreover, the researcher also added examples to a few main statements as it was noticed that they were unclear by the respondents of the pilot study. This test also helped the researcher to understand the estimated time required to fill out the questionnaire by the participants, which ranged between 8-10 minutes.

This also helped to identify the appropriate time a participant needs to complete the questionnaire during the actual distribution.

The next stage was to conduct the actual pilot study, where the researcher invited around 45 citizens in Muscat who were introduced to the researcher by friends and family members to check the questionnaire's validity further. The main aim behind this stage was to ensure the validity and reliability of the developed instrument and, more specifically, to ensure the content validity of the items. The sample size in a pilot study varies from one study to another; however, an insufficient sample size of a pilot study might lead to lower statistical power. As a result, it is important to identify a proper sample size for a pilot study (Lancaster, Dodd and Williamson, 2004). Hertzog (2008) argued that assigning a sample size for a trial survey is a complex decision as different factors may be of influence. Some researchers suggested using a specific percentage of the total sample size to assess the feasibility of the research survey. For instance, Connelly (2008) stated that many experts recommended 10% of the study's total sample size. Hill (1998) proposed using 10-30 participants, whereas Browne (1995) recommended 30 respondents per group. Ideally, to test the questionnaire, at least 10% of the total sample size is essential (Lackey and Wingate, 1997). Thus, in this research, the questionnaire piloting is carried out on 40 citizens representing 10% of the total sample size of 400. The 40 participants were selected and approached by the researcher, drawing on her network. They were chosen to ensure a wide spread of participants with different backgrounds, regions, and ages. Then the cover letter, ethical approval and the link to the questionnaire were sent to them. The agreed participants were asked to fill out the questionnaire and respond with their feedback. At this stage, the researcher tested the validity and reliability of the instrument by running a range of preliminary statistical tests obtained through SPSS software. The pilot study is critical to emphasise any demand to refine the questionnaire statement and get feedback on the survey design. Table 5.1 shows the pilot study results in which Cronbach’s Alpha of each factor was calculated and illustrated. The value of Cronbach’s alpha is above 0.7 for all factors, which means that the internal consistency requirement is met. The lowest value was in awareness (0.588); it was considered bad. However, as it is near 0.6 which is considered still acceptable, the researcher decided to keep it with special attention to it in the real study.

Table 5.1: The pilot study reliability test’s result

Constructs	Number of items	Cronbach’s alpha
Performance Expectancy	4	0.887
Effort Expectancy	4	0.886
Social Influence	4	0.821
Price value	3	0.822
Facilitating Conditions	4	0.804
Habit	3	0.745
Trust	4	0.865

Satisfaction	4	0.937
Former Practice	3	0.803
Awareness	3	0.588
Behavioural Intention	3	0.777

5.2.6.2.9 Administrating the Questionnaire

The research questionnaire is designed to be distributed using the online web distribution methods as the sample size of the research is considered large and planned to cover the different regions of Muscat city. The online survey method is regarded as a vital tool as it allows the following advantages: it increases the response rate, reduces costs, offers better questionnaire design flexibility and is considered to be faster than the manual questionnaire (Nayak and Narayan, 2019). Moreover, the online questionnaire enables researchers to easily observe the responses and start an initial exploration of the data in a short time (Farmer, Oakman and Rice, 2016). As the questionnaire used in the ongoing research is designed to gather the perceptions of citizens from different regions in Muscat, the online questionnaire approach is well suited to the study since it enables reaching participants throughout Muscat with minimum cost and faster time. According to Lefever, Dal and Matthíasdóttir (2007), participants can quickly fill out electronic surveys at a time and place of their convenience. Therefore, for a large sample size, the questionnaire is more efficient and accessible as it is more convenient for participants to complete and submit it. Moreover, delivering the questionnaire online make it inexpensive while also maintaining the privacy of the participant (Sue and Ritter, 2012). The questionnaire has the advantage of being self-reported and collecting structured data, which enhances quantifying and better understanding in accordance with the perceptions of a phenomenon. Due to the Covid-19 pandemic, an online questionnaire is chosen as a suitable tool to study a large number of influencers within a large population in an Omani context.

Since it is impossible to obtain the personal email of the citizens in Oman due to privacy rules and to meet the university's ethical requirements, the researcher could not send a direct copy of the questionnaire to the citizens via their email addresses. Instead, a link for the questionnaire was sent to the participants via social media and social network applications. A well-designed invitation letter explaining the research objectives, duration, instruction, contact details, and confidentiality and anonymity details were included within the questionnaire link. After getting the ethical approval, the questionnaire was administered for four months, from March 2022 to June 2022.

The researcher used Google Forms to distribute the online questionnaire for several reasons. Firstly, unlike many other online survey websites, it designs questionnaires compatible with smart devices such as smartphones and tablets. This is crucial as "*smartphones are your window for higher response rates and more satisfied respondent*" (Cole, 2012). Secondly, today researchers from different fields use the Google Form survey tool in data collection as it brings other benefits such as friendly designing, developing, and collecting responses in the most straightforward ways (Vasantha Raju and Harinarayana, 2016). Thirdly, Google Forms also offers a variety of survey designs, unlike other websites with limited options. The available designs within Google Forms are accurate, enhancing the analysis later. Moreover, Google Forms allows the presentation of the collected data into a spreadsheet which can be quickly adopted for analysis in SPSS and Smart-PLS software. It also produces some descriptive analysis besides being free of charge. It allows researchers to distribute as many questionnaires as they want.

The respondents will not be asked to provide their names, emails or occupations, as it is agreed that anonymity boosts forthright answers (Lodico, Spaulding and Voegtle., 2010). Thus, the questionnaire clearly states that all participants' personal information is kept hidden and considered confidential to ensure their anonymity. Google Forms also give them the freedom to answer in their preferred language. A consent form is attached as the first page of the questionnaire to inform different participants that completing the questionnaire will be considered an agreement to participate in the research. In addition, an extra information sheet is also attached to the introduction part of the questionnaire to help the participants understand the research aims.

The current research nature with 11 variables and the adoption of the SEM tool means that at least 200 participants are required to implement SEM as this kind of analysis is very sensitive to the sample size (Saunders, Lewis and Thornhill, 2009). The data collection process was prolonged because the quantitative data collection was voluntary and depended on the end user’s willingness to contribute. The researcher distributed the questionnaire online using Google Forms through social media in the first round. Moreover, the researcher encouraged participants to distribute the link to their network of friends and families. In the first round, the researcher collected around 227 responses.

As the received response rate was lower than expected, the researcher worked hard to boost the number of participants. Because this way of distribution did not achieve an adequate sample size, the researcher had to additionally contact some organizations to distribute the link among their staff. The target population was citizens living in Muscat, and due to the Covid-19 pandemic, it was impossible to collect responses by face to face. The university rejected distributing hard copy surveys to the citizens during the Covid-19 pandemic. To solve the sample size issue, the researcher contacted another round to collect responses and this time by utilizing a wider range of social network platforms such as Twitter, YouTube and Instagram. Also, the researcher requested people with a high number of followers to post the link of the survey on their pages to be accessed by a higher number of citizens. Many agreed to post the link to the Google Form through their accounts and send it to their networks. The researcher also requested these people to post a reminder of the link to their followers a week after the first post to encourage citizens to complete the survey by explaining the benefits expected to be gained from the current research and how it contributes to enjoying better transportation services and mobile applications in Oman. The researcher also ensured providing citizens with reasonable time to complete (almost a month). After reaching the target sample size, the researcher disabled the survey link to analyze the collected data. A total of 211 citizens completed the questionnaire; therefore, the sample size increased to 438 participants by the end of the second round. However, the analysis was based on 383 valid responses only. Out of 438 participants, 51 claimed they used at least one smart transportation mobile application in Oman. Therefore, they were eliminated from the analysis. It was also noticed that four were below 18 years old. Therefore 55 participants in total were discarded. After that, the researcher started importing the data into the SPSS and Smart-PLS software to start the analysis.

5.2.6.2.10 Quantitative Data Analysis Method: Structural Equation Modelling (SEM)

As the data collected at this research stage are quantitative, the researcher analyzed the gathered data using the quantitative IBM Statistical Package for Social Since (SPSS) version 26 and SmartPLS version 3.3.9 software. SPSS and Excel software were used to screen and clean the collected data and check the sampling adequacy. SPSS software is also used to conduct the initial data analysis, such as the descriptive statistics of each construct, to generate a rich understanding of the collected data. Later, SmartPLS software is used to conduct Structure Equation Modeling (SEM) to test the hypotheses developed for the current study.

SEM is described as a set of severe statistical analysis techniques which allows for capturing complex relations among studied variables (Teo, 2011). Kaplan (2009, p. 3) stated that SEM is "*a modelling of factor analysis and path analysis into one comprehensive statistical methodology*". It is also described by Byrne (2001, p. 3) as "*a statistical methodology that takes a confirmatory (i.e. hypothesis-testing) approach to the analysis of a structural theory bearing on some phenomenon*". The SEM technique has been adopted as the most suitable method to test the relation between dependent and independent variables in the current research for many reasons. Firstly, SEM is considered one of the most common tools used in social studies to measure users' acceptance (Bajaj and Nidumolu, 1998). It has been implemented in different Information System studies such as (Wang and Liao, 2008; Hair *et al.*, 2017). Secondly, SEM is one of the most valuable methods to directly measure both observed and unobserved variables such as human behaviour and intelligence (Lei and Wu, 2007; Byrne, 2015). For instance, height and weight can be directly measured, whereas it is not possible to measure an individual intelligence in the same way. As this research is designed to investigate citizens' perception of smart transportation mobile applications acceptance, most of the constructs are not observed easily. They can only be derived through measured variables. In the current study, the questionnaire instrument has been designed to measure citizens' acceptance of smart transportation mobile applications. Acceptance and other factors used in the current research are considered as not directly observed variables, and they need items to measure them. It is built based on the UTAUT2 model, and SEM is used to examine the theory against the data at hand. According to Loehlin (2004, p. 232), "*So long as we want to try to describe complex real-life phenomena as they occur in their natural settings, it seems that our chief alternatives are the literary essay and the path model*". Thirdly, SEM allows measurements of complicated relations among variables (Teo, 2011). SEM is assigned as the primary tool enabling the study of complex and multidimensional relationships through measuring, simulating and understanding relationships among all the variables to gain a complete view of the phenomena (Byrne, 2013). Multivariate linear regression is another method used to conduct statistical analysis; however, it is limited to examining only one outcome construct per time instead of testing relations across various outcome variables based on the entire proposed framework (Hair, Ringle and Sarstedt, 2013). Compared to multivariate linear regression, SEM performs regression on more than one variable simultaneously and evaluates the loading of a group of independent and dependent variables concurrently (Astrachan, Patel and Wanzenried, 2014). Thus, it enables validating complex models statistically in a simultaneous test of all variables to explore the degree to which the proposed framework is consistent with the data (Byrne, 2013). Fourth, SEM has the advantage of considering potential errors as an integrated part of the model by utilizing latent variables to measure and estimate errors. In contrast, other tools assume that all variables are tested without errors (Berkout, Gross and Young, 2014). Fifth, SEM allows testing the hypotheses incorporated with the proposed model at a construct level (Holbert and Stephenson, 2002). The proposed model in this research investigates a range of hypothesised linkages between two variables. According to Azlina and Jamaluddin (2010, p. 5), the main goal of SEM in model testing is to "*determine the goodness-of-fit between the hypothesized model and the sample data*". SEM enables conducting goodness of fit analysis for the assumed model, whereas such analysis is not possible with other tools. After forming a theory about a phenomenon, the theory is proved by empirical data to either accept or reject it. SEM employs confirmatory analysis, and the objective of the current study is to accept or reject the hypothesised relationship between the various model factors (Gates *et al.*, 2011). In summary, since the considered model in this study is complex, the regression test is not applicable, as testing such complex relationships is impossible.

5.2.6.2.11 Questionnaire Data Validity

Quantitative data should be evaluated with regard to validity and reliability. Hence the collected data are needed to be adequately measured to figure out any potential insufficiency to minimise any chance for errors in producing valid, accurate and confident results (Webb, 2009). According to Krathwohl (1993), the quality of the instrument and its validation is an essential step prior to the data analysis. In quantitative studies, the accuracy and trustworthiness of participants' answers can be easily influenced by various elements which later affect the findings' validity and reliability (Heale and Twycross, 2015). Concerning quantitative studies, validity and reliability are the two primary standards followed for well and convincing research outcomes (Mohajan, 2017). Validity is "*the extent to which differences in observed scale scores reflect true differences among objects on the characteristics being measured, rather than systematic or random error*" (Sukati and ALmashani, 2019, p. 321). Similarly, Imo (2017) considered validity as a phrase used to describe a measurement that correctly captures the principle it is meant to measure. Valid research truly emphasizes the world being described (Pedhazur and Schmelkin, 2013). Therefore, research validity is "*the degree to which a test measures what it claims, or purports, to be measuring*" (Brown, 2005, p. 231). There are various procedures and steps to achieve the trustfulness and validity of the study's findings (Creswell, 2014). There are four main tests to assess the validity of any quantitative research, including:

- Content validity refers to the extent to which the measurements and items adequately reflect the investigated questions (Polit and Beck, 2006). It shows the extent to which an item included in each scale can reflect the significance of the construct (Huizinga and Elliott, 1986; Malhotra *et al.*, 2006).
- Face validity answers the following question "whether a test appears to measure what it's supposed to measure" (Printha, 2022). It demonstrates that questionnaire or survey participants are aware of the information the research is seeking, and accordingly, they can contribute with rich information (Hardesty and Bearden, 2004).
- Criterion validity helps to correlate and conduct a comparison between the test with other available existing standard measures within the criteria to be accepted. It evaluates the degree to which an instrument reflects the latent construct (Hair *et al.*, 2014). This test is conducted when the study aims to understand the linkages between the test and a specific criterion of the construct (Dros, 2011). This validity is used when measuring the power of an instrument to predict future outcomes (Amirkhan, 1994). There are two assessments to meet criterion validity: concurrent and predictive validity. Concurrent validity is the agreement of the test data with criteria measures at the same time, whereas predictive validity is the extent to which a measure can predict the other measures of the same construct in the future.
- Construct validity: refers to the extent to which the assessment actually measures the presence of the constructs the researcher planned to test (Cooper and Schindler, 2008). There are two main construct validity types: convergent and discriminant. Convergent validity proves that two items in a construct are related and measuring the

same construct (Chin, 1998). Conversely, discriminant validity shows that the two measures do not correlate. Discriminant validity refers to the extent to which each construct differs from other constructs within the same theoretical framework (Lucas, Diener and Suh, 1996).

How the current research is planned to meet the requirements of each of these tests is discussed in detail in Chapter 7.

5.2.6.2.12 Questionnaire Data Reliability

One of the important steps in getting quality collected data is to test the collected data's validity, reliability and consistency (Williams, 2003). Bryman and Cramer (2004) argued that reliability involves two distinct aspects: internal and external. Regarding external reliability, it examines a research assessment tool's ability to produce stable and consistent results if the tests are administrated multiple times. In other words, the external reliability test indicates that when repeating the test over time to the same participants of subjects, the results are anticipated to be the same, and the group who scored high in the initial test will also achieve so when the test is re-administrated over the time (Mohajan, 2017). On the other hand, internal consistency is specifically vital when using a multiple-factor scale as it helps identify whether each individual scale is measuring a single idea and, consequently, if the various items that build the scale are internally consistent (Bryman and Cramer, 2004). Cronbach alpha is commonly used as an indicator of internal reliability coefficients of the collected data (Ercan *et al.*, 2007). As per this study, the researcher decided to follow Cronbach's alpha coefficient (α) to measure the internal consistency of the collected data (Sijtsma, 2009). According to Taber (2018. p.1), "*Cronbach's alpha is a statistic commonly quoted by authors to demonstrate that tests and scales that have been constructed or adopted for research projects are fit for purpose*". The Cronbach's coefficient is common in social science investigations to calculate the consistency and reliability of collected data (Sun *et al.*, 2007). It is a coefficient that ranges from 0.00 to 1.00, where 0.00 means there is no consistency at all and 1.00 reflects a perfect consistency among the collected data (Katz *et al.*, 2007; Verra *et al.*, 2012). Cronbach's coefficient with a value of 0.70 or higher is believed to be acceptable to approve the consistency of collected data as it shows that 70% of the variance in the scores is reliable variance (Tavakol and Dennick, 2011). On the other hand, getting a negative range means that the data's consistency is unacceptable, and it is inappropriate to estimate data based on them. The closer the value of Cronbach's alpha to 1, the more consistent and reliable the data are (Woollins, 1992; Gliem and Gliem, 2003).

5.3 Summary

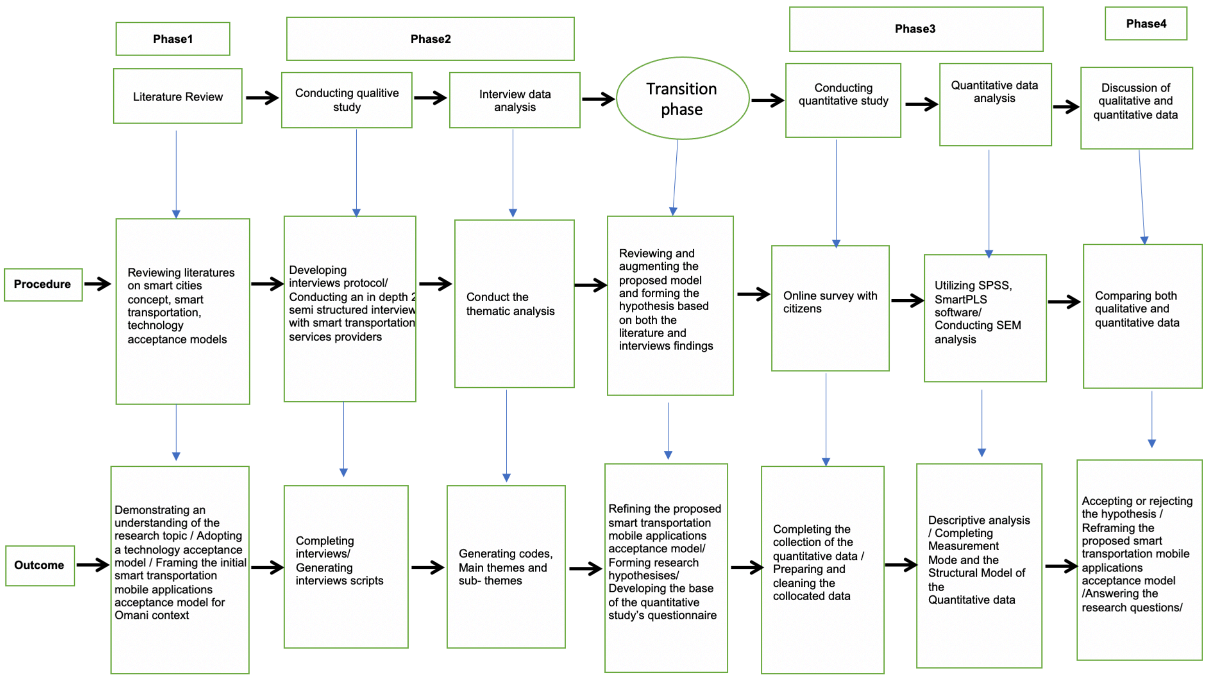
This chapter revealed the best techniques and approaches to answer the research questions. It involved an explanation of the various methods involved in data collection, the processes, and the tools adapted to analyse the collected data. Table 5.2 briefly explains the study's research design and methodology.

Table 5.2: Summary of the research's onion decision for the current study.

Layer number	Layer name	Adopted approach
First layer	Research philosophy	Pragmatism
Second layer	Approach to theory development	Abductive
Third layer	Methodology choice	A sequential mixed exploratory method.
Fourth layer	Strategies	A case study
Fifth layer	Time Horizon	Cross-sectional
Sixth layer	Techniques and producers	Semi-structured interviews- Thematic analysis Questionnaire- SEM analysis

Figure 5.2 represents the flowchart of the current research. It explains in detail all the phases involved in the current research, as discussed above.

Figure 5.2: The sequential mixed exploratory flowchart of the current research.



Chapter 6: Qualitative Study Analysis And Findings

6.1 Introduction

As mentioned in the methodology chapter, the study has adopted semi-structured interviews to gather qualitative data from smart transportation service providers regarding their perceptions about implementing such services and applications in Oman. The aim of conducting these preliminary interviews is to explore the smart transportation service providers' understanding of the factors influencing citizens' adoption of such applications. Thus, interviews help reveal service providers' understanding of the end user's acceptance of the smart transportation mobile applications and what is needed to support and facilitate their acceptance. Qualitative semi-structured interviews are also used to confirm the findings from the literature review chapter, besides also adding to the model. As a result, it was necessary to interview the service providers to reflect the current study's aims and objectives to better explore citizens' acceptance issues. Appendix C presents the details of the interview's question.

Four organisations have been involved in the qualitative data collection phase. After the development of the semi-structured interview guide, it was introduced to each participant prior to the interview to provide a chance for them to understand the interview's questions and to think about the study's focus. This also helped in allowing the participants to consider any doubts and concerns before undertaking the interview. The researcher conducted twenty interviews from July to September 2021. Each of these lasted between one hour and twenty minutes to thirty-eight minutes in length. The twenty interviewees were selected from different management levels, from managerial to operational. This was critical to guarantee the involvement of the main players in the implementation of smart transportation services to gather different perspectives on the factors influencing the adoption.

The ongoing research emphasises Oman, particularly the capital, Muscat, as the focal point and a case study of the ongoing research. The four organisations have been selected as sources where the interview participants are drawn. Thus, these four organisations are the organisations that demonstrated their willingness and commitment to providing the research with a selection of their staff members to be interviewed to collaborate in the success of exploring the factors influencing the acceptance of smart transportation mobile applications in the Omani context. As a result, these organisations are not the case study; instead, they are the organisations that approved their collaboration to be engaged in the research.

This chapter analyses the data collected from the in-depth semi-structured interviews. This analysis contributes to exploring smart transportation services providers' understanding of the smart transportation mobile applications adoption, exploring activities conducted by them to facilitate user acceptance, and the factors they believe in their abilities in influencing the utilisation. Accordingly, the results of this research will be directly and indirectly affected by the views and perceptions of smart transportation service providers. The data analysis and the main findings from the interviews are presented using the thematic analysis technique explained earlier in the research methodology chapter. The researcher divided the factors influencing citizens' acceptance into two main parts: traditional factors of the UTAUT2 model and factors extracted from the literature review and interviewees' perceptions. At the end of this chapter, the hypotheses will be developed based on the qualitative study's findings aligned with the literature review's findings. This section will also discuss and present the justification and the rationality for the study hypotheses in addition to explaining the relationships in the research framework.

6.2 Interviewee Sampling

One of the current thesis's main critical tasks was deciding on the most appropriate organisations and companies to be part of the qualitative study. The selected organisations are the main transportation services providers in The Sultanate. The chosen organisations are those who have implemented a smart transportation mobile application for their customers. Moreover, the selected organisations are from different backgrounds, sizes, structures, and types. The organisation's selection was limited only to those who agreed to participate in the current research. The following paragraphs briefly introduce the organisations involved in the study.

Organization A is a private organisation that implemented various smart technologies to help citizens reach their destinations through a smart booking application. This organisation is responsible for managing and organising all its smart projects by itself in cooperation with some other governmental agencies to obtain permits and some facilities related to their projects. Most of the projects of this company are directly related to the citizens, so including it in this study is a great benefit in obtaining valuable and exciting information. In total, six interviewees were involved from this organisation, including two Marketing Specialists (MS1 and MS2), an Operations Manager (OM1), a Taxi Driver (TD1), an Operation Support (OS1), and a Business Development Manager (BDM1).

Organisation B is an entity owned by the government, and it adopted smart technologies to make its services available anywhere, anytime and in a smart manner. It is responsible for many tasks in different sectors, and transportation is one of its main tasks. Its responsibilities include smart parking planning, parking reservations, and finding solutions for traffic congestion and road developments. Most of the road's designs and construction are implemented by this organisation, and many smart transportation projects have been assigned to it for implementation. Therefore, incorporating this organisation helps gather rich data regarding smart transportation services implementation. As this organisation is extensive and involves different units, the researcher selected the departments dealing only with smart transportation services. The following employees took part: a Director of Lighting and Traffic-light (DOLTL1), a Senior Application Specialist (SAS1), a Director General of Information System (DGOIS1), and a Landscape Architect (LA1).

Organisation C is also a national company belonging to the government which aims to provide attractive public transportation services, reduce city congestion, and provide safe and reliable transportation services in Oman. Recently this organisation has implemented a smart application to enhance citizens' experience with public transport services. As these services are designed to be directly used by the public, it is of great value to interview officials from this organisation to enhance the understanding of the acceptance of its smart transportation mobile application. Five participants from different departments within this organisation were interviewed: a Customer Experience Manager (CEM1), an Application Specialist (AS1), an Operation Control Centre Controller (OCCC1), a Public Service Supervisor (PSS1), and a Data Analysis Officer (DAO1).

Organization D is one of the main enforcement agencies owned by the government. In addition to controlling traffic on roads, it emphasises a variety of tasks, such as safeguarding security within the country. It is classified as a leading organisation in Oman to adopt smart technologies to provide quality services to Omani citizens and residents. It benefits its users by enabling various kinds of smart services. One of its main initiatives is developing a smart mobile application to enhance the accessibility of its services at any time. Its smart mobile application helps in providing instant information about accidents, allows enquiring about traffic offences, enables private vehicle registration, license renewal, locating nearby stations based on GPS and many other smart services. Five employees have been interviewed in this organisation: an Information Technology Support Specialist (ITSS1), the Head Of Information Technology (HOIT1), the Head of The Traffic Department (HOTD1), a Projects Manager (PM1), and a Software Engineer (SE1). Table 6.1 shows the key characteristics of each interviewee and how they have been coded before the semi-structured interview data analysis to protect their identities and confidentiality:

Table 6.1: Key demographic characteristics of interviewees and their code book

No	Organization Code	Gender	Interviewee title	Interviewee code
1	Organization A	Female	Marketing Specialist	MS1
2	Organization A	Male	Marketing Specialist	MS2
3	Organization A	Female	Operations Manager	OM1
4	Organization A	Male	Taxi Driver	TD1
5	Organization A	Female	Operation Support	OS1
6	Organization A	Male	Business Development Manager	BDM1
7	Organization B	Male	Director of Lighting and Traffic-light	DOLTL1
8	Organization B	Male	Senior Application Specialist	SAS1
9	Organization B	Male	Director General of Information System	DGOIS1
10	Organization B	Female	Landscape Architect	LA1
11	Organization C	Female	Customer Experience Manager	CEM1
12	Organization C	Female	Application Specialist	AS1
13	Organization C	Male	Public Service Supervisor	PSS1
14	Organization C	Male	Operation Control Centre Controller	OCCC1
15	Organization C	Male	Data Analysis Officer	DAO1
16	Organization D	Female	Information Technology Support Specialist	ITSS1
17	Organization D	Female	Head Of Information Technology	HOIT1
18	Organization D	Male	Head of Traffic Department	HOTD1
19	Organization D	Male	Software Engineer	SE1
20	Organization D	Male	Projects Manager	PM1

6.3 Themes Arisen from the Qualitative Study

To analyse interview data, the researcher has adopted the steps administrated by Braun and Clarke (2006) in developing themes and subthemes. After following all the steps (which are mentioned in detail in Chapter 5) in analysing the qualitative data, the main themes and sub-themes emerged.

The analysis of the entire qualitative data revealed around ten distinct themes, most of which are comprised of other subthemes. Although the main themes and subthemes have emerged freely from the interview's qualitative data analysis, many also embraced the main issues that appeared previously in the literature review chapter and the traditional UTAUT2 model. In other words, the literature review chapter and the technology acceptance models have provided the researcher with a guideline to be used in the analysis and presentation of the themes. However, the author did not mainly depend only on the issues that appeared in the literature; instead, the author was very serious about driving the final themes from the interview data analysis and then presenting, naming, and organising them by using the findings from the literature review chapter. Table 6.2 shows all the themes and sub-themes that appeared from the analysis. The below table also include the frequency of occurrence for each subthemes to gain insights into the significance of each subthemes.

Table 6.2: The main themes and sub-themes emerged from interviews qualitative data analysis

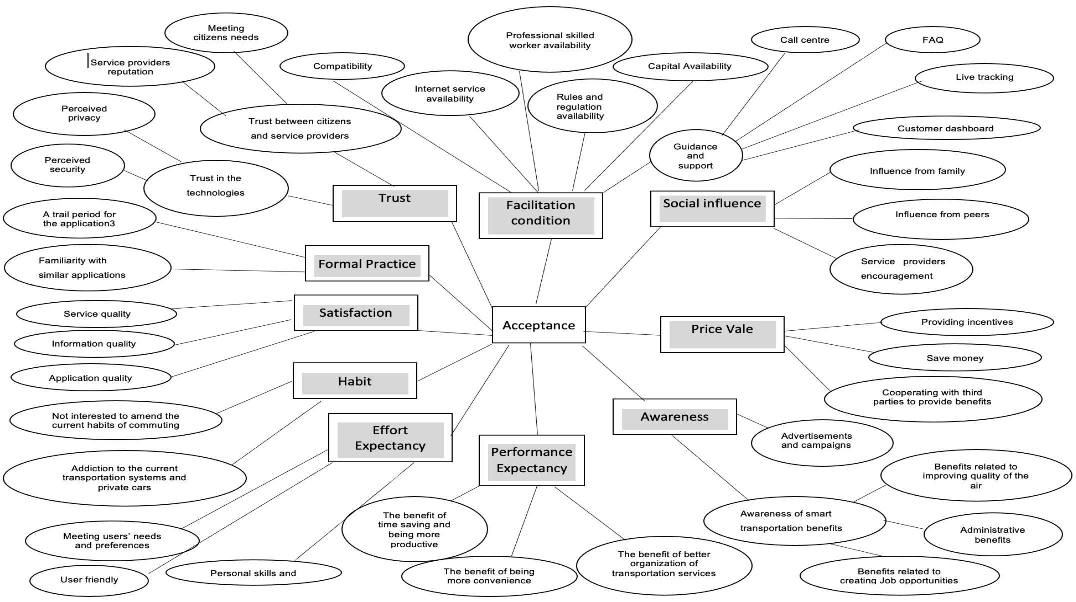
No	Main-Themes	Sub-themes		Actual number of occurrences
1	Performance Expectancy (PE)	The benefit of greater convenience		(11)
		The benefit of saving time and being more productive		(16)
		The benefit of better organisation of transportation services		(13)
2	Effort Expectancy (EE)	User friendly		(17)
		Personal skills and knowledge		(12)
		Meeting users' needs and preferences		(07)
3	Social Influence (SI)	Influence from peers		(14)
		Influence from family members		(17)
		Service providers encouragement		(06)
4	Habit (HB)	Not interested to amend the current habits of commuting		(08)
		Addiction to the current transportation systems and private cars		(09)
5	Price Value (PV)	Providing incentives		(15)
		Saving money		(17)
		Cooperating with third parties to provide benefits		(12)
6	Facilitating Conditions (FC)	Guidance and support	▪ Call centre	(09)
			▪ Customer dashboard	(05)
			▪ Live tracking	(11)
			▪ Frequently Asked Questions (FAQ)	(06)
		Compatibility		(15)
		Internet service availability		(16)
		Rules and regulation availability		(08)
		Capital availability		(14)
		Professional skilled worker availability		(08)
7	Trust (TR)	Trust between citizens and service providers	▪ Services providers reputation	(07)
			▪ Meeting citizens needs	(09)

		Trust in technologies	▪ Perceived security	(15)
			▪ Perceived privacy	(17)
8	Satisfaction (SAF)	Application quality		(10)
		Information quality		(09)
		Service quality		(14)
9	Awareness (AW)	Awareness of smart transportation benefits	▪ Benefits related to improving quality of the air	(05)
			▪ Administrative benefits	(07)
			▪ Benefits related to creating Job opportunities	(10)
		Advertisements and campaigns		(17)
10	Formal Practice (FP)	A trail period for the smart transportation Application		(07)
		Familiarity with similar applications		(05)

Note: PE: Performance Expectancy; EE: Effort Expectancy; SI: Social Influence; FC: Facilitating Conditions; PV: Price Value, HB: Habit; TR: Trust; SAF: Satisfaction; FP: Former practice; AW: Awareness; BI: Behavioural Intention

Moreover, Figure 6.1 indicates the thematic map of the main themes and subthemes illustrated in the above table and will be discussed in detail in Section 6.4.

Figure 6.1: The thematic map of the preliminary qualitative data



6.4 Original Factors From The Traditional UTAUT2 Model

6.4.1 Performance Expectancy (PE)

The UTAUT2 model suggests that the adoption of new technologies and applications is directly influenced by performance expectancy (PE). Performance Expectancy (PE) is understood as the extent to which citizens think smart transportation mobile applications would be helpful and beneficial in improving the quality of their daily commuting. In response to the reasons for adopting smart transportation mobile applications, service providers have raised different benefits and how such applications bring various advantages to the citizens in their daily commuting decision-making. Based on the interview data analysis, the following themes and subthemes emerged with regard to this construct:

- **The benefit of greater convenience**

Most service providers who have been interviewed acknowledged the usefulness of smart transportation mobile applications in improving the travelling and transportation experience by making commuting more convenient. The analysis of interview data showed different challenges regarding the overall public transportation services situation in Oman, which make them inconvenient and discouraging among citizens. For instance, it was reported by an employee in organisation A working as an Operation Support (OS1) that smart transportation mobile applications are more convenient as people are not forced to leave their houses or offices to seek taxis on highways. She further argued that:

> *"Previously, with the absence of smart transportation mobile applications, citizens had to leave their houses, endure the high temperature and walk long distances to reach the main roads, where they could stop a taxi. Depending on their lucks, this process might take from half an hour to an hour"* (OS1).

A taxi driver (TD1) from organisation A also raised the same idea, who stated:

> *"In Oman, apart from malls, airports and few famous places, there are no properly designed points to request taxis or catch a public transport as the process of catching a taxi is random [……], requesting a taxi is a problem as there is no dedicated passengers' pick up and drop off areas" (*TD1).

Likewise, The Operation Control Centre Controller in Organisation C (OCCC1) stated that placing bus stations only near main highways streets and the absence of pedestrian corridors to reach them constitute an obstacle to citizens' accessing them, as most of their houses are located away from the high streets. He argued:

> *"In addition to building the public transportation stations in inconvenient locations, most of these stations lack shades, shelter, and chairs for passengers. Moreover, the absence of air conditioning has also contributed to reducing their attractiveness and acceptance by citizens as Oman is known for its very hot weather throughout the year"* (OCCC1).

On the other hand, the new smart transportation mobile applications have contributed to improving commuters' experiences by offering a range of convenient facilities to their users, as mentioned by the Marketing Specialist in organisation A (MS1):

> *"Our smart taxi application helps riders by providing them with instant access to information about their routes and trips. Moreover, the app sends passengers notifications about service changes so they can plan their journey accordingly"* (MS1).

It is widely recognised from the interview data that convenience is one of the main benefits of smart transportation services, as mentioned by most of the smart transportation service providers interviewed. Most of the interview responses stated that such applications are powerful not only for the citizens but also for the service providers. The Data Analysis Officer in Organisation C (DAO1) said:

> *"The marketing of our smart transportation application depends mainly on highlighting how these applications make people's lives more convenient. For example, our smart application helps improve the travelling experience by letting passengers know about the public buses' arrival and departure timing while at home. Further, our smart application allows riders quick access to the trip plans option to help them choose the best route for them"* (DAO1).

An Operations Manager in Organisation A reported:

> *"Allowing the riders to track their taxis while they travel all the route toward them helps the commuters to count down the time till their arrivals and therefore reduce the waiting time under heat"* (OM1).

- **The benefit of saving time and being more productive**

Most of the service providers interviewed stated that smart transportation mobile applications help save time for both smart transportation service providers and passengers. A Taxi Driver from organisation A reported that according to the customer's feedback, significant benefits are recorded in the area of time-saving after the adoption of the smart transportation mobile application. The Head of the Traffic Department in organisation D (HOTD1) commented that posting live information about the traffic on roads helps travellers in making more informed decisions about which route to choose to arrive faster to their destinations by providing them with information about the estimated travel time for each road beside giving information about the traffic. Similarly, a Taxi Driver from organisation A (TD1) stated that such applications help service providers too. He stated that:

> *"As a driver, automation of most of the taxis requests helps in receiving requests and accepting payments online while also enhancing familiarity with the shortest and less crowded route through smart mobile applications. This automation, therefore, helps save time to serve more customers…."* (TD1).

Also, a Data Analysis Officer from Organisation C (DAO1) argued that:

> *"By enriching riders with real-time data about the traffic, seat availability, timing, the current location of the buses and the needed time to reach a particular stop, they do not need to wait at length in hot weather for their taxis or buses, but instead they can walk outside when their transportation method is only one minute away"* (DAO1).

Moreover, the Director of Lighting and Traffic-light (DOLTL1) in organisation B complained that the old car parking system in Oman has contributed to extensive wastage of time besides also contributing to the driver's frustration as they might not have the necessary coins used to book parking slots. On the other hand, The Information Technology Support Specialist (ITSS1) argued that allowing consumers to apply for and pay for their car parking through smart mobile applications contributed to saving time spent searching for car parking meter machines to pay for a parking slot. As a result, Oman is planning to remove most of the parking meters machines, and instead, car owners are encouraged to use either smart mobile applications or SMS services to pay their parking fees. This will help optimise the use of scarce resources such as time and fuels, as stated by the Director of Lighting and Traffic-light (DOLTL1).

Many service providers mentioned that smart transportation mobile applications help passengers and service providers become more productive. The Landscape Architect from organisation B (LA1) argued that busy roads cause delays that indirectly affect the financial situation and quality of life. She further explained that most of Oman's existing roads are difficult to be expanded. Accordingly, the only available solution is to think smart and improve the capacity of these roads by implementing smart technologies and solutions. Also, most of the interviewees from Organisation A stated that taxi drivers would save energy and time by using smart mobile applications as they would not need to roam randomly in their search for passengers. According to a Marketing Specialist from Organization A (MS1):

> *"……the smart mobile application help drivers to serve more customers by reducing the waiting time between the rides, which consequently contributes to making more money" (*MS1*).*

Many service providers from organisations A and C who were interviewed agreed that smart transportation mobile applications help passengers feel more relaxed and enjoy completing their work while on board by allowing public transportation drivers to deal with the congestion. The Operation Control Centre Controller in Organization C (OCCC1) stated that:

> *"Overcrowded roads in Oman are very common these days, and many people started to lose their patience and become bored, angry, and anxious in the traffic congestion points. However, some smart transportation mobile applications help passengers feel more relaxed, boost their mental health and enjoy having a longer time to complete their other tasks while on board"* (OCCC1).

The interview data has also revealed that cities' efficiency and productivity can be improved by connecting a city's infrastructure with smart technologies such as IoT to produce real-time data. The live information generated by smart technologies helps in predicting and recommending actions for effective and improved reactions. Moreover, this will further enhance citizens' safety, improve emergency management, and steer drivers away from possible closings of streets due to many reasons, for example, rains and cyclones.

- **The benefit of better organisation of transportation services**

The majority of the service providers agreed that the implementation of smart technologies in transportation services helped them organise their work better. They claimed that getting rapid and live notifications of the trouble spots and the congestion on the city streets helped them respond rapidly and react more effectively to the different road emergency cases. The Taxi Driver (TD1) from organisation A commented that his organisation's smart mobile transportation application keeps passengers and drivers organised throughout the trip. For example, it helps keep records of the travelling time, and departure point, track the journey and monitor the drivers. A Data Analysis Officer from organisation C (DAO1) supported this idea by commenting:

> *" …….. Our smart transportation mobile application provides rich and detailed information on different aspects of our business. Such detailed information helped us better control our operating, inspecting, maintaining, and repairing needs. […..] it also helps us to detect the main problems needed to be fixed to improve the business and its services"* (DAO1).

Many interviewees from organisations A and C agreed that by implementing smart transportation mobile applications, passengers could track their trips and figure out the exact time of public transportation arrival and departure. An Operations Manager (OM1) from organisation A argued that knowing the exact time of the public transport arrival and departure will help customers manage their schedule accordingly and therefore avoid wasting time, effort, and money. She further remarked:

> *"The availability of smart transportation applications is an excellent opportunity to protect customers' rights; for example, payment through applications protects their rights, which drivers cannot judge or steal. Also, allowing passengers to follow the trip path through our smart application provides them with more safety in terms of their ability to follow the path of their trip comfortably"* (OM1).

Similarly, The Head Of Information Technology (HOIT1) in Organisation D reported:

> *"For example, surveillance devices and other smart services which rely mainly on smart technologies such as artificial intelligence have contributed to providing real-time data which contributed to enhancing a better management and operation while also troubleshooting the problems remotely and effectively"* (HOIT1).

6.4.2 Effort Expectancy (EE)

Venkatesh et al. (2003) defined effort expectancy as how easy it is to adopt new technology. The following paragraphs determine the service providers' perspectives of the construct of effort expectancy associated with the UTAUT2 model regarding the degree of ease related to the citizen's adoption of the smart transportation mobile applications.

- **User friendly**

Most service providers argued that complicated smart transportation mobile application designs are expected to require serious efforts to learn, use and implement. For example, the Head of Information Technology of Organization D (HOIT1) stated that having smart transportation applications available for mobile and tablet computers makes them attractive and motivates various citizens to adopt them. Having transportation applications installed in their mobile phones allows them to check traffic, make decisions and order taxis easily from wherever they are. This view was further supported by a group of interviewees, such as a Project Manager in Organization D (PM1), who discussed that:

> *"When we first introduced our smart transportation mobile application to the market, it was one of the first of its kind in the Omani market. Therefore, its adoption was uncertain. [……….]. On the other hand, the smart transportation mobile application itself is considered another challenge. For example, sometimes citizens find the instruction to install the application, the processes to be followed to register, the navigation around the application and the payment processes are complicated. Such factors often lead users to give up using the application"* (PM1).

The Software Engineer in organisation D (SE1) mentioned that:

> *"The first impression is the last impression; therefore, in our organisation, we had worked hard in developing our smart application interface by enhancing our application with arrows, buttons and graphics that can improve our overall application design, interface and impression"* (SE1).

Most interview members indicated that the more complicated the transportation applications are, the more improved and upgraded services and features they can offer. However, on the other hand, a Marketing Specialist (MS2) from organisation A argued that such new complicated features and functions might influence users' experiences with the application layout and usability as they may become more challenging to use. He stated that:

> *" […..] most of the customers have short focus abilities and designing the application in a complex way makes it difficult for them to navigate within it. Consequently, this makes them lose interest quickly and often look for other substitutes which are easier and more direct. [………..] Customers always prefer to use applications with easy steps that make it easy for them to access the required information with less effort and faster ways"* (MS2).

Moreover, the Director of Lighting and Traffic-light (DOLTL1) from organisation B discussed that providing updated, accurate and valuable information within the application, such as accurate traffic information coupled with easy and straightforward steps to accomplish a task, helps provide a positive interaction with the application. Similarly, an Operation Control Centre Controller of Organization C (OCCC1) noted that simplifying the interaction between the users and application makes the processes more convenient and accordingly enhances delivering comprehensive services and functions. An Information Technology Support Specialist (ITSS1) from organisation D stated that providing the autofill feature into their smart transportation mobile application has made their users' lives easier as it contributes to making the process of filling forms and fields faster.

Based on the above discussion, user-friendly and straightforward processes are considered critical factors affecting users' adoption and acceptance of smart transportation mobile applications. This finding is considered consistent with the meaning of effort expectancy. The analysis from the above discussion proved that complex interactions between the smart transportation mobile applications and their end users may cause negative experiences and, therefore, could directly influence their perceptions of the applications. Users, thus, may consider them confusing, especially if they need significant effort and time to learn and use. Consequently, they may refuse to employ them in their daily commuting.

- **Personal skills and knowledge**

Another group of service providers argued that the effort needed to use a smart transportation mobile application depends mainly on the end user's background. In this respect, an Information Technology Support Specialist (ITSS1) from organisation D stressed:

> *"Before designing any mobile applications, including smart transportation mobile applications, it is essential to study their end users as they are the ones who accordingly the functionality of the applications will be decided"* (ITSS1).

A Senior Application Specialist in organisation B (SAS1) commented:

> *"I believe that our smart transportation mobile application features are basic and straightforward. However, learning new features and services takes time, depending on the end users' background and education level. [……..] generally talking, users with good IT and technical backgrounds are expected to know such tools and features previously and accordingly will need less time and effort to adopt, while people with less education and technical skills may require more time to learn and explore the new features*" (SAS1).

On the other hand, an Application Specialist (AS1) from organisation C argued that citizens would hesitate to adopt smart transportation mobile applications, especially if they demand them to learn considerable skills and knowledge. In addition, Operation Support in Organisation A (OS1) claimed that most of the services within their smart transportation mobile application are easy to follow and remember, especially after accumulated usage. Accordingly, less effort and skills will be needed for future use. A Director of Lighting and Traffic-light (DOLTL1) from organisation B declared that:

> *"I believe that most smart transportation mobile applications users are from both elders and younger people, with many having limited ICT skills. Accordingly, I*

believe they should be designed to target all groups of users, especially those with limited skills, experience and even those without educational qualifications" (DOLTL1).

- **Meeting users' needs and preferences**

Clear and understandable interaction is considered critical in accepting smart transportation mobile applications. Many authors emphasised that user acceptance of smart transportation mobile applications is affected by their experience of interaction with the applications. For example, Consolvo, Arnstein and Franza (2002) argued that users' needs and preferences should be considered while designing smart applications to enhance their acceptance. Likewise, many interviewees argued that designing applications based on users' preferences is essential. For example, an Application Specialist in organisation C (AS1) commented that providing both language options, namely Arabic and English, simplifies communication with the application without any language difficulty or needing help to interact. Likewise, an Operation Support (OS1) in Organization A said:

> *"Our smart transportation mobile application offers its users options for choosing what meets their needs. For example, it allows them to choose the payment method from cash, debt, and credit cards"* (OS1).

Also, a Taxi Driver (TD1) from organisation A said:

> *"Giving the passengers a chance to be flexible by deciding the location of pick up and drop off is very valuable to them. Also, choosing the car's model to serve them is another privilege available by our company"* (TD1).

6.4.3 Social Influence (SI)

Social influence surrounding a specific technology is shown to influence customers' intention to use and adopt new technologies. It is expected to significantly impact people's perceptions of the mobile services (Nysveen et al. 2005). When new technologies emerge, individuals often try to communicate with other members of society, especially those in their circles or at the same social levels, to reduce the uncertainty and fears related to adopting such new technologies (Karahanna, Straub, and Chervany 1999). Citizens' acceptance and adoption of new technologies and innovations depend on the information they receive from others about the quality and risk associated with adopting these technologies, ideas and products (Keong et al. 2012). The perception of individuals can be influenced in different ways depending on the kind of information they receive from families, friends, and other people in society. For example, in the context of an organisation, adopting a new innovation or technology is easier as employees are directly influenced by their colleagues' perceptions and rely upon them in constructing their behavioural intention (Talukder and Quazi 2011). On the other hand, considering the smart transportation mobile applications context, citizens are affected by almost the entire population, such as their relatives, friends and other people surrounding them. With this regard, interviews analysis has revealed the following themes and subthemes:

- **Influence from peers**

Peers are defined as "*a person who is equal to another in abilities, qualifications, age, background, and social status*" (RLC Newsletter 2013, 1). Therefore, peers are referred to as a person's friends, co-workers and any other person they are familiar. Many of the participants interviewed from the four organisations indicated that citizens are sensitive to the thoughts and ideas they receive from their peers. They considered this influence as one of the key factors shaping their intention to accept smart transportation mobile applications. It has been mentioned earlier in the literature review chapter that Omani culture is more collectives. Accordingly, the social relationship between individuals' ties is very strong, and most of the time, people join solid, cohesive groups. The dominance of individualism or collectivism in any culture affects the acceptance of new technologies (Bagchi, Hart, and Peterson 2004). This means that if one person is using new technology in Oman, people surrounding this person and who are within their network most probably feel influenced. The Public Service Supervisor in Organization C (PSS1) commented:

> *"Personally, if I find a friend using a new technology or an application, this will affect my decision and encourage me to adopt it, especially if this friend advised me to do so. I will consider adopting it as I always trust my friends' feedback and recommendations"* (PSS1).

Similarly, An Information Technology Support Specialist in organisation D (ITSS1) claimed that:

> *"Friends usually indirectly pressure their peers to own and try out new products. For example, when someone around you starts using a new technology, automatically, everyone expects that you will also embrace this technology sooner or later. One of my colleagues was used to traditional ways of ordering taxis, and later his friends influenced him to adopt an online taxi application. His friends helped him to change his lifestyle and assisted him to master the best use of this application by teaching him how to order a taxi, pay, track the order and insert feedback online"* (ITSS1).

Peers are usually more excited about introducing the innovations and products they are using in light of their fulfilling experience with them. The Marketing Specialist in Organization A (MS1) stated:

> *"Advertising and promotions play a large role in communicating information and benefits of new products to persuade people to buy them. But in fact, it is difficult for people to perceive and believe these benefits unless they try and use them by themselves, so some companies use rewards to convince people to adopt them.*

Once they are convinced and satisfied with the product quality, they will informally offer them to others to use them" (MS1).

On the other hand, people are following their peers, which is true not only with regard to their positive suggestions but also about their negative experiences. Two respondents mentioned that when someone publishes a bad experience using a specific technology, it will often affect the rest of the people. This opposite effect will quickly spread among different circles. The Projects Manager in Organization D said (PM1):

> "*The reluctance of some people to adopt new technologies can affect the rest of the users because such resistance may raise doubts about the quality and validity of the product, and gradually the number of adopters will decrease. This is what is currently happening with the Covid-19 vaccine, as the doubt and reluctance of a certain group raise fears among other members in their circles and thus affected the extent to which people accept it*". (PM1).

From the above discussion, it can be summarised that peers play a vital role in influencing other citizens' perceptions of using smart transportation mobile applications in their daily lives. They have a direct impact on people's willingness to use them.

- **Influence from family members**

Tucker (2011) conducted a study to investigate the main groups that influence adults in adopting new technologies and found that adults are mainly influenced by their friends in the first place, followed by their families. Likewise, most interviewees insist on the importance of families' influence in adopting mobile transportation applications in a smart city context. The Director of Lighting and Traffic-light (DOLTL1) in organisation B argued:

> *"People always try to rely on trusted sources to guarantee quality information. Since family members are closest people to a person and are among the most important people in any individual life, people always count on the feedback and experience they receive from them"* (DOLTL1).

In the Arab culture, elderlies are treated with great respect, not only by members of their families but also by all members of society. Although they are exempted from any physical effort, most middle-aged and young people turn to them for their opinions and thoughts (Ibrahim and Bayen 2019). Oman, as an Arab country, is no different from other Arab cultures in which children are taught to respect and listen to their parents and older people. This implies that a family member is more likely to adopt new technology as long as it has been implemented by at least one of the elder members of their family. Similarly, a Data Analysis Officer in Organization C argued that (DAO1):

> *"The final stage of running our smart application before releasing it to the public was testing it. Therefore, after building our application and completing the design by our team, universities students were consulted to start using it as an*

experimental stage before making it available to the public to obtain feedback from them before the final launch. This, on the one hand, has helped identify the problems from the end users' prospects that could be impossible to obtain from the application's developers and contributed to ensuring their positive feedback to the rest of the society on the other hand" (DAO1).

A Public Service Supervisor in Organization C (PSS1) stated that introducing the application to families and hearing from them before launching is critical as they will start recommending it to other families if satisfied. Likewise, A Customer Experience Manager (CEM1) in Organization C claimed that if our families are satisfied, this positive impact will spread slowly to other families, and eventually, the mobile application will become more popular and trusted among families. She further mentioned that if the application is issued and originated by a trusted party, most family members will have no issues trying it. Of her experience in this area she indicated:

"When I started using a smart transportation mobile application for commuting and locating the best route to follow, paying my fines and book parking, my brother and other relatives got influenced, and after my recommendations, they took in their accounts to use them as they trust my opinion" (CEM1).

Based on the above discussion and the analysis of the service providers' perceptions, it is notable that families strongly influence the adoption of smart transportation mobile applications. The positive experiences of these smart applications by a family member would enhance their use and acceptance by the rest of the family members.

- **Service providers encouragement**

Many officials from the selected four organisations have encouraged citizens to use smart transportation mobile applications to enhance their commuting process. Yet, the Covid-19 pandemic has severely restricted countries, resources, companies, citizens and economies around the world (E. Chen, Lerman, and Ferrara 2020). It has also impacted almost every aspect of citizens' lives by issuing social distances, self-quarantine, business closures, and more restrictions on visiting governmental organisations (Lades et al. 2020). Therefore, in the context of the ongoing research, citizens have started using some smart transportation mobile applications because some of these applications have become compulsory to accomplish some main tasks during the Covid-19 pandemic. The Head of the traffic department in organisation D (HOTD1) said:

"Due to Covid-19, many departments and sections have been closed temporarily, and citizens were encouraged to adopt our organisation's smart mobile application along with our website to get the services. For example, vehicle registration, vehicle renewal, driving licence renewable, exchange of the eligible foreign licence, traffic offence payment and many other services are available through our organisation's smart application. Consequently, the organisation has made the usage of the smart

mobile application mandatory and enforced by the top-level management to reduce the spread of the virus. However, we believe this will become a culture even after the pandemic is over. After realising their benefits, everyone will prefer to use the smart application instead of consuming time to visit the organisation" (HOTD1).

On the other hand, although the Software Engineer in Organization D (SE1) mentioned that adoption and implementation of their smart transportation mobile application are not mandatory, using the smart application of the company became a social norm as most of the instructions, applications forms, visa payments and tracking are available mainly through the smart mobile application. Likewise, a Director General of Information Systems (DGOIS1) from organisation B said that:

> *"The lack of means to pay parking fees easily in the various locations subject to fees, in addition to the need for the availability of coins with a certain financial value, made paying by traditional methods difficult for the users where they need to walk a distance in the sun and heat only to reach the payment device, which may be out of service sometimes. This indirectly encourages* citizens to use our smart mobile application as it is easy, fast and does not take seconds" (DGOIS1).

6.4.4 Facilitating Conditions (FC)

Regarding this study, facilitating condition is the end users' perceptions of the availability of knowledge, skills, and technical infrastructure to support the smart transportation mobile applications adoption (Venkatesh, Thong, and Xu 2012a). The following themes and subthemes have emerged from the investigation of the perceptions of smart transportation services providers:

- **Guidance and support**

According to the analysis of the interview data, most participants agreed that training and facilitating activities are essential in guiding users and enhancing their usage experiences. Izarul, Syed and Nayan (2020) argued that most customers would ditch a service if they received a bad or unexpected level of service. With this in mind, most of the service providers being interviewed agreed that their organisations are attuned to the quality of customer service they offer to their users and are reviewing them consistently to seek improvements. They mention the following supportive activities and guidance:

  - The Call centres

The call centre is considered one of the well-managed methods helping organisations land new customers while retaining old ones (Russel 2008). Although many studies agreed on the importance of the call centre as a vital tool in serving customers, a Customer Experience Manager (CEM1) from organisation C declared that they needed to improve this service within their organisation. She stated that although they have launched it, they are willing to improve it in the coming future to support customers in operating the application effectively and efficiently. On the other hand, a Business Development Manager (BDM1) from organisation A declared that:

> "*Currently, we mainly depend on the call centre tool as a main method to serve our customers. In our company, we believe that the call centre works as an ambassador to reflect and maintain a bright image of our company in the eyes of our smart application users. [……..] Our company's call numbers are available even on our taxis, and we are available 24/7, to receive calls and listen to our customer's concerns and solve them. Because we do not neglect any call we receive and due to our good reputation for quick response to our customer's calls, this makes them trust this method as the best way to communicate with us"* (BDM1).

Likewise, an interviewee from Organisation A said:

> *"In our organisation, we understand the value of instant and direct interaction with the customer, and therefore we are paying critical attention to providing proper communications channels with the customers. Our customer service staff are trained to respond promptly to complaints and inquiries. Our employees are trained not to ignore any query and communicate with the customers who ranked our services low to understand the reason behind their evaluation"* (BDM1).

- Customer dashboard

Another facilitating conditions tool most smart transportation mobile applications are offering to their customers these days is the customer dashboard (Pauwels et al. 2009). Such dashboards help organisations by providing them with guidance on making informed decisions related to promotional activities. In addition, it contributes to users by working as a profile account where they can check their buying history and get access to their past orders (Velcu-Laitinen and Yigitbasioglu 2012). Creating logs for customers with all their past interactions, including chats and emails, helps reference them via transcript whenever needed. This results in customers feeling valuable, showing that firms remember and care about them.

Customer dashboards are offered by three of the organisations involved in this study, namely organisations A, C and D, where they have mentioned that the citizens usually use such dashboards to track orders and by the service providers to monitor the quality of the services offered. A Public Service Supervise (PSS1) in Organization C said:

> "*As our smart transportation mobile application represents the first exposure to our company, we tried to make it personal and user-friendly. In other words, we focused on providing our customers with the best experience by ensuring they can utilise all our services. […….] dashboards are used to analyse the different problems accruing and the best approaches to solve them, to make better business*

development plans, improving the efficiency and effectiveness of the decisions taken, and to communicate with customers and coordinate their orders" (PSS1).

- Live Tracking

Live tracking is considered one of the most highly recommended types of assistance that positively impacts the usage of smart transportation mobile applications, as agreed by most service providers interviewed. For example, a Business Development Manager (BDM1) in Organization A stated that live taxi tracking is essential as it helps passengers track their current locations. He further elaborated that live taxi tracking is vital in Oman as with the present situation booking a taxi service is that passengers call taxis on the street based on their luck and experiences. It is considered time-consuming for both passengers and taxi drivers. He further argued that most of the time, passengers are not aware of the places of the nearby taxis as taxis can be requested only at the hot spots of the city while neglecting the rural areas. Most of the service providers interviewed from this organisation believed that live tracking was the main method of solving the above challenges. For example, the Marketing Specialist (MS1) who is responsible for the services standards in organisation A stated that:

> "With smart transportation mobile applications, *passengers can easily avail a taxi by pressing a single button in which GPS systems work to direct the request to the nearest taxi. Passengers are also provided with the expected time of arrival, the driver's data and the car's data. Therefore, they are not forced to stand outside in the hot weather waiting for the taxi to arrive; instead, people decide where to wait for their taxis"* (MS1).

An Application Specialist (AS1) from organisation C stated that:

> *"Live tracking allows generating real-time data which the bus drivers can use to take immediate actions. This information is used to adjust the buses schedules and routes"* (AS1).

- Frequently Asked Questions (FAQ)

FAQ is a page designed for customers to easily find the answers to the most asked questions about a company's services, products and business at their convenience (Singh, 2002). According to many researchers, the FAQ facility has different advantages, such as building trust by proving to the customers that you do understand their challenges and paying attention to enhancing their experience by simplifying the process of locating answers to their doubts instead of consuming time by searching over the entire site (Kongthon et al. 2009; Heo and Lee 2018; Tsuda et al. 2012). FAQ also helps in saving time and money spent on answering calls or replying to emails received by the support staff and subsequently relieving the stress assigned to them (Giarratana 2017). Some interviewees pointed out the importance of FAQs in improving customers' experiences with smart transportation mobile applications. For example, an Operations Manager in Organization A (OM1) mentioned that:

"Customers most often keep asking the same questions, for example, doubts about our services, how to pay fees, available payment methods and order cancellation. Later we realised that if we do not answer these questions clearly, we will keep receiving the same questions repeatedly, which may affect the quality of the services and waste our time and money. Therefore, our organisation decided to *create a comprehensive FAQ in which we answer the possible number of repeated questions. We also conducted brainstorming sessions to extract all other possible questions to save time and effort for both parties, we as service providers and passengers as consumers for our services"* (OM1).

- **Compatibility**

Some interviewees declared that they built their smart transportation mobile application to be compatible with most smartphones, allowing end users to use them with high quality. Also, some participants of the service providers argued that if users have any further issues, they can visit the organisations where they can get all support. A Data Analysis Officer (DAO1) from organisation C argued that:

"During the trial period, we received some comments about some problems in browsing the application with specific kinds of browsers. Therefore, the mobile application has been reconsidered to solve such issues" (DAO1).

Similarly, a Senior Application Specialist (SAS1) from organisation B said:

"I prefer using Windows browser over macOS most of the time as most of the feedbacks demonstrate its limitations in terms of performance and compatibility" (SAS1).

A Software Engineer (SE1) from organisation D complained that receiving a message saying that this application cannot be run on a device is the worst thing as that might be the only device a customer has.

- **Internet service availability**

Information Technology Authority (ITA) is responsible for implementing IT infrastructure projects in Oman (The Ministry of Technology and Communications 2019). ITA is also accountable for setting up infrastructure such as servers, networks, and storage to meet the main IT infrastructure requirements of the various projects implemented in Oman. Oman has been seriously investing in IT infrastructure as it represents a driving force in its economic diversification and growth (Ashrafi and Murtaza 2008). However, most interviewees argued that government needs to pay more attention to internet service quality and speed. For example, the Operation Control Centre Controller in Organization C (OCCC1) argued that:

"Internet in Oman is not very cheap, and currently, there are only two main service providers, Omantel and Ooredoo, which are fair enough. However, the rates of personal internet packages range from 22 to 25 OMR per month, which is

considered too high compared to other GCC countries. The internet service is slow and does not cover the rural areas in Oman" (OCCC1).

Most service providers had the same concept about internet quality in Oman and argued that this would affect their businesses in many ways. For instance, a Director General of Information Systems from organisation B (DGOIS1) said that the slow Internet directly affects their organisation's productivity as their application depends on complicated tools and a variety of cloud-based systems which rely on fast internet to work efficiently and effectively. An Information Technology Support Specialist from organisation D (ITSS1) noted that a slow internet connection also influences their ability to serve their customers professionally. She further argued that today many customers are served by streaming videos, screen sharing, or other digital forms of serving customers, yet implementing such customer service options requires high internet speeds. An Application Specialist (AS1) from organisation C complained that the more customers start using our smart mobile application to check the timing and book tickets, the slower the application becomes due to the bandwidth needed to be split among a more significant number of customers.

It is apparent from the above discussion that most of the service providers in Oman are demanding improvement in the internet quality to support them in better serving their customers. According to Sarrayrih and Sriram (2015), Oman is a developing country, and there is still a strong need to expand the internet service to involve all parts of the country besides improving the international internet bandwidth.

- **Rules and regulation availability**

According to the United Nations (2007, p. 1), "*technology presents particular challenges to law-makers, primarily due to the pace of change that occurs in the subject matter itself, e.g. software, computers and networks, and the manner in which such technology is utilised*". Oman is a developing country that faces challenges in establishing a legal framework to organise the use of information communication technology, such as consumer protection over cybersecurity violations (Sarrayrih and Sriram 2015). Many previous studies have highlighted the importance of rules and regulations as a significant predictor of the mobile applications adoption (Qiang et al. 2011; K. Xu, Zhang, and Yan 2018). According to a Senior Application Specialist (SAS1) from organisation B:

> *"Most Omani may be nervous about the privacy and security of their personal and financial data because the rules and regulations related to their right to privacy are still evolving"* (SAS1).

- **Capital availability**

Another factor mentioned by a Data Analysis Officer in Organisation C (DAO1) is the significant capital required to implement smart transportation services. He further argued that the affair of building a mobile application depends on the nature of the application and many other parameters, but generally talking, the cost ranges from 5,000 to 150,000 US Doller. Today after the Covid-19 pandemic coupled with the low oil prices, Oman decided to cut the expenditure in most sectors, including the ICT infrastructure (Ansari and Engerer 2020). Therefore, managing and financing adequate funds to build and design smart transportation mobile applications, besides improving the technical infrastructure, is an issue in most cases. According to the Head of Traffic Department (HOTD1) from Organisation D, the government has many obligations to be considered. Especially after the economic crises followed by the impact of the Covid-19 pandemic, the decision of which project to implement is subject to priorities.

- **Professional skilled worker availability**

The Director of Lighting and Traffic-light from organisation B (DOLTL1) commented that the main pain point of the lack of technical skills and the work experiences needed had made things worse. More than half of the interviewees agreed that the shortage of experienced, skilled people made their job more problematic, as getting a candidate with the needed technical skills is always challenging. The Senior Application Specialist (SAS1) in Organisation B complained that hiring a candidate with narrow skills might fit the short needs but would leave the organisation in a lurch whenever new challenges arise. Thus, one of the factors that should be considered as a challenge is the availability of the technical skills needed to manage the smart mobile application. The Software Engineer (SE1) from organisation D said:

> *"In Oman, the limited technical skills needed in developing and designing mobile applications is another problem. Securing skilled employees, especially in the technical support department, is more challenging than ever before. I strongly believe that government should put further effort into incorporating the necessary educational programmes suitable to graduate students with the technical skills needed today in the market as graduates with poor technical skills can adversely affect the quality of the services delivered by organisations"* (SE1).

The Senior Application Specialist (SAS1) from Organisation B also explored the issue of computer skills among the citizens. He argued that introducing the new parking system was not easy to adopt by some groups of society. Accordingly, assisting them by attending the location and giving guidance was essential. Therefore, there was facilitation by the service providers during the first months of activating the service while not holding the violators accountable for a few months until it became a familiar task among citizens.

6.4.5 Price Value (PV)

Based on the analysis of the interview data, all four organisations have followed different intensive methods to convince consumers to adopt their smart transportation mobile applications. The following paragraphs explain the various techniques that have been followed by them to add extra value and benefits:

- **Saving money**

According to a study conducted by Sanyala and Hisamb (2019) investigating the factors affecting people to adopt e-commerce websites, it is reported price value is a significant factor that influences their acceptance. Some people interviewed supported such views and believed in the importance of providing services that can save riders money. According to Public Service Supervisor (PSS1) from Organisation C:

> "*By signing up for our smart transportation mobile applications, riders can easily compare the prices, routes and journey length and decide on the best package which meets their requirement. We have also made the prices of the tickets from our smart mobile application cheaper compared to any other method of buying tickets"* (PSS1).

Similarly, Customer Experience Manager (CEM1) argued that enabling the riders to access all the commuting information they need makes it more convenient for them to plan their trips. She also further stated:

> *"Allowing commuters to access and buy tickets through our smart transportation mobile application has made commuting flexible as it allows them to know and compare the prices to choose the super saving plans"* (CEM1).

Moreover, an Information Technology Support Specialist in Organization (ITSS1) from Organisation D argued:

> "*Some of the applications offer free rides in addition to many other extra benefits. Riders, by exploring the applications, can locate good offers and sometimes free rides*" (ITSS1).

- **Providing incentives**

Choosing the right reward system helps companies and service providers differentiate themselves from their competitors. Such rewards can further enthral customers and their loyalty to the company. Most interviewees mentioned that they had offered incentives in the early stages of their businesses to encourage their customers to adopt their applications. This was because most customers' desire to embrace new services and applications is usually very low. Providing rewards contributes to building loyal customers who keep visiting the applications to use their services (Wiegran and Koth 1999). Maintaining the current customers in long-lasting relations is profitable and indispensable; however, searching for new customers is also crucial to increase the customer base and enjoying more profit (Boadu and Achiaa 2019). Therefore, most interviewees stated they had given their customers different rewards to attract them. Based on the interview data, the service providers in some organisations have offered rewards programmes for their customers, such as points rewards, vouchers, coupons and more. Most participants argued that offering extra values and advantages to the customers speeds up their adoption and implementation desires, specifically among people who have not yet adopted the services. For example, the Marketing Specialist (MS1) in Organisation A declared that:

> *"The intensive program within my organisation consists of three main methods: rewards points, VIP cards and referrals. The rewards points are used to keep current customers, and the more they spend, the more rewards they get. VIP customers are considered the most important customers as they bring the most value to our business; therefore, it is important to design loyalty programmes for them to keep them engaged. Recently we have included the VIP intensive program for those passengers who have taken more than ten rides per month. Such VIP passengers enjoy greater access to the highest-rated drivers and luxury cars. […….] Referrals programmes help in getting the use of our customers in motivating new users to adopt our services. By referring our smart application to a new consumer, they can get a discount for their next journey. Also, customers who give positive comments on the usage of our services are usually offered discount codes for their next order"* (MS1).

From the above statement, it can be noticed that the reward system is powerful in attracting people to accept the service by asking them to refer it to other possible customers to get more discount. This is another way to offer extra benefits after adopting the smart transportation mobile applications. An Operation Support in Organisation A (OS1) said that:

> *"In our company, we are most committed to permanent communication with our customers, not only to know their evaluation of our services, but we also sometimes contact our regular customers to offer them an invitation to dinner and at the same time listen to them. […..] We also check the customers who had downloaded our smart transportation mobile application but did not use it to offer them a free journey at any time convenient to them to try our services and later get encouraged to use our services in future"* (OS1).

It can be observed from the above discussion that offering rewards to customers contributes to building a friendly relationship between the service providers and their customers. Likewise, a Director of Lighting and Traffic-light (DOLTL1) from Organisation B mentioned that they are planning to offer citizens who are regular users of the controlled parking zones a discount of 20% on their next added zone parking purchase.

On the other hand, organisation D is recognised as a governmental application allowing its users to make payments of their traffic fines and other transportation services' fees. The Projects Manager in Organization D (PM1) mentioned that:

> *"It is essential before implementing any incentive programs to study the market to know the best possible ways to motivate citizens to adopt. Knowing which kind of promotions fit the market and which is more attractive to the citizens is critical to*

achieving a successful marketing plan. Following useless methods and incentives is a waste of both time and effort" (PM1).

Likewise, a Taxi Driver from organisation A (TD1) said their company offers their customers free water bottles and snacks. He also mentioned that last year they collaborated with a flower shop to provide free flowers to their customers on Valentine's Day.

According to Wakefield and Blodgett (1999), in practice, studies have approved that tangible incentives take advantage of intangible in attracting and retaining customers besides getting them enthused about new possibilities. It is argued that tangible incentives are more powerful in influencing the short-term behaviour of consumers. In contrast, intangible rewards are more valuable in maintaining longer relations between organisations and their customers (Roehm, Pullins, and Roehm 2002). In line with this, the Public Service Supervisor in Organization C (PSS1) said that their organisation conducts regular meetings to introduce and review the rewards they are offering to their customer. He commented:

> *"[…..] without customers there will be no businesses and therefore maintaining current customers while also attracting new customers is pretty obvious to stay in the market. Consequently, we introduced different intensive programmes such as inviting our smart application link to a friend gives a customer specific number of free points they can later use for free trips"* (PSS1).

A Marketing Specialist (MS2) in organisation A also argued that:

> *"After agreeing on providing rewards to the customers who filled the feedback form with valuable information, the company received thousands of feedback forms exceeding the expected number, which further forced the company to set a limit for the number of forms received as the passengers were very active to the extent, they exceeded the assigned rewords budget"* (MS2).

- **Cooperating with Third parties to provide benefits**

The interview data analysis showed that most service providers believe that incentives are significant and do matter in attracting customers; consequently, nominating a diversity of incentives is extremely important. They further argued that collaborating with external parties is extremely important in motivating customers to get attracted to the services. They also mentioned various effective corporation tactics such as coupons for discounts, vouchers from well-known shopping malls and free cinema tickets to get people to try their smart mobile applications. In this respect, a Projects Manager (PM1) from organisation D said:

> *"We are cooperating with one of the official and favourable e-Government Services Portals "Omanuna", which provides links to our smart mobile application. This portal works as a single window access to the e-services and platforms served by smartphone applications in Android and IOS in Oman. They can directly click and download our smart transportation application through this portal. Moreover, since*

our organisation is designed to support all other governmental entities, we have signed cooperation agreements with most of them. Consequently, customers can locate links to our smart applications within these entities to enhance customers' abilities to recognise and utilise our smart transportation application" (PM1).

An Operation Control Centre Controller (OCCC1) from organisation C mentioned that they team up with telecommunication companies to offer free WIFI to their passengers. He further said several bus stops and shaded bus stops had been built in corporation with Muscat Municipality. To sum up, collaborating with third parties helped add customer value.

6.4.6 Habit (HB)

The interview data revealed two main themes concerning the habit construct mentioned by the service providers who had been interviewed. First, citizens have no time and interest in changing their current habits. The second one is that people in Oman are addicted to the current commuting systems, particularly those related to using private cars. These two themes are explained in detail in the following paragraphs:

- **Not interested in amending the current habits of commuting**

According to the head of the traffic department, some citizens may not care about matters unrelated to their interests, particularly if doing so would require them to alter their usual patterns of utilising commuting services. He continued by saying that someone who feels they have no additional time to realise and learn anything new is mentally unable to deal with new innovations and, in the current case, the new smart transportation applications. This may explain why someone of this type would not be bothered by the new smart technologies introduced to improve their commuting and live.

- **Addiction to the current transportation systems and private cars**

Based on a social-psychological perspective, different factors contribute to the acceptance of new phenomena, including behavioural variables such as citizens' past experience (Zinn, Manfredo, and Vaske 2000). It can be observed from the above analysis that most of the citizens have an unpleasant experience with the current transportation systems in Oman. The lack of better transportation services that fulfil the needs of the citizens, the unavailability of convenient transport systems and services, and the unpleasant experience they have faced caused an excessive dependence of the citizens on private cars as a main method of transportation in Oman. Today, most of the citizens in Oman are aware of the problems assigned with private vehicles, as they are a main contributor to air pollution. However, like anything, reliance on personal cars has become a habit. According to Maltz (1960), forming a habit usually takes around 21 days. Habits represent a comfort zone as they are related to things or places you are familiar with and people you are at ease with. According to Lally and Gardner (2013), strong habits affect people by reducing their ability to consider other opportunities or act otherwise. Accordingly, most citizens, especially those whose private cars represent a comfort zone, feel that it is hard to leave their comfort zone. This further holds them from trying new experiences. An Information Technology Support Specialist (ITSS1) in Organization D commented that from a behavioural prospect, in Oman, private cars stand for a distinct social position, and therefore, people in Oman are addicted to using their cars. As a result, citizens adapted very well to private cars as the main transportation mode to the extent that they were unwilling to try and accept the new, improved systems. Their old habit has affected their intention to try the new smart transportation systems. The Head of the traffic department from organisation D (HOTD1) argued that:

> *"In Oman, I believe that most customers are very aware that private cars and the growing number of them on roads every year is a major source of heavy traffic and car accidents. However, most of them are used to these issues and have adjusted themselves by making important calls during traffic jams. They have adapted to the traffic jams and learnt how to use this time efficiently"* (HOTD1).

Representers from both organisations B and D also complained that although their smart transportation mobile applications are designed to allow citizens to accomplish many tasks via the applications in more convenient and easy ways, there are still some citizens bare the cost and the waste of time to visit organisations to accomplish these tasks which contribute to crowed and waste of time and effort. They also complained that most of these people argue that they prefer this old way as they used to do it in such ways since they started driving.

The above discussion shows that most of the citizens adjusted to the Oman transportation system by forming different habits helping them to reduce their losses. According to Verplanken *et al.* (2008), the transportation options that meet the majority of the passengers' needs represent the most robust travel habit that could radically reduce the need to obtain data about other available transportation options.

6.5 Augmenting The Model

In addition to the two factors extracted from the literature review, namely trust (TR) and satisfaction (SAF), the analysis of the interview data revealed two new factors that influence citizens' intention to use smart transportation mobile applications, including former practice (FP) and awareness (AWA). Each of these factors is discussed in detail in the following paragraphs:

6.5.1 Trust (TR)

Trust is emerging as an important leading construct controlling citizens' acceptance of smart technologies, as discussed in the literature review chapter. Trust is granted when users find enough competency, integrity and benevolence in a system (Köksal and Penez 2015). It is considered an important factor in engaging new customers while also attracting them to return to the application (Gefen 2002). Interviews' data analysis also supported this finding and underlined that trust contributes to the user's decisions in accepting smart transportation mobile applications in the Omani context. Two main themes have been founded from the interviews' data analysis regarding the trust factor in smart transportation mobile applications adoption: trust in the organisations and trust in technologies. The former is related to the trust between citizens and the service providers, which, most of the time, is built based on the service providers' reputation. In contrast, the latter is about the privacy and security by which citizens trust the technology infrastructure to deliver transportation services safely. These two crucial themes explored from the interview data will be explained in detail in the coming sections.

- **Trust between citizens and service providers**
    - Services providers reputation

Government and companies play a vital role in the city's development and improvement. Since this research addresses the adoption of smart transportation mobile applications, citizens' trust in service providers is expected to play a vital role as it affects citizens' intention to adopt smart transportation mobile applications. Most interviewees believed that the role of the Omani government and the private sector has been evolving, especially these days, due to the changes in economic, environmental, social and citizen needs. According to Information Technology Support Specialist (ITSS1) in organisation B:

> *"The economic and social challenges Oman has been experiencing for the last 12 years have contributed to the citizen's scepticism in the abilities of services providers in responding to their increasing demands in planning, designing, financing, and successfully implementing new projects. [……] This includes all kinds of projects such as entertaining projects, economic projects and even transportation"* (ITSS1).

There are various methods that should support building trust between citizens and their governments. For example, Zussman (2008) argued that citizen engagement and well government reputation enhance trust between them. He further said that building confidence between a government and their citizens contributes to enforcing trust and acknowledging government legitimacy as a valid entity representing citizens. Moreover, citizens' previous interaction with government systems and applications is another significant predictor of trust (Warkentin et al. 2002). Blind (2007) argued that corruption is a factor that may directly or indirectly influence trust as it could split the power besides contributing to the absence of agreement, whilst Meer (2003) believes that strong governmental performance convinces people to feel better about their governments and consequently better trust them, enhancing their willingness to corporate with them. Concerning the Omani context, the interviewees' data analysis revealed that government reputation in Oman is one of the major factors influencing people's trust level. This is especially true as the government's reputation has been affected because the implementation of many previous projects was missing to meet the standards and advertisements campaigns of these projects. One of the Data Analysis Officers in organisation C (DAO1) argued:

> *"Today, social media gave chances for individuals to express their actual feelings freely. Studying social media comments clearly shows that most of the citizens in Oman are not happy about the standard and quality of the projects implemented in Oman. For example, talking about the water park project's quality and children's entertainment parks raised suspicious criticism. The doubts about such projects are enough to let their providers lose their creditability and trust"* (DAO1).

Similarly, another Application Specialist (AS1) from organisation C said:

> *"Talking about the e-government project in Oman started in the early 2000s, the Omani government has invested a huge amount of money in implementing the digital government. However, apart from many projects implemented widely within this era, the diffusion and implementation of digital government is still evolving and comparing it to the other neighbourhood and western countries, we still need to work hard in some areas"* (AS1).

Also, a Marketing Specialist (MS2) from organisation A said:

> *"Our organisation is designed to provide better taxi services to consumers. Instead of getting a taxi randomly from the highways, you can order taxis easily from wherever you are. However, relying on the old orange taxis available already in the market with their unpleasant reputation has affected us negatively. Orange taxis are well known for their low-quality services, including unclean cars, unprofessional drivers, and bad service. Accordingly, hiring them has somehow influenced our customers' acceptance"* (MS2).

It can be seen from the above statements that citizens' perceptions of the reputations of the service providers are built based on the quality of the different projects delivered by them. If citizens had negative perceptions of the previous projects, this consequently is expected to affect their service providers' reputations. The service providers have been interviewed, declared that the relationship between trust and reputation is expected to be positive. Therefore, governmental organisations need to work intensively to rebuild their reputation as it has a direct influence on citizens' trust to accept smart transportation mobile applications (Bouckaert and Van de Walle 2014).

- Meeting citizens needs

Another exciting factor extracted from the interviews' data analysis as a factor affecting citizens' trust in the service providers is whether a particular project is meeting the needs of their citizens. Most countries design innovative projects mainly to improve their economy and indirectly to enhance the quality of their citizens' life (Macke et al. 2018). Therefore, if citizens doubt the usability and value added by implementing the new smart projects, they will be upset for not respecting their interests and meeting their needs. This point was highlighted by an Information Technology Support Specialist (ITSS1) from organisation D:

> *"Planning for smart projects specifically and building smart cities generally involve several holistic advantages including economic, environmental, and quality of life improvement. Yet focusing on the side that contributes to the government benefits while not respecting citizens' needs is unacceptable. There are direct problems facing citizens, and citizens are expecting them to be considered and solved by smart cities projects [……]" (*ITSS1).

Similarly, a Landscape Architect (LA1) from organisation B argued that:

> *"Installing smart water meters was expected to serve citizens better; however, after installing them, most of the citizens claimed that they did not gain any valuable outcome. Instead, they have faced unexplained increments in their water and electricity bills. Therefore, most citizens think that the higher bills are caused by missing the understanding of the citizen's needs in the first place"* (LA1).

The above comment shows that ignoring citizens and not giving their needs the highest priority by solving their problems and addressing them makes them feel disappointed as the provided services will not meet their expectations and needs. This will further affect citizens' trust in smart transportation service providers and their perception of smart transportation mobile applications.

- **Trust in technologies**
    - Perceived security

Security refers to "*the risks associated with stealing financial information by unauthorised personnel, viruses, and malicious software*" (Sarkar, Chauhan, and Khare 2020, 289). Two of the main concerns mobile application service providers face are the security risk and preventing personal information breaching (Jain and Shanbhag 2012). Today, although many people gladly install different mobile applications and insert their personal information, they never stop thinking about the security consequences (Weichbroth and Łysik 2020). According to Park and Kim (2014), security is one of the significant concerns preventing people from relying on smart mobile applications. The Operation Support (OS1) in Organization A commented that:

> *"We consider customer's collected data as a precious competitive asset which we need to work hard to protect them. However, end users are often very sensitive about their financial information security issues assigned with the smart mobile application"* (OS1).

A Taxi Driver (TD1) from organisation A *reported:*

> *"[…..]. Also, many of them prefer to pay offline directly to the taxi drivers to avoid inserting their bank card details"*

The above quotes show that citizens are very concerned about their financial information while using smart transportation mobile applications. According to Roman (2007), customers' financial information enclosed during online purchasing represents one of the main challenges to application users. It is also clearly noticed from the above quotes that citizens are concerned not only about their financial information but also about their personal information. A Senior Application Specialist (SAS1) from organisation B raised the issue that some customers are curious about their registered information to be secured against malware and viruses and that their information is not shared with other third parties for any reason without their approval. An Operation Support (OS1) from organisation A said:

> *"It is always helpful to investigate customers' characteristics to know them and understand their behaviour. For example, after analysing our customer database, we noticed that many customers had downloaded our smart transportation mobile application but did not complete the registration. After investigation, many of them said they hesitate to insert their credit card details into a mobile application"* (OS1).

As shown above, most interviewees agreed that collecting vast amounts of customers' personal and critical information affects trust, and they must store them carefully and securely in accordance with legal laws as there are different complicated legal requirements to save them.

- Perceived privacy

Customers to participate in a purchase online are asked to divulge their personal information, such as their name, home address, gender, contact number, date of birth and credit card information (Trepte and Leonard Reinecke 2011). Therefore, privacy is another vital factor affecting trust in online shopping as it is a critical factor affecting consumers' decisions to participate in an online purchase (Chang Liu et al. 2004). The Customer Experience Manager (CEM1) in Organization C remarked:

> *"Collecting information about consumers is also crucial for smart mobile applications to better understand where gaps exist to fill them and also in knowing which products and services your customers are interested in. However, this will not happen without personalised communications and suggestions by consumers"* (CEM1).

Similarly, the Data Analysis Officer (DAO1) of organisation C argued that:

> *"Most of companies are eager to collect a vast trove of their customer's data by asking them to fill complicated long forms before even being able to make a simple purchase within their applications. [….] Collecting customer information is essential to tailor the services and expand the business. However, most of the time, such collected information is not related directly to the customers' purchases and improving the services delivered to them. Service providers need to understand that there are legal requirements about the security of such collected data"* (DAO1).

Therefore, from the above statement, it can be observed that while collecting consumers' information is essential in improving the delivered services and the final products, yet, it is also essential to ensure that they do not comprise breaching the privacy of their consumers, as failing to do so leads to a public backlash. According to Culnan and Bies (2003), consumers should have the right to know the third parties and companies with access to their personal information inserted in various databases. In the context of smart mobile applications, consumers believe that service providers will protect their confidential information and ask for permission before sharing or selling them to a third party (Miyazaki and Fernandez 2001). In this study, privacy is considered the degree to which citizens predict that smart transportation mobile applications are safe by protecting their personal and sensitive data. With regard to this, a Senior Application Specialist (SAS1) from organisation B commented:

> *"Our organisation seriously deals with consumers' privacy in which no information is disclosed unless consent has been legally and officially approved. This is because we believe that the higher perceived privacy by the consumer, the higher the chance they will trust and adopt our smart mobile transportation application"* (SAS1).

Similarly, the Application Specialist (AS1) from organisation C argued that they keep receiving complaints from the customer about the registration processes, mainly the part where they are asked to fill in personal information such as their mobile and ID numbers. She further argued that most customers consider such information as confidential information they prefer to keep safe and protected from outside intruders.

Most interviewees agreed that privacy is one of the main concerns affecting citizens' trust and intentions to use smart transportation mobile applications. This has been emphasised by Obiria and Kimwele (2017), who conducted a study on privacy and showed that the better the privacy, the better the acceptance. Also, most interviewees mentioned that collecting lengthy and complicated forms to be filled out by customers with their personal information encourages them to switch to other competitors.

6.5.2 Satisfaction (SAF)

Satisfaction is another factor extracted from the literature review chapter and has been approved to be a significant influencer in various settings. Different studies have investigated the need for the satisfaction factor for online interaction between service providers and their consumers (Lee and Kozar, 2006; Hernández, Jiménez and Martín, 2009). This factor has been shown to be important in mobile learning, where students and educationists strongly need fast and quality information through informative videos, electronic books and library (ALjaaidi, Bagais, and Sharma 2020). The interview data analysis revealed that most service providers have also agreed on the importance of the satisfaction factor as an influencer in the acceptance of smart transportation mobile applications. Interviewees argued that the satisfaction factor involves information quality, applications' appearance quality and service quality as the three main satisfaction prospects influencing citizens' acceptance of the smart transportation mobile applications in Oman. Each of these is considered a main theme and is explained in detail in the coming sections.

- **Applications quality**

Most service providers mentioned that mobile applications today stand as online storefronts by which consumers' first impression is shaped. Accordingly, the quality of such mobile systems is essential. DeLone and McLean (2004) referred to system quality as the manifested quality exhibited in a system's performance. For example, system navigation, system reachability and accessing speed are vital in influencing consumers' acceptance (Silic and Ruf 2018). Most interviewees argued that end-user satisfaction is something that all organisations need to work hard to earn. They further argued that it is a complex topic that cannot be gained simply by words but, most importantly, by actions. In Oman, the government has used technology in developing various sectors such as billing, education, transportation, and health to shift Oman to a digital country (The Ministry of Technology and Communications 2019). However, according to the Data Analysis Officer (DAO1) in organisation C:

> *"Technology involves many critical technical challenges such as glitches, access, complexity and many other issues that are bound to happen. Such technical issues affect citizens' satisfaction with technology-based services"* (DAO1).

Moreover, according to the Customer Experience Manager (CEM1) of Organization C:

> *"Mobile phones market is growing sharply, and they play an important role in our daily lives as well as being an integral part of most of the business's activities […..], users of the mobile applications are expecting high functionality and expecting meaningful experiences. If they receive low-quality application systems, they will probably discard this application and look for a more qualified one"* (CEM1).

A Software Engineer (SE1) from organisation D argued that:

> "*Within our organisation, there are different factors we have tried to focus upon to ensure delivering a high-quality mobile application to our customers.* For instance, we tried to ensure that our system does not crush or *freeze while used by end users. We also considered building an application that does not require consuming high battery usage or is slow to respond to consumers' requests. The unpleasant consumer experience of not meeting their quality expectations leads users to uninstall the application"* (SE1).

It can be seen from the above quotes that service providers have system quality concerns, and they believe it will shape users' satisfaction. Low system quality disappoints citizens due to their higher expectations of system quality. It is fair to assume that low system quality reduces citizens' satisfaction with the services provided. According to Bäckstrm, Larsson and Wiklund

(2009), companies should prepare a system quality checklist and work accordingly to ensure meeting this target.

- **Information quality**

Information quality refers to providing users with qualified, sufficient, timeless and relevant information (Gao and Waechter 2017). Information quality in smart transportation mobile applications means providing visible information about the arrival, departure and trip routes for the passengers to enjoy a journey free of hassles (Cairns et al. 2004). Providing poor, wrong and outdated information shows that the smart mobile application cannot offer quality updated information, affecting both passengers' experience and their satisfaction (Gao, Waechter, and Bai 2015). From the interviews data analysis, it can be noticed that most of the service providers were very sensitive to the quality of information they provide over their smart transportation mobile applications as they all believed that smart transportation mobile applications services rely mainly on providing passengers with updated information. By doing so, citizens can manage their journeys efficiently by reducing the waiting time. This consequently enhances their experiences and acceptance of smart transportation mobile applications. This issue was outlined by a Data Analysis Officer (DAO1) from the IT department in organisation C:

> *"Smart transportation mobile applications are expected to provide innovative services compared to the old transportation systems by providing updated information about buses arrival and departure times, which represents a critical piece of information that is needed to be updated regularly"* (DAO1).

Similarly, an Operations Manager (OM1) in Organization A said:

> *"We are not only concerned about providing real-time updated information to our valuable customers; our smart mobile application provides them with all information that may concern them, such as the prices, how to order, refunds, routes and much other related information"* (OM1).

Therefore, it can be noticed from the above quotes that service providers have tried to publish possible updated and valuable information to their customers to simplify and enhance their commuting. Providing quality information resulted in improving the experience of the customers, and this could directly enhance their satisfaction level and indirectly increase the number of customers adopting smart mobile applications.

- **Service quality**

Besides system quality and information quality, service quality also emerged as an essential influencer impacting passengers' satisfaction levels. The service providers mentioned the quality of the service as a necessary factor influencing consumers' first impression of using smart transportation mobile applications. This was supported by most of the interviewees from the four organisations involved in this investigation. According to Gao and Waechter (2017), service quality refers to the capability of an application to deliver reliable, personalised, assured services to its consumers. It also can be understood as consumers' overall evaluation of the offered service and the extent to which it meets their expectations. Therefore it contributes to the application adoption and acceptance success (Pakurár et al. 2019). On the other hand, the untimely and unreliable services contribute to constructing a negative image of the mobile application, as has been reported by many authors, such as (Sarkar, Chauhan, and Khare 2020; Dennison et al. 2013). A Marketing Specialist (MS2) in Organization A said:

> *"Imagine one of our customers is relying on our smart mobile application to deliver him to a critical meeting. Our application did not provide him with the taxi he booked on time. Imagine how annoyed this customer will be; I do not think he will return to our application in the future"* (MS2).

Similarly, another Public Service Supervisor (PSS1) from organisation B argued:

> "*Negative feedback about the service quality spread very fast. One negative tweet or comment about poor service will cost the company many current and future customers. Therefore, to avoid losing your customer, always meet the required standards you have designed for your service*s" (PSS1).

Moreover, an Operation Control Centre Controller (OCCC1) from organisation C stated:

> "*Promising your riders to enjoy free WIFI services on board but surprising them that the WIFI is not working most of the time will result in unsatisfied passengers*" (OCCC1).

It can be noticed from the above statements that the level of service quality a company offers to its customers has a significant effect on acceptance and adoption. Smart transportation mobile application services are delivered to the end users through online smart mobile applications and are expected to be available anytime and anywhere. Thus, offering high-quality transportation services to citizens will increase the chances of satisfied passengers and, accordingly, better adoption and utilisation.

6.5.3 Awareness (AW)

Awareness is a new factor emerged from the qualitative interviews as one that may influence the adoption of smart transportation mobile applications from the service providers' perceptions. Awareness is defined in the literature as "*knowledge about a technology, its benefits and risks that are key factors in the voluntary use of systems*" (Alsheikh and Bojei. 2014, 212). When a person gets acquainted with a new idea, they may not know enough about it, so it is necessary to spread awareness and sufficient knowledge about it to help people make their decisions to adopt it or leave it (Rogers, 1995). Based on such awareness, users can build subjective opinions about their intentions towards a particular behaviour (Choudrie and Dwivedi 2005). Safeena (2011) further argued that awareness is critical, especially in emerging economies, as it reduces the risk of adopting new technologies. Several main themes and subthemes have been observed within this construct from the interviews' data analysis and are discussed in the below sections.

- **Awareness of smart transportation benefits**
    - Benefits related to improving the quality of the air

Many interviewees believed in the importance of spreading awareness of the smart transportation mobile applications' benefits and advantages among citizens as a main element to encourage them to adopt them smoothly. With urbanisation and expansions of the cities, there was a noticeable increment in the number of automobiles, industrial production and a rapid decrement in the number of agricultural lands (Sokhi 2008). Consequently, air pollution and the decrement in air quality have reached an alarming stage (Baldasano, Valera, and Jiménez 2003). It has become quintessential for such cities to monitor air quality through air quality monitoring sensors and produce real-time air quality data (Marinov et al. 2016). Several interviewees complained about the air quality in Oman, and their main concern was the CO_2 emission from the increasing number of cars on the roads. A supportive comment of the above view came from the Projects Manager (PM1), who was mainly concerned about vehicular traffic and their CO_2 emissions. He argued that:

> *"It is essential to educate citizens that the harmful gases produced by their cars contribute heavily to air pollution. They need to know that this pollution later affects their environment besides affecting the Ozon layer. As a result, considerable programs need to be implemented to educate citizens about how to minimise car pollution and enjoy fresh and clean air"* (PM1).

A Landscape Architect (LA1) from organisation B suggested that:

> *"Introducing well-smart transportation mobile applications encourage people to adopt them to improve their commuting. As a result, more people encouraged to adopt them means fewer cars on the roads. Fewer cars mean enjoying better health by improving their mental health by reducing panic while also improving their physical health by enjoying more fresh air"* (LA1).

An Operation Control Centre Controller (OCCC1) from organisation C argued:

> *"Our smart application has a very strong potential in delivering cleaner, less polluted transportation services…."* (OCCC1).

A Senior Application Specialist (SAS1) from organisation B stated:

> *"Some European countries had implemented costs of rush hour traffic to encourage people to use public transport and reduce* CO_2 *emissions"* (SAS1).

Thus, Smart cities are intended to provide a decent quality of life by ensuring a sustainable environment by monitoring the environment and identifying the sources of air pollution to mitigate them accordingly (Schürholz, Kubler, and Zaslavsky 2020). More specifically, smart transportation mobile applications are designed to offer such benefits, which are needed to be passed to the citizens to make them aware of these advantages to improve their acceptance and utilisation.

- Benefits related to creating Job opportunities

Different researchers argued that smart city construction contributes to economic prosperity and consequently to job creation (Granath 2016). In addition, the construction of smart transportation projects means hiring a large team of experts to monitor the different sensors across the smart city, such as smart traffic lights monitoring (K. G. Kim 2018). Also, there will be a need for cybersecurity specialists who work on securing the networks and protecting data exchange in smart cities (Darra et al. 2015). Beliveau-Dunn and Jeanne (2016), founder and leader of Cisco's Internet Business Solutions Group Cisco Inc, stated that such cities will also need enough analysts to collect, process and analyse the collected data. Smart cities will result in not only an increment in the number of jobs created in the technical area but also new kinds of jobs, such as jobs requiring hybrid skills.

More than half of the participants stated that job opportunities in Oman are challenging and are among the country's most critical issues. Many interviewees said that today's unemployment rate in Oman represents a crucial issue since the number has increased sharply in the last few years. According to the Operation Control Centre Controller (OCCC1) from organisation C, most of the citizens started forcing the government to foster greater employment opportunities. They described the situation in Oman as stressful as it does affect not only jobless individuals but also causes other consequences. This was also reflected in the comment of the Head of Information Technology (HOIT1) from organisation D:

> *"High unemployment rate means that the country's economy cannot offer a sufficient number of jobs for the job seekers, which indicates an unhealthy economic situation. This will further affect family's income and the citizens' purchasing power"* (HOIT1).

A Public Service Supervisor (PSS1) from organisation C agreed with the above statement and believes that the capacity of the Omani market and the sizes of the businesses are not mature enough to accommodate all graduates:

> *"I believe unemployment will only be solved by improving and developing the economy. There is indeed an increment in SMES number in Oman; however, on the other hand, we have only very few large private companies in Oman. SMES helps the economy, but they do not contribute heavily to job creation as they mostly hire very few people. In addition, in most cases, they target low-skill workers as they cannot afford high-skilled workers with high salaries. As a result, we need to focus on attracting large foreign companies to implement, for*

example, smart transportation projects. This will enrich the economy, and job opportunities will rise automatically" (PSS1).

Another participant from organisation B, a Senior Application Specialist (SAS1), argued that:

"Smart transportation sector is critical regarding job creation and economic prosperity. Considering other indirect jobs that are value chains linked with the transportation sector, the total number of jobs assigned within this sector is critical" (SAS1).

Another Marketing Specialist (MS2) from organisation A said:

"*When implementing our smart transportation mobile application, we employed a range of highly educated people and not educated people as well in which some are working as designers, system analysts, data analysis and taxi drivers*" (MS2).

The analysis of the interview data revealed that spreading awareness of the diverse job opportunities created by smart transportation projects and their link to economic development in Oman and other sectors worldwide will stimulate citizens to use such applications and services.

- Administrative benefits

The growing population has drawn pressure on the local governments and their plans for sustainability (Echendu and Okafor 2021). The quality of the public governmental administrative services has been affected due to the city's expansion which caused a high demand for such services (McNicoll 1984). For instance, most governmental public offices have become hectic places, and there are always long waiting queues for government agencies (Tšernov 2020). Many authors recommended using ICT to implement e-government to foster the quality of the administration and management services delivered (Alshehri and Drew 2010). Application of such technologies will allow people and businesses to access governmental information at any time (Almarashdeh and Alsmadi 2017). Such technologies will also help reduce costs and streamline governmental operation procedures (Alenezi et al. 2017). In addition, such technologies will help government agencies improve the quality of their services by enhancing the efficiency and effectiveness of the delivered public services (Aritonang 2017).

Most participants stated that the administrative services in Oman are still evolving and that the journey toward digital Oman still needs to be achieved. According to the Head of the traffic department (HOTD1) from organisation D, today, citizens have become more aware of their rights and are more demanding quality services than before. Therefore, slow and unprofessional services are not accepted anymore. Similarly, a Customer Experience Manager (CEM1) declared that citizens are demanding the adoption of leaner ways to deliver citizens' service by adopting a system that helps the government provide improved services, save time and reduce costs while improving communication with the public in more effective and efficient manners. Moreover, a Projects Manager (PM1) from organisation D discussed:

> *"Citizens can log into the application anytime and from anywhere 24/7. This contributes to reducing traffic and crowds in physical places" (*PM1).

On the other hand, An Information Technology Support Specialist (ITSS1) from organisation D argued that some of the ministries' employees and due to low experience, are unaware of the exact procedures and documents needed to complete an application. Therefore, they keep sending citizens back and forth many times for no valid reason. She declared:

> *"For example, if a citizen wants to get a car parking permit, there is no clear explanation of the documents and procedures required to apply for such services. Citizens are forced to visit them or use their network to seek such information, which complicates and slows down the process. On the other hand, making all the requirements and documents needed for an application posted clearly in a mobile application will save time for both service providers and citizens as well"* (ITSS1).

On the other hand, most participants expressed great happiness when the government transferred many services to electronic one in conjunction with the Covid 19 pandemic. Also, many of them praised the quality of the services provided by the Royal Oman Police. They also called for the necessity for all governmental agencies to follow the example of the Royal Oman Police by activating their websites and mobile application to convert their services into electronic ones. A Director General of Information Systems (DGOIS1) commented:

> "*Previously, citizens had to take leave from their work to renew the ownership of their cars or driver's licenses, but today, with the availability of an application for the Royal Oman Police, they can do most of the tasks through the application which saves them time and effort*" (DGOIS1).

- **Advertisements and campaigns**

According to Yunusova (2021, p. 235), " *advertising is not only a means of promoting the product, but also a rapid factor that demonstrates certain achievements in production, informs the population, has a rapid impact on the mental and intellectual state of man*". Likewise, Bara *et al.*(2021) argued that advertisements are a communication channel with the community intended to inform, educate and remind people about companies' products and businesses. They also argued that advertising helps consumers to be aware of the alternatives, which consequently helps in giving birth to choices. According to Susanto and Goodwin (2010, p. 68), "*Governments should run advertising campaigns on using the services in all mass media channels. The advertising should involve family and friends of the target users and be delivered by experts, public figures and teachers*".

Interestingly, the analysis of the interview transcripts has revealed some remarkable thoughts and ideas regarding advertisements. Accordingly, a group of participants noted that in addition to the influence of families and peers, smart transportation service providers should also focus on the importance of brand marketing in enhancing end users' intentions to use their smart transportation mobile applications. Therefore, they urge designing and formulating particular educational marketing strategies to attract different targeted citizens. This educational marketing is considered necessary as citizens have diverse educational backgrounds, which might affect their understanding of the rationality of smart technologies and, consequently, their acceptance of smart transportation mobile applications. For example, the Information Technology Support Specialist (ITSS1) in Organization D stated:

> *"We always have certain methods to educate citizens about new services, and these methods change and vary according to the type of service provided. For example, we always seek to hold an annual exhibition in the fairground open to the general public. We aim to educate and make people aware of the new services during this event. For example, we once introduced citizens to the new smart traffic lights installed in the streets of the Sultanate to inform them of the mechanism of their work and the desired benefit of adopting them. Similarly, in another year, we introduced them to the new speed control devices adopted to maintain street safety"* (ITSS1).

An Operation Control Centre Controller C (OCCC1) argued that they hosted a blood donation campaign more than once a year, and he considered it as a great gift as it saves lives and helps ensure a stable blood supply to hospitals while also inviting donators to try our smart application to become familiar with it. In addition, the interview data analyses revealed another concern related to the normative influence: educating people about the importance of smart transportation applications and services by spreading knowledge and information. For example, the head of the Traffic Department (HOTD1) in Organization D said that to draw citizens' attention to the importance of our smart transportation mobile application, we are regularly present on the daily morning radio programs to spread awareness by hearing from the public and immediately reply to the citizens inquires. This further helped spread awareness about illegal traffic actions to reach an agreement to work against such actions. This was further discussed by a Software Engineer (SE1) from Organization D:

> "*Inviting experts to a discussion to evaluate and analyse with them the different traffic issues are a common task within our organisation. This is in addition to our interest in sharing reports and images sent by citizens through the application with the general public to spread awareness. For example, if one of the traffic lights breaks down or an accident occurs, as soon as we receive a notification about it,*

whether through the application or by calling, we share it with the public so that everyone can take their precautions" (SE1).

It is clear from the above comments that service providers were keen to engage citizens in logical discussions to include them in the decision-making process rather than considering them only as recipients executing rules and tasks. This is in addition to their focus on spreading education and knowledge among citizens to educate them about these smart applications to facilitate awareness of their existence and their benefits and thus reduce their resistance.

A Business Development Manager (BDM1) from organisation A claimed that not hearing or knowing about any smart transportation applications until today indicates that the channels and media used by the service providers need to be updated and sufficient to promote the use of the smart transportation mobile applications. He further suggested the utilisation of new channels, such as social media, to communicate with citizens as TV and radio are outdated, and most of the residents are not regularly following them. Also, some interviewees commented that not reaching citizens is considered one of the main barriers that can delay the implementation of smart transportation applications. A Public Service Supervisor (PSS1) suggested that launching new smart transportation services should involve a marketing strategy by providing simple and straightforward induction programs designed for citizens to acknowledge the new applications and how they work.

A Marketing Specialist (MS2) was proud to state that:

> *"I remember that there was a launching party before introducing our application to the public in which we invited social media influencers, journalists, a few of the early adopters and some governmental representatives"* (MS2).

Similarly, a Director General of Information Systems (DOLTL1) from organisation B argued that:

> *"We decide to go for paid advertising to redirect people to our application, and they can directly install it right away and register"* (DOLTL1).

A Marketing Specialist (MS1) from organisation A declared,

> "*Making our mobile application accessible for downloading easily from all of our officials' representors including our website, social media account, our marketing emails and even by putting a code on our taxis have contributed to their adoption*" (MS1).

6.5.4 Former Practice (FP)

Another interesting construct derived from the semi-structured interviews data analysis is the former practice construct, which is not an original construct of the UTAUT2 model. A few smart transportation services providers indicated that citizens who have used smart transportation mobile applications in other countries are more encouraged to use their smart applications in Oman. Additionally, some mentioned that citizens who were offered a trial period of usage of their smart applications have been noticed to be more motivated to adopt. The former practice differs from the moderator experience, which is that the longer the usage, the less effort is required to use the application. On the other hand, the former practice is about the confidence gained from the earlier adoption of similar transportation applications. It means an individual can adopt the new application without doubts about their advantages. It is also essential to notice that this construct is not about the amount of effort needed but is associated with the reputation of such smart applications. The two main sub-themes explored from the analysis related to this construct are the following:

- **A trial period for the smart transportation mobile application**

Introducing new products and services to the market is a complicated task, as after development, their companies need to convince customers to adopt them (Simester 2016). Considering smart mobile applications, most of them are created by IT teams who need to consider end users' needs as a main dimension affecting the acceptance of such applications (Malavolta et al. 2015). A trial period of any new smart mobile application helps in testing and better understanding the missed requirements considered necessary by the end users. All members from the four organisations demanded the importance of the trial period to understand end users better and start reworking it based on the strength and weaknesses received from the trial. They further argued that the final version of the application should be launched after completing the evaluation, maintenance and changes are administered. According to the Business Development Manager (BDM1) of the Organization A:

> *"Our company offered a free trial period of our smart transportation application by offering it to a range of our employees and their families as a trial for around sixty days. Our smart transportation mobile application is built professionally by using advanced technologies. Therefore, in most cases, they need essential trials by the end users to understand if they are meeting the user's requirements. We believe that a free trial helps to put us in our customer's shoes"* (BDM1).

An Application Specialist (AS1) from organisation C argued:

> "*We always analyse the number of users who have downloaded our application and filter the people who downloaded the application but did not try it yet. We contact this group of customers and offer them a free trip at any time they want to encourage them to get to know us and the quality of our service"* (AS1).

Similarly, a Senior Application Specialist (SAS1) from organisation B confirmed that after building their smart parking mobile application, they conducted a pilot test by waiting next to the busy parking areas to explore customers' experience in using the application and discover if they have the needed confidences and knowledge to use it. Also, a Software Engineer (SE1) from organisation D stated that:

"*Offering a trial period for citizens gives them a chance to be confident that they are capable of using the application and that it is meeting their criteria of enhancing their commuting*" (SE1).

Based on the above discussion, offering suitable former practices contributes to the smoother implementation of smart transportation mobile applications. Moreover, it is reported that the more beneficial the application is in solving serious commuting problems citizens face, the easier it is to accept them.

- **Familiarity with similar smart applications**

This is another exciting point has been raised by three of the interviewees. A Marketing Specialist (MS1) from organisation A reported that:

"*Being exposed to similar smart ride-hailing applications from other countries helps in becoming more familiar with them and accordingly enabling the adoption of a positive association to them*" (MS1).

On the other hand, a Data Analysis Officer (DAO1) from organisation C argued:

"*I believe that even if someone is not aware of the advantages, usability and benefits of adopting our application, the repeated exposure to similar transportation applications inevitably makes them willing to adopt*" (DAO1).

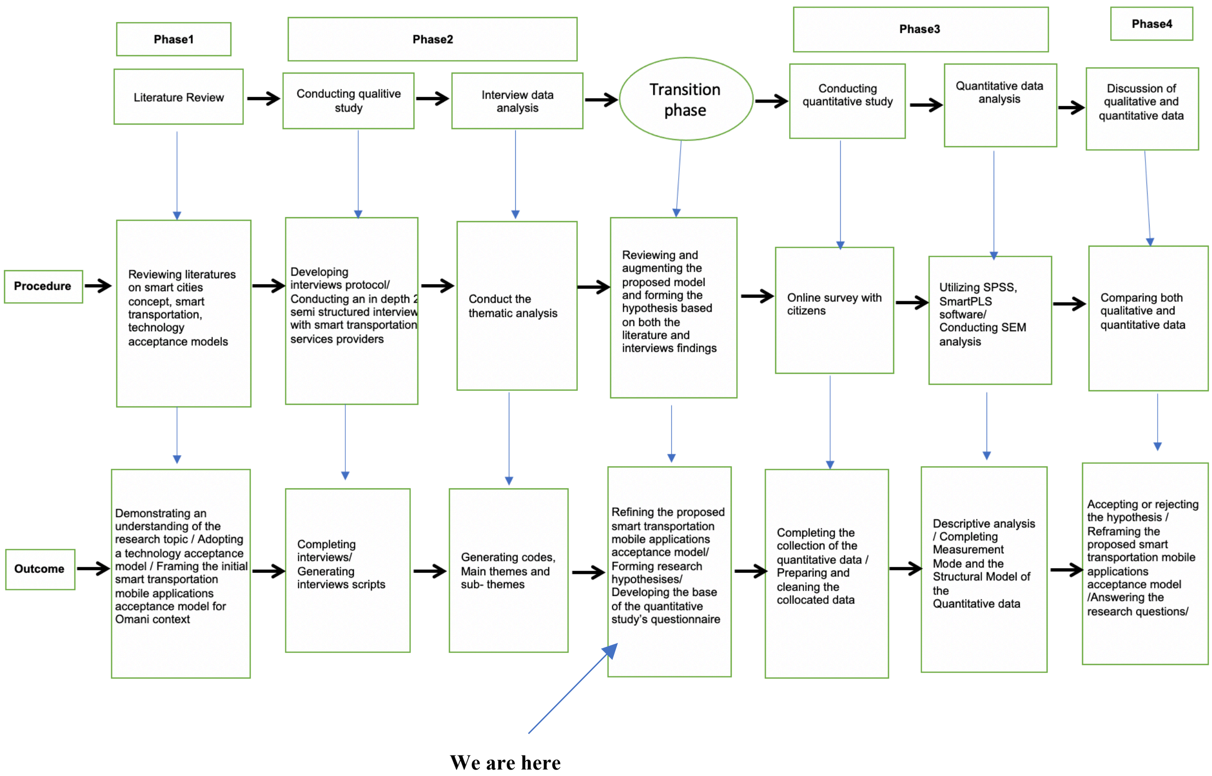
A taxi driver (TD1) from organisation A claimed that:

"*Once I asked a passenger how he becomes encouraged to adopt our smart application, and he replied that he always uses the Uber application abroad, and therefore it becomes easy for him to think about our smart mobile application*" (TD1).

6.6 Transition Phase

This research started by reviewing the literature and exploring the technology acceptance models to gain and build a theoretical framework for accepting smart transportation mobile applications in the Omani context. Later, the researcher collected qualitative data through in-depth semi-structured interviews to test and modify the proposed theoretical framework while also exploring other contextual constructs to be added based on the interviews conducted with the service providers. Based on the understanding of the qualitative study's outcomes and the literature review findings, the researcher established a range of hypotheses to be tested by using quantitative research in the next stage. The findings from this qualitative study and literature review will be used to design the hypotheses for the quantitative research. The quantitative analysis is intended to verify the built hypothesised model. Figure 6.2 below is the flowchart highlighting the study's current stage, the transition phase. It involves translating the insights from the qualitative findings into the design of the quantitative study to inform the discussion of the next stage.

Figure 6.2: Current phase of the research on the sequential exploratory flowchart of the recent research.



6.6.1 Hypotheses' Formulation Based On The Literature Review And The Findings of The Qualitative Study

The proposed acceptance framework of this study is designed based on the UTAUT2 model to serve as a starting point for investigating the smart transportation mobile applications' adoption and to identify the different possible constructs that might influence citizens' intention to adopt them. Thus, the proposed model for acceptance of smart transportation mobile applications in Oman is based on the traditional factors of the UTAUT2 model together with some new constructs extracted from the literature, as mentioned earlier, in the adoption of smart technologies and services. The initial acceptance model designed for the current research consists of six main factors adopted from the traditional UTAUT2 model: performance acceptancy, effort expectancy, social influence, facilitating condition, price value and habits. Although the original UTAUT2 model involves hedonic motivation, it has been excluded from this study model for the reasons mentioned earlier in Chapter 3. Moderators of age, gender, and experience that moderate the relationship between each factor and their influence on the behaviour intention have been included. In addition to the UTAUT2 factors, the literature review revealed two new elements explored and studied in the previous research and proved to influence the technology acceptance. Trust and satisfaction are the two new constructs extracted from the literature review and used to extend the UTAUT2 model in this study context. The semi-structured interview data analysis has built a coherent argument in emphasising the relevance of these factors to the current research context, as most of the service providers approved their effect on the consumers' acceptance in the Omani context. On the other hand, and apart from these two factors, awareness and former practice are the other two extra constructs revealed from the qualitative study analysis and have been hypothesised to augment the proposed model. As a result, these factors are incorporated into the proposed framework, along with designing a hypothesis for each based on the interview data to be further tested in the quantitative study. The following Table 6.3 shows the hypotheses built based on the UTAUT2 model, literature review, and qualitative study:

Table 6.3: The formed hypothesis based on the UTAUT2 model, literature review and qualitative findings.

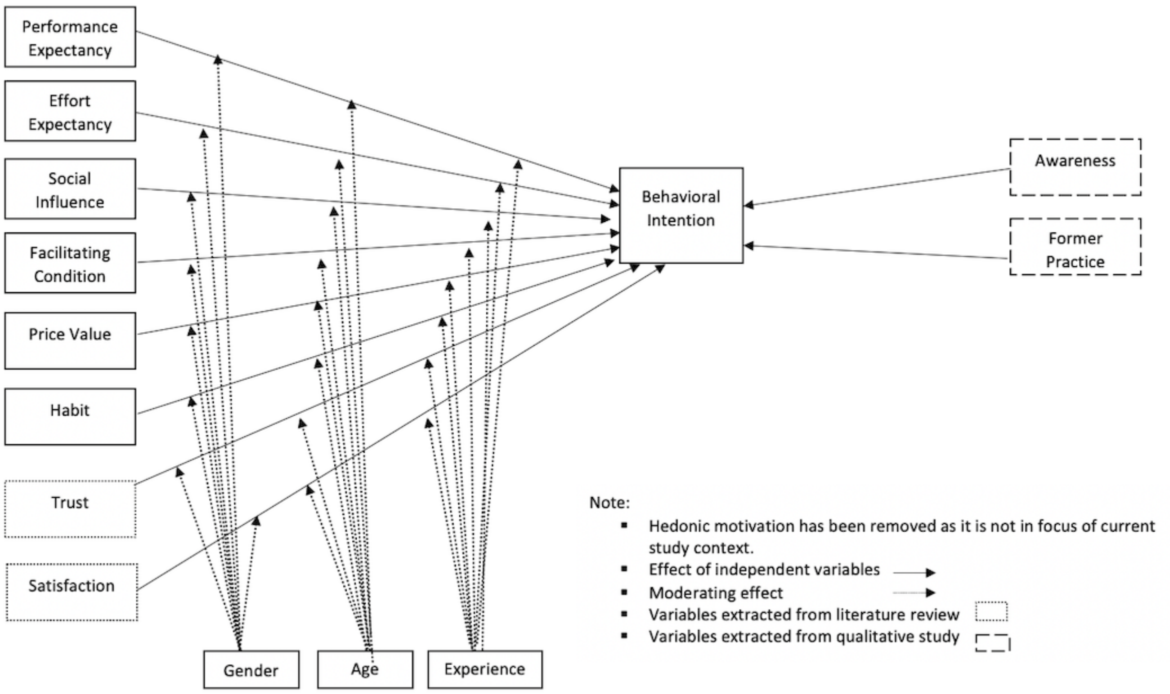
Performance Expectancy (moderated by gender, age and experience)
H1: There is a positive relationship between Performance Expectancy (PE) and Behavioural Intention (BI) towards adopting smart transportation mobile applications in Oman. **H1a:** The effect of Performance Expectancy (PE) on the intention to adopt smart transportation mobile applications is moderated by age. **H1b:** The effect of Performance Expectancy (PE) on the intention to adopt smart transportation mobile applications is moderated by gender. **H1c:** The effect of Performance Expectancy (PE) on the intention to adopt smart transportation mobile applications is moderated by experience.
Effort Expectancy (moderated by gender, age and experience)
H2: There is a positive relationship between Effort Expectancy (EE) and Behavioural Intention (BI) towards adopting smart transportation mobile applications in Oman. **H2a:** The effect of Effort Expectancy (EE) on the intention to adopt smart transportation mobile applications is moderated by age. **H2b:** The effect of Effort Expectancy (EE) on the intention to adopt smart transportation mobile applications is moderated by gender. **H2c:** The effect of Effort Expectancy (EE) on the intention to adopt smart transportation mobile applications is moderated by experience.
Social influence (moderated by gender, age and experience)
H3: There is a positive relationship between Social Influence (SI) and Behavioural Intention (BI) towards adopting smart transportation mobile applications in Oman. **H3a:** The effect of Social Influence (SI) on the intention to adopt smart transportation mobile applications is moderated by age. **H3b:** The effect of Social Influence (SI) on the intention to adopt smart transportation mobile applications is moderated by gender. **H3c:** The effect of Social Influence (SI) on the intention to adopt smart transportation mobile applications is moderated by experience.
Facilitating conditions (moderated by gender, age and experience)
H4: There is a positive relationship between Facilitating Conditions (FC) and Behavioural Intention (BI) towards adopting smart transportation mobile applications in Oman. **H4a:** The effect of Facilitating Conditions (FC) on the intention to adopt smart transportation mobile applications is moderated by age. **H4b:** The effect of Facilitating Conditions (FC) on the intention to adopt smart transportation mobile applications is moderated by gender. **H4c:** The effect of Facilitating Conditions (FC) on the intention to adopt smart transportation mobile applications is moderated by experience.
Price value (moderated by gender, age and experience)
H5: There is a positive relationship between Price Value (PV) and Behavioural Intention (BI) towards adopting smart transportation mobile applications in Oman. **H5a:** The effect of Price Value (PV) on the intention to adopt smart transportation mobile applications is moderated by age. **H5b:** The effect of Price Value (PV) on the intention to adopt smart transportation mobile applications is moderated by gender. **H5c:** The effect of Price Value (PV) on the intention to adopt smart transportation mobile applications is moderated by experience.
Habit (moderated by gender, age and experience)
H6: There is a positive relationship between Habit (HB) and Behavioural Intention (BI) towards adopting smart transportation mobile applications in Oman. **H6a:** The effect of Habit (HB) on the intention to adopt smart transportation mobile applications is moderated by age. **H6b:** The effect of Habit (HB) on the intention to adopt smart transportation mobile applications is moderated by gender. **H6c:** The effect of Habit (HB) on the intention to adopt smart transportation mobile applications is moderated by experience.
Trust (moderated by gender, age and experience)
H7: There is a positive relationship between Trust (TR) and and Behavioural Intention (BI) towards adopting smart transportation mobile applications in Oman. **H7a:** The effect of Trust (TR) on the intention to adopt smart transportation mobile applications is moderated by age. **H7b:** The effect of Trust (TR) on the intention to adopt smart transportation mobile applications is moderated by gender. **H7c:** The effect of Trust (TR) on the intention to adopt smart transportation mobile applications is moderated by experience.

Satisfaction (moderated by gender, age and experience)
H8: There is a positive relationship between Satisfaction (SAF) and Behavioural Intention (BI) towards adopting smart transportation mobile applications in Oman. **H8a:** The effect of Satisfaction (SAF) on the intention to adopt smart transportation mobile applications is moderated by age. **H8b:** The effect of Satisfaction (SAF) on the intention to adopt smart transportation mobile applications is moderated by gender. **H8c:** The effect of Satisfaction (SAF) on the intention to adopt smart transportation mobile applications is moderated by experience.
Awareness (AW)
H9: There is a positive relationship between Awareness (AW) and Behavioural Intention (BI) towards adopting smart transportation mobile applications in Oman.
Former practice (FP)
H10: There is a positive relationship between Former Practice (FP) and Behavioural Intention (BI) adopting smart transportation mobile applications in Oman.

6.6.2 Revised Research Framework

After developing the hypotheses in the previous section, the researcher again revised the proposed conceptual model based on the qualitative study findings' outcome along with the inter-relationships between the dependents and independents and the moderating factors. Two factors were integrated into the proposed model based on the literature review presented in Chapter 2: trust and satisfaction. In line with the objectives of the current study, which explores the factors influencing citizens' adoption of smart transportation mobile applications from services providers' perception, two additional independent factors have been introduced to the model: awareness and former practice. The two new factors explored from the qualitative study have been incorporated into the model without moderators to moderate the link between them and the behavioural intention to adopt smart transportation mobile applications. The moderator impact of these two new factors is considered beyond the current research's aim. Diagram 6.1 presents the extended acceptance model proposed for this study to be tested later in the quantitative study phase by the end users of these applications.

Figure 6.3: The revised research conceptual model.



6.6.3 Preparing Draft Instruments

The next step in the research was to develop the survey based on the literature review findings and the qualitative study discussion presented earlier in this chapter and the literature review chapter. The main part of the questionnaire was developed based on the various constructs of the UTAUT2 model, which later were modified to the context of the current study of smart transportation mobile applications. Thus, the questionnaire is based on the components of the UTAUT2 model, and the statements were modified to the context of smart transportation mobile applications. The proposed model in this study is also built based on some mature elements tested in many other settings and backgrounds previously. Therefore, in addition to the hypothesised factors influencing citizens' acceptance based on the traditional factors of the UTAUT2 model, the questionnaire also included factors identified from the literature review in Chapter 2 and factors identified from the preliminary qualitative semi-structured interviews in this chapter. Both the qualitative finding and the literature review have revealed some new constructs to be added to the proposed model. Hence, the hypothesised factors developed from the technology acceptance models, literature review, and preliminary qualitative study findings are used as a base for the development of the questionnaire of the current study. Around ten constructs are expected to influence the acceptance and utilisation of smart transportation mobile applications in the Omani context, including performance expectancy, effort expectancy, social influence, facilitating condition, price value, habit, trust, satisfaction, awareness, and formal practice. Most of the constructs' involved items derived from either the UTAUT2 model, qualitative study or the literature review. The survey is composed of 11 factors and 39 items: four items to measure performance expectancy, four items to measure effort expectancy, four to measure social influence, four to measure facilitating conditions, three to measure price value, three to measure habit, four to measure trust, three to measure awareness, four to measure satisfaction, three to measure former practice and three to measure behavioural intention. It can be noticed that most of the items have been extracted from the original UTAUT2 model. However, few are incorporated from both the preliminary qualitative semi-structured interview finding and the literature review chapter. Table 6.4 shows the questions with regard to each factor. As shown in the bellow table, most of the questions are extracted from the original variables of the UTAUT2 model and have been modified to the context of the current study. In addition, most of the constructs' involved items have been derived from either the qualitative study or the literature review. The table also indicates each item within a construct and its source.

Table 6.4: Construct items questions and their sources.

Measurement Items	
Performance expectancy (PE); sources: (Venkatesh, Thong, and Xu 2012a); (Venkatesh et al. 2003b).; (Fleury et al. 2017).	
PE1	I would expect smart transportation mobile applications to be useful in my daily travelling life
PE2	I would expect the use of smart transportation mobile applications to improve the quality of my commuting
PE3	I would expect using smart transportation mobile applications will make my working day more productive
PE4	I would expect using smart transportation mobile applications will help me in accessing transportations more quickly
Effort Expectancy (EE); sources: (Venkatesh, Thong, and Xu 2012a); (Venkatesh et al. 2003b).	
EE1	I expect that learning how to use smart transportation mobile applications will be easy for me.
EE2	I expect the interaction with smart transportation mobile applications will be simple, clear, and understandable.
EE3	I expect smart transportation mobile applications will be easy to use.
EE4	I expect that it will be easy for me to become skilful at using smart transportation mobile applications.
Facilitating conditions (FC); sources: (Venkatesh, Thong, and Xu 2012a); (Venkatesh and Zhang 2010a).	
FC1	I have/expect to have the knowledge necessary to use smart transportation mobile applications.
FC2	I have/expect to have the resources necessary to use smart transportation mobile applications.
FC3	I expect a specific person (or group) to be available to assist me with smart transportation mobile applications.
FC4	I expect smart transportation mobile applications are compatible with other technologies I use.
Price value (PV); sources; sources: (Indrawati and Amalia 2019a);Qualitative interview.	
PV1	I expect smart transportation mobile applications will be able to save my money.
PV2	I expect using smart transportation mobile applications will involves other benefits such as vouchers, points, and discounts.
PV3	I expect smart transportation mobile applications will help me in exploring deals with best prices.
Habit (HB); sources; sources: (Venkatesh, Thong, and Xu 2012a).	
HB1	I expect the use of smart transportation mobile applications will become a habit for me.
HB2	I expect using smart transportation mobile applications will become natural to me.
Hb3	I expect to be addicted to smart transportation mobile applications usage.
Social Influence (SI); sources: (Venkatesh, Thong, and Xu 2012a); ((Venkatesh et al. 2003b).	
SI1	My family members and relatives could affect my perception of smart transportation mobile applications usage.
SI2	People whose opinion I value could affect my decision to use smart transportation mobile applications.

SI3	People who influence my behaviour could affect my decision to use smart transportation mobile applications.
SI4	Smart transportation applications providers might encourage me to execute tasks through it.
Trust (TR); sources: (V. Acharya, Junare, and Gadhavi 2019); Qualitative interview.	
TR1	I expect to rely on smart transportation mobile applications' services providers reputations.
TR2	I expect that smart transportation mobile applications to have enough safeguards to make me feel comfortable using.
TR3	In general, I expect that smart transportation mobile applications to be a robust and safe environment in which to transact.
TR4	I expect to be confident that the data I submit through smart transportation mobile applications will not be misused and will be treated confidentially.
Satisfaction (SAF); sources: (Marinkovic and Kalinic 2017); (Chao, 2019).	
SAF1	I expect to be satisfied with smart transportation mobile applications efficiency.
SAF2	I expect to be satisfied with smart transportation mobile applications services.
SAF3	I expect smart transportation applications services will meet my expectations.
SAF4	I expect my experience with using smart transportation mobile applications will be positive.
Awareness (AW); sources: Qualitative interview.	
AW1	I am aware of smart transportation mobile applications in Oman.
AW2	I am aware of smart transportation mobile applications using benefits.
AW3	I have come across camping/advertisements of smart transportation mobile applications in Oman.
Former Practice (FP); sources: Qualitative interview.	
FP1	I have used mobile applications similar to smart transportation mobile applications before in other countries.
FP2	Previous familiarity with similar mobile applications will drive me to use smart transportation mobile applications.
FP3	I would be willing to try out a trail version of smart transportation mobile applications services.
Behavioural Intention (BI); sources: (Venkatesh et al. 2003b)	
BI1	I intend to use smart transportation mobile applications in the future.
BI2	I plan to use smart transportation mobile applications to improve my commuting.
BI3	I predict I would use smart transportation mobile applications in future.
Note: PE: Performance Expectancy; EE: Effort Expectancy; SI: Social Influence; FC: Facilitating Conditions; PV: Price Value, HB: Habit; TR: Trust; SAF: Satisfaction; FP: Former Practice; AW: Awareness; BI: Behavioural Intention	

6.7 Summary

This chapter has presented an extensive analysis of the qualitative data collected via the semi structures interviews. The analysis has revealed two new factors to be incorporated to the model explored from the service providers perceptions on the factors which influence citizens acceptance of smart transportation mobile applications in Omani setting. As a result, at the end of this chapter, the researcher was able to propose a revised model by incorporating the finding from the interview analysis. Later an explanation of the transition phase was conducted. This chapter presented the list of hypotheses to be tested later in the next chapter via the quantitative survey. This section also demonstrated a list of the constructs and their corresponding items to be used in the next phase.

Chapter 7: Quantitative Study Analysis and Findings

7.1 Introduction

This chapter is concerned with analysing and interpreting the data collected from the questionnaire. It presents the results of the different statistical tests implemented in analysing the quantitative data. It also investigates the proposed factors expected to influence the adoption of smart transportation mobile applications in the Omani context. It deals with quantitative data analysis to specify an in-depth numerical stance concerning the factors crucial to accepting smart transportation mobile applications in Oman. Therefore, it explains the set of statistical analysis steps applied by the researcher to analyse the quantitative data, such as validity assessment, descriptive statistics for both demographic and measurement scales, and Structural Equation Modelling (SEM). These tests are conducted to validate the model proposed earlier by empirically testing the proposed hypotheses.

The descriptive data analysis was conducted using SPSS IBM software, whereas SmartPLS is used for measurement and structural model analysis. This chapter is structured into the following sections. Initially, the analysis starts with examining and cleaning the collected quantitative data by checking the missing data, the outliers, and the normality. This step is considered essential before conducting statistical tests as it prepares the quantitative data by cleaning and identifying the unaccepted responses. After cleaning the collected data, this is followed by data coding and data entry into SPSS and SmartPLS software. Later, the chapter introduces the results of the demographic information and provides insights into the background information of the various participants involved in the questionnaire. The researcher uses mean and standard deviation to investigate the responses' distribution. Later, the validity and reliability tests are conducted, followed by an investigation of the proposed hypotheses by implementing SEM to test the adequacy of the proposed model through implementing the measurement and structural model analysis. Subsequently, the analysis will calculate the model fit. Statistical packages such as SPSS and SmartPLS were used to analyse the collected data. They validated the proposed model, constructed based on the UTAUT2 model but modified to be used in the Omani context.

7.2 Preparation of The Survey Data for The Statistical Analysis: Preliminary Stages

This step is critical to select the most suitable data analysis techniques besides cleaning the data, screening, and pre-coding the replies (James and Simister, 2017). This step was crucial because not checking missing or inconsistent data directly affects the analytic process and the findings (Kang, 2013). Data obtained on Microsoft Excel from Google Forms was uploaded to the SPSS and SmartPLS software for further analysis. Each variable was involved in frequency tests to identify any missing data. The following steps are involved in this stage: screening and cleaning procedures to examine the data for normal distribution, outliers, accuracy, missing data, and normality tests to understand better the primary determinants of smart transportation mobile applications adoption in Oman. These steps are explained in detail in the following sections.

7.2.1 Missing Data

Missing values happen when the intended sample members fail to respond to one or more of the questionnaire's questions. Regarding the current investigation, the participant cannot move on to the next page if they have not answered all the questions. Thus, the online questionnaire used for this study does not allow for any missing data. As a result, there is no possibility of missing data, and the researcher does not need to be concerned about this issue. However, as the current study is exclusively focused on the new users, completed surveys were additionally filtered to distinguish respondents who had previously used any smart transportation mobile applications from those who had not. Thus, all users who have stated that they have adopted any smart transportation mobile applications in Oman have been dropped from the analysis.

Additionally, this study looked at unengaged replies since respondents occasionally choose the same response to every inquiry. The researcher utilised Excel software to visually evaluate the data and check for any disengaged answers in the Likert scale questions by calculating the standard deviation of the replies. Cases were removed if the standard deviation was smaller than 0.5 (using a five-point Likert scale), indicating that the respondents were not paying close attention (Hair *et al.*, 2014).Three questionnaires were detected as unengaged replies and disregarded since they were not valuable to the study.

7.2.2 Detecting Outliers

Before continuing with the data analysis, it was crucial to ascertain whether there was any unusual data that differed from the other observations. Extreme data are referred to as outliers when they are found to be significantly different from the majority of the other response data. Hair *et al.* (2010) argued that the term outliers refer to observations that stand out strangely from other observations. With the aid of the SPSS software, the incidence of outliers was evaluated. There are two categories of outliers, according to research: (i) univariate outliers, which have an extreme value for a single variable, (ii) a multivariate outliers with a combination of odd results on at least two different variables (Tabachnick and Fidell, 2001; Kline, 2005). An outlier may be a single variable with an extraordinarily high or very low value or a multivariate outlier with an exceptionally uncommon mix of values from many other variables (Hair *et al.*, 2010). Outliers are significant and can influence factors as the analysis results could introduce bias to the chosen model as they could skew the mean and raise the standard deviation (Field, 2009). Outliers may also affect the normality of the data when conducting the SEM test used in this work (Field, 2009).

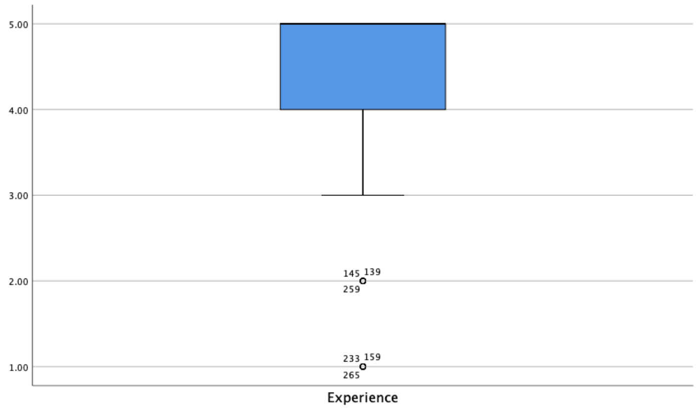
Researchers must choose whether to keep or discard outliers when they are present (Hair and Joseph, 2006; Hair *et al.*, 2014). Researchers should also look into how and why outliers appear in their data since it is possible that these anomalies belong to particular groups or that they were anticipated before the data was analysed. Outliers can be attributed to many reasons, such as participants are unaware of the survey topic or unwilling to reveal certain kinds of data (Wentland, 1993). Such errors happen when respondents are forced or when incentives are provided. However, in the current research, the questionnaire was utterly voluntary with no rewards, and respondents had the right to leave the survey at any point without providing any justification. Human mistake in data entry is another potential explanation for outliers. The current study has no direct human involvement because the statistical software imports the data from the online survey.

Most of the factors in this study are evaluated on a 5-point Likert scale, with strongly disagree (1) being the lowest and strongly agree (5) being the highest. As a result, the threat of outliers is unimportant because the Likert scale items did not require the assessment of outliers as the scale had five points, and the respondents chose one based on their opinions making the extreme values (1 and 5) the only legitimate outliers (Osborne and Overbay, 2004). However, through the use of a boxplot and SPSS and z scores, the replies of the Likert scale in this research were checked for outliers, and several were found. Yet, a detailed examination of these outliers revealed no "illegitimate outliers”. When legitimate outliers are present in the data, the decision to remove them becomes unclear. Judd, McClelland and Culhane (1989) provide numerous compelling arguments for removal, even if they are legitimate, to get the most accurate estimate of population characteristics. But not all researchers share this viewpoint (Orr, Sackett and Dubois, 1991). In making conclusions in this situation, researchers must draw on their experience, intuition, logical reasoning, and careful deliberation. In the current study, the researcher decided that the outliers in this study may be deemed legitimate and do not constitute any problems, especially for Likert scale questions.

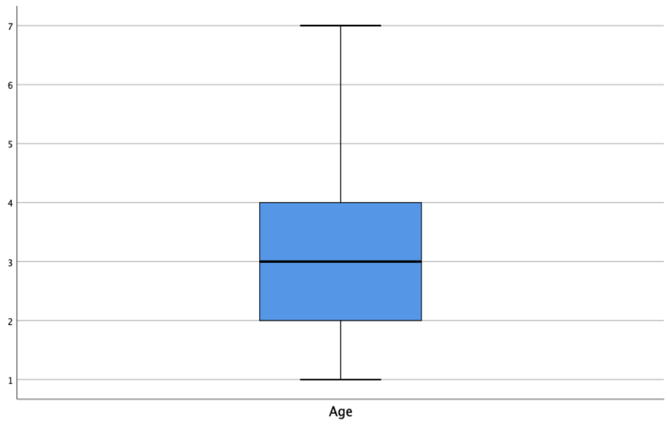
However, in this study, the three main variables of age, gender, and experience were assessed seriously for outliers. The Box and Whisker (Boxplot) and Z scores techniques were used in SPSS software to identify outliers (Pallant, 2010). There were no outliers in the age and gender variables, as seen in Figure 7.1. In terms of experience, only some examples (a total of six cases), as presented in Figure 7.1, were beyond the typical range of the respondents' experiences in this study and were identified as outliers. However, this was anticipated because it was expected that the responders would have a range of experiences. They were not omitted because it was expected that they would show up and because it is common to include a range of experience levels to aid in differentiating between respondents with low and high experience levels. The researcher closely examined the outlier examples, but no issues were discovered.

Figure 7.1: Outliers

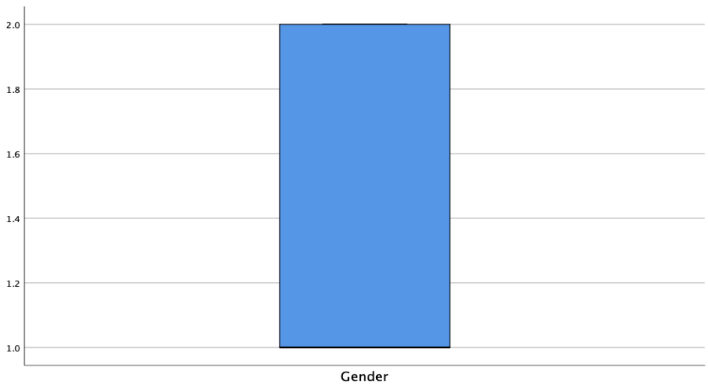
Outliers in the variable’s “experience”.



Outliers in the variable's "age".



Outliers in the variable's "Gender".



7.2.3 Data Editing and Coding

After getting a satisfactory sample, all replies were downloaded from the researcher account in the Google form server, which provided the results in Excel file format, compatible with SPSS software. Pallant (2010) stated that coding gives each reply labels, symbols, or numbers. According to Cooper and Schindler (2008), the coding procedure can be carried out either before the questionnaire is answered, in which case it is called pre-ceding, or it can be done after and referred to as post-coding. The pre-coding method involved assigning numerical values to each value. Some questions required text replies to be changed to numeric values, such as those relating to different options, including experience, age, and gender. In the current study, the post-coding approach was employed. All categorical data collected in the questionnaire, such as age, gender, experience, and the measurement scale of the Likert scale, were converted from categorical data into numerical data. The online survey server offers a unique coding for each responder, which only becomes visible to the researcher after each respondent has finished answering the questions and the link has been closed.

Regarding the SPSS software, data coding is considered an integral part of it as the researcher must allocate question numbers, variable names, and codes to the SPSS data file. Each measurement statement in the questionnaire served as a measurement item for a latent variable, and the coding process was used to assign variable names to each statement. Also, each potential response to every question was given a code as part of the data coding procedure so that the replies could be categorised into a certain number of groups (Cooper and Schindler, 2008). Table 7.1 below presents the codes assigned for each variable in the model.

Table 7.1: Codes for questionnaire items

No	Construct	code	Item
1	Performance Expectancy (PE)	PE1	I would expect smart transportation mobile applications to be useful in my daily travelling life
		PE2	I would expect the use of smart transportation mobile applications to improve the quality of my commuting
		PE3	I would expect using smart transportation mobile applications will make my working day more productive
		PE4	I would expect using smart transportation mobile applications will help me in accessing transportations more quickly
2	Effort Expectancy (EE)	EE1	I expect that learning how to use smart transportation mobile applications will be easy for me.
		EE2	I expect the interaction with smart transportation mobile applications will be simple, clear, and understandable.
		EE3	I expect smart transportation mobile applications will be easy to use.
		EE4	I expect that it will be easy for me to become skillful at using smart transportation mobile applications.
3	Social Influence (SI)	SI1	My family members and relatives could affect my perception of smart transportation mobile applications usage.
		SI2	People whose opinion I value could affect my decision to use smart transportation mobile applications.
		SI3	People who influence my behaviour could affect my decision to use smart transportation mobile applications.
		SI4	Smart transportation applications providers might encourage me to execute tasks through it.
4	Facilitating Conditions (FC)	FC1	I have/expect to have the knowledge necessary to use smart transportation mobile applications.
		FC2	I have/expect to have the resources necessary to use smart transportation mobile applications.
		FC3	I expect a specific person (or group) to be available to assist me with smart transportation mobile applications.
		FC4	I expect smart transportation mobile applications are compatible with other technologies I use.
5	Price Value (PV)	PV1	I expect smart transportation mobile applications will be able to save my money.
		PV2	I expect using smart transportation mobile applications will involves other benefits such as vouchers, points, and discounts.
		PV3	I expect smart transportation mobile applications will help me in exploring deals with best prices.
6	Habit (HB)	HB1	I expect the use of smart transportation mobile applications will become a habit for me.

		HB2	I expect using smart transportation mobile applications will become natural to me.
		HB3	I expect to be addicted to smart transportation mobile applications usage.
7	Trust (TR)	TR1	I expect to rely on smart transportation mobile applications' services providers reputations.
		TR2	I expect that smart transportation mobile applications to have enough safeguards to make me feel comfortable using.
		TR3	In general, I expect that smart transportation mobile applications to be a robust and safe environment in which to transact.
		TR4	I expect to be confident that the data I submit through smart transportation mobile applications will not be misused and will be treated confidentially.
8	Satisfaction (SAF)	SAF1	I expect to be satisfied with smart transportation mobile applications efficiency.
		SAF2	I expect to be satisfied with smart transportation mobile applications services.
		SAF3	I expect smart transportation applications services will meet my expectations.
		SAF4	I expect my experience with using smart transportation mobile applications will be positive.
9	Former Practice (FP)	FP1	I have used mobile applications similar to smart transportation mobile applications before in other countries.
		FP 2	Previous familiarity with similar mobile applications will drive me to use smart transportation mobile applications.
		FP3	I would be willing to try out a trail version of smart transportation mobile applications services.
10	Awareness (AW)	AW1	I am aware of smart transportation mobile applications in Oman.
		AW2	I am aware of smart transportation mobile applications using benefits.
		AW3	I have come across camping/advertisements of smart transportation mobile applications in Oman.
11	Behavioural Intention (BI)	BI1	I intend to use smart transportation mobile applications in the future.
		BI2	I plan to use smart transportation mobile applications to improve my commuting.
		BI3	I predict I would use smart transportation mobile applications in future.

Note: PE: Performance Expectancy; EE: Effort Expectancy; SI: Social Influence; FC: Facilitating Conditions; PV: Price Value, HB: Habit; TR: Trust; SAF: Satisfaction; FP: Former Practice; AW: Awareness; BI: Behavioural Intention.

7.3 Descriptive Analysis of The Demographic Information

Before conducting the test in SmartPLS, it was essential to understand the demographic profile of the participants. The descriptive statistics for demographic and the Likert scale measurements were conducted by SPSS IBM version 20 software. Table 7.2 demonstrates the summary of the demographic information of the sample. The following paragraphs describe the personal profile of the participants involved in the research. The main elements of the demographic factors include age, gender, and experience. The participants of this study include Omani residents only.

Table 7.2: Descriptive statistics of demographic factors

Variables	Scale	Frequency	Total
Age	Between 18-25 years	65	17%
	Between 26-30 years	62	16.2%
	Between 31-35 years	71	18.5%
	Between 36-40 years	91	23.8%
	Between 41-45 years	60	15.7%
	Between 46-50 years	22	5.7%
	Above 50 years	12	3.1%

	Total	383	100%
Gender	Female	228	59.5%
	Male	155	40.5%
	Total	383	100%
Experience	Less than 1 year	8	2.1%
	From1-2 year	8	2.1%
	From 2- 5 years	34	8.9%
	From 5-10 years	71	18.5%
	More than 10 years	262	68.4%
	Total	383	100%

- **Age:** The participants' age is divided into seven age groups, with the largest corresponding to those aged between 36-40 years old, who accounted for 23.8% of the total sample, followed by the age group of 31-35, constituting about 18.5% and then the age group of 26-30 with 16.2% of the entire population. Only 5.7% of respondents were between 56-50 years old, whereas the smallest group of the study sample is the age group above 50 years old (3.1%). According to the statistics of the data portal of the National Centre for Statistics and Information (2022), the highest group range in Oman is between 20-34 years old, whereas people above 50 make up the lowest percentage of the population. Moreover, according to Worldometer in 2022, the median age in Oman is 30.6 years; therefore, most online service users tend to be from the younger generation. This survey was distributed online, and it has been noticed in previous studies that older people are less likely to interact and use social media (Bell *et al.*, 2013). Thus, this sampling distribution reflects the population distribution of the Sultanate of Oman.
- **Gender:** As far as gender is concerned, the results show that the number of female participants is comparable to the percentage of male respondents, in which 59.5% are female and 40.5% are male.
- **Experience:** The data presented in Table 7.2 indicates that the experience level is divided into five groups: less than 1 year, from 1-2 years, from 2-5 years, from 5-10 and above 10 years. From the total 383 participants, the majority of the respondents, around 68.4%, had the experience of more than ten years, and around 18.5% of the participants acquired experience of between 5-10 years. Participants with less than 1 year of experience and between 1 to 2 years of experience each constitute 2.1% of the total sample. This indicates that most participants generally had a high level of expertise in technology usage. The literature review supports this view and proves that

most Omanis are well-educated, and the literacy rate in Oman in 2020 was 95.7% (CIA World Factbook, 2020).

7.4 Descriptive analysis of the measures of the constructs

This section presents a descriptive analysis of the measures of the constructs employed in the current study. The extended UTAUT2 model is scaled from 1 to 5 using 39 questions in 11 areas including, Performance Expectancy, Effort Expectancy, Social Influence, Price Value, Facilitating Condition, Habit, Trust, Satisfaction, Awareness, Former Practice, and Behavioural Intention for smart transposition mobile applications adoption in Oman. As has been mentioned in the methodology chapter, these constructs are measured by adopting a five-point Likert scale as follows, 1- “strongly disagree”, 2- “disagree”, 3- “neutral”, 4- “agree” and 5- “strongly agree”. Each construct in the proposed model has four or three questions that comprise the mean score for each subscale group. The measurement item’s mean and standard devotion values will be used to interpret their descriptive statistics.

- **Performance Expectancy**

This construct measures the extent to which an individual believes smart transportation mobile applications will be useful in daily commuting. The descriptive analysis of this variable is presented in the below table:

Table 7.3: Descriptive statistics of measures of Performance Expectancy construct

Performance Expectancy (PE)	Mean	Standard Deviation	Median	Variance	Percentages				
					SD	D	N	A	SA
PE1: “I would expect smart transportation mobile applications to be useful in my daily travelling life”	4.09	0.778	4.00	0.605	0.8	1.8	15.9	50.7	30.8
PE2: “I would expect the use of smart transportation mobile applications to improve the quality of my commuting”	4.04	0.797	4.00	0.635	1.0	3.1	14.1	54.3	27.4
PE3: “I would expect using smart transportation mobile applications will make my working day more productive”	3.80	0.895	4.00	0.801	1.3	6.3	25.6	45.2	21.7
PE4: “I would expect using smart transportation mobile applications will help me in accessing transportations more quickly”	4.08	0.791	4.00	0.625	1.3	1.8	14.4	53.0	29.5
Overall PE	4.0000	0.70316							

Note: PE: Performance Expectancy; SD: Strongly Disagree; D: Disagree; N: Neutral; A: Agree; SA: Strongly Agree.

Four main items determine performance expectancy: “I would expect smart transportation mobile applications to be useful in my daily travelling life”, “I would expect the use of smart transportation mobile applications to improve the quality of my commuting”, “I would expect using smart transportation mobile applications will make my working day more productive” and “I would expect using smart transportation mobile applications will help me in accessing transportations more quickly”. All four items were extracted from (Venkatesh *et al.*, 2003; Venkatesh, Thong and Xu, 2012; Fleury *et al.*, 2017). The questions from the main model of

UTAUT2 were modified to make them more grounded in the context of smart transportation mobile applications. As shown in Table 7.3, the overall mean of performance expectancy is 4.0, and the standard deviation is 0.703. For example, 50.7% of the total number of participants agreed with the statement PE1 “I would expect smart transportation mobile applications to be useful in my daily travelling life”. Also, 54.3% of the total number of participants agreed with “I would expect the use of smart transportation mobile applications to improve the quality of my commuting”. Moreover, around 53% of the citizens agreed with "I would expect using smart transportation mobile applications will help me in accessing transportation more quickly”. According to the table, the highest rated item in performance expectancy was the item in which participants believed that smart mobile applications would be helpful in their daily commuting (mean =4.09 and SD= 0.778) and that transportation applications help them in accessing transportation services quickly (mean= 4.08 and SD= 0.791).

- **Effort Expectancy**

This factor measures the extent an individual believes that adopting smart transportation mobile applications requires less effort and skills to use. The means and standard deviations of each item under this construct are indicated in the below table:

Table 7.4: Descriptive statistics of measures of Effort Expectancy construct

Effort Expectancy (EE)	Mean	Standard Deviation	Median	Variance	Percentages				
					SD	D	N	A	SA
EE1: “I expect that learning how to use smart transportation mobile applications will be easy for me.”	4.14	0.734	4.00	0.538	0.8	2.1	9.9	56.9	30.3
EE2: “I expect the interaction with smart transportation mobile applications will be simple, clear, and understandable”	4.08	.769	4.00	0.591	1.0	2.1	13.3	55.1	28.5
EE3: “I expect smart transportation mobile applications will be easy to use”	4.11	0.737	4.00	0.543	0.8	1.0	14.4	54.0	29.8
EE4: “I expect that it will be easy for me to become skillful at using smart transportation mobile applications”	2.16	0.732	4.00	0.536	0.8	1.3	11.2	54.0	32.6
Overall EE	4.1227	0.65143							

Note: EE: Effort Expectancy; SD: Strongly Disagree; D: Disagree; N: Neutral; A: Agree; SA: Strongly Agree.

Table 7.4 implies that the overall mean for performance expectancy is about 4.12, and the standard deviation was 0.65. Table 7.4 also indicates that most respondents, around 55.1% of the citizens surveyed agreed with the statement, “I expect the interaction with smart transportation mobile applications will be simple, clear, and understandable”. Moreover, 54% of the total number of participants agreed on the following statements “I expect smart transportation mobile applications will be easy to use” and “I expect that it will be easy for me to become skilful at using smart transportation mobile applications”. Among all items, the highest rated question measuring effort expectancy is “I expect smart transportation mobile applications will be easy to use”, with a mean of 4.14 and a standard deviation of 0.734. The lowest mean was recorded as “I expect that it will be easy for me to become skilful at using smart transportation mobile applications” (mean= 2.16 and SD=0.732), which is considered lower than the mid-point scale of 3. Therefore, this suggests that most respondents do not expect it to be easy to become skilful in using smart transportation mobile applications. Respondents generally expect to find smart transportation mobile applications easy to be utilised and that not much effort is needed to utilise them as the mean value exceeds 4 with most of the items.

- **Social Influence**

Regarding the current study, social influence refers to the degree to which individuals realise that family members and people who are vital to them believe that they should adopt smart transportation mobile applications. Table 7.5 reflects the descriptive statistics for the social influence in which each item's mean and standard deviation are calculated.

Table 7.5: Descriptive statistics of measures of Social Influence construct

Social Influence (SI)	Mean	Standard Deviation	Median	Variance	Percentages				
					SD	D	N	A	SA
SI1: “My family members and relatives could affect my perception of smart transportation mobile applications usage”	3.28	0.961	3.00	0.924	3.9	15.1	39.2	32.6	9.1
SI2: “People whose opinion I value could affect my decision to use smart transportation mobile applications”	3.48	0.920	4.00	0.847	2.9	9.9	35.2	40.7	11.2
SI3: “People who influence my behavior could affect my decision to use smart transportation mobile applications”	3.34	0.963	3.00	0.928	3.9	13.3	37.1	35.8	9.9
SI4: “Smart transportation applications providers might encourage me to execute tasks through it.”	3.81	0.855	4.00	0.731	2.1	3.9	23.5	52.0	18.5
Overall SI	3.4772	0.79960							

Note: SI: Social Influence; SD: Strongly Disagree; D: Disagree; N: Neutral; A: Agree; SA: Strongly Agree.

The results indicate that the frequency of the answers “neutral” and “agree” are more than “strongly agree”, “strongly disagree”, and “disagree”. The overall mean of this variable is 3.48, and the standard deviation is 0.799. These findings reflect that most participants somewhat agreed on the social influence as a factor influencing the acceptance of smart transportation mobile applications, as the mean values were close to 4 for almost all the items. The individual mean for the items ranged from 3.28 to 3.81. Therefore, participants, on average, agree that social influence may affect the usage of smart transportation mobile applications. This can be further reflected in the percentage of the distribution of the scale items measuring social influence construct. Table 7.5 also suggests that the highest rated item is “smart transportation applications providers might encourage me to execute tasks through it”, with a mean equal to 3.8, SD equal to 0.85, and around 52% of the participants’ sample surveyed agreeing with this item.

- **Price Value**

Regarding the current study, price value indicates the trade-off between the benefits of adopting smart transportation mobile applications and the monetary and non-monetary benefits assigned to the adoption.

Table 7.6: Descriptive statistics of measures of Price Value construct

Price Value (PV)	Mean	Standard Deviation	Median	Variance	Percentages				
					SD	D	N	A	SA
PV1: “I expect smart transportation mobile applications will be able to save my money”	3.59	1.017	4.00	1.034	4.2	9.7	26.6	42.3	17.2
PV2: “I expect using smart transportation mobile applications will involves other benefits such as vouchers, points, and discounts”	3.89	0.837	4.00	0.700	1.3	4.4	19.8	52.7	21.7
PV3: “I expect smart transportation mobile applications will help me in exploring deals with best prices”	3.88	0.876	4.00	0.768	2.1	4.7	18.5	52.7	21.9
Overall PV	3.7850	0.78890							

Note: PV: Price Value; SD: Strongly Disagree; D: Disagree; N: Neutral; A: Agree; SA: Strongly Agree.

The overall mean and standard deviation assigned with price value are 3.78 and 0.788, respectively. The mean values of the items are above 3, which is the neutral point of the five-point Likert scale. This is noticed by the percentage distribution of the Likert scale used to evaluate each item designed to measure this construct appearing in Table 7.6. For instance, around 52.7% of the total number of participants agreed with both statements “I expect using smart transportation mobile applications will involve other benefits such as vouchers, points, and discounts” and “I expect smart transportation mobile applications will help me explore deals with best prices”. Around 42.3% of the total sample size agreed with the “I expect smart transportation mobile applications will be able to save my money”. Table 7.6 also indicates that the mean values of all items are almost 4, reflecting that the sample size agreed that the smart transportations mobile applications adoption has a great value.

- **Habit**

Table 7.7: Descriptive statistics of measures of Habit construct

Habit (HB)	Mean	Standard Deviation	Median	Variance	Percentages				
					SD	D	N	A	SA
HB1: “I expect the use of smart transportation mobile applications will become a habit for me”	3.51	1.005	4.00	1.010	4.2	11.2	27.9	27.9	43.3
HB2: “I expect using smart transportation mobile applications will become natural to me”	3.70	0.919	4.00	0.844	2.1	8.6	23.2	49.3	16.7
HB3: “I expect to be addicted to smart transportation mobile applications usage”	3.03	1.149	3.00	1.321	12.3	19.3	29.2	31.1	8.1
Overall HB	3.4151	0.90550							

Note: HB: Habit; SD: Strongly Disagree; D: Disagree; N: Neutral; A: Agree; SA: Strongly Agree.

Habit is one of the most significant theoretical contributions incorporated into the UTAUT2 model. Habit is added to measure the extent to which a person feels a behaviour is automatic due to the learning (Venkatesh, Thong and Xu, 2012). Table 7.7 displays the descriptive analysis using mean and standard deviation. The habit construct's overall mean and standard deviation were: 3.41 and 0.905, respectively. This is observed from the percentage distribution of the scale items used to represent the habit construct. For example, 43.3% of citizens sample surveyed strongly agreed with the item “I expect the use of smart transportation mobile applications will become a habit for me”, and 49.3% of the total number of the participants agreed with the statement “I expect using smart transportation mobile applications will become natural to me”. The second statement, “I expect using smart transportation mobile applications will become natural to me" had the highest mean value of 3.7 and 0.919 as the standard deviation. This implies that most Omani citizens expect to use smart transportation mobile applications more often because they will become natural to them.

- **Facilitating Conditions**

Table 7.8: Descriptive statistics of measures of Facilitating Condition construct

Facilitating Conditions (FC)	Mean	Standard Deviation	Median	Variance	Percentages				
					SD	D	N	A	SA
FC1: “I have/expect to have the knowledge necessary to use smart transportation mobile applications”	4.01	.731	4.00	0.534	.5	2.1	17.0	57.2	23.2
FC2: “I have/expect to have the resources necessary to use smart transportation mobile applications”	3.96	.733	4.00	0.538	.5	3.1	16.4	59.8	20.1
FC3: “I expect a specific person (or group) to be available to assist me with smart transportation mobile applications”	3.84	.819	4.00	0.670	1.3	4.4	21.7	54.3	18.3

FC4: "I expect smart transportation mobile applications are compatible with other technologies I use"	4.01	.752	4.00	0.565	0.8	2.1	16.7	56.1	24.3
Overall FC	3.9530	0.62722							

Note: FC: Facilitating Conditions; SD: Strongly Disagree; D: Disagree; N: Neutral; A: Agree; SA: Strongly Agree.

Facilitating conditions construct is about the extent citizens believe in the availability of the technical support that facilities the usage and adoption of smart transportation mobile applications. It also measures citizens' abilities to use these smart applications. The above table 7.8 shows the mean and standard division of each item incorporated to measure this construct. According to Table 7.8, the standard deviation was 0.627, and the average was 3.95. Around 59.8% of the total number of participants participants agreed with the statement "I have/expect to have the resources necessary to use smart transportation mobile applications", and 57.2% of the citizens' sample surveyed also agreed with "I have/expect to have the knowledge necessary to use smart transportation mobile applications". It can be noticed that the highest mean of 4.01 was scored by two items "I expect smart transportation mobile applications are compatible with other technologies I use" and "I have/expect to have the knowledge necessary to use smart transportation mobile applications". This reflects that participants agreed they have the technical resources and the knowledge required to adopt smart transportation mobile applications.

- **Satisfaction**

Table 7.9: Descriptive statistics of measures of Satisfaction

Satisfaction (SAF)	Mean	Standard Deviation	Median	Variance	Percentages				
					SD	D	N	A	SA
SAF1: "I expect to be satisfied with smart transportation mobile applications efficiency"	3.71	0.729	4.00	0.532	0.8	3.4	30.5	54.8	10.4
SAF2: "I expect to be satisfied with smart transportation mobile applications services"	3.71	0.746	4.00	0.557	1.0	3.7	29.2	55.4	10.7
SAF3: "I expect smart transportation applications services will meet my expectations"	3.75	.747	4.00	0.559	1.3	3.7	24.5	59.5	11.0
SAF4: "I expect my experience with using smart transportation mobile applications will be positive"	3.87	.702	4.00	0.493	0.5	2.9	20.4	61.9	14.4
Overall SAF	3.7591	0.64864							

Note: SAF: Satisfaction; SD: Strongly Disagree; D: Disagree; N: Neutral; A: Agree; SA: Strongly Agree.

The estimated standard deviation of the satisfaction factor was 0.64, and the average mean value was 3.75. These results show that the statements used to test satisfaction are broadly accepted by participants. On an item-by-item examination, the mean values for all measure elements were over 3. For instance, 54.8% of the total number of respondents strongly agree with the statement, “I expect to be satisfied with smart transportation mobile applications efficiency” (mean = 3.71, SD =0.729), and 59.5% of the total number of respondents agree with the statement, “I expect smart transportation applications services will meet my expectations” (mean = 3.75, SD =0.747). The results showed that the most highly evaluated satisfaction statement was “I expect my experience with using smart transportation mobile applications will be positive” (mean = 3.87, SD =0.702).

- **Trust**

Table 7.10: Descriptive statistics of measures of Trust construct

Trust (TR)	Mean	Standard Deviation	Median	Variance	Percentages				
					SD	D	N	A	SA
TR1: “I expect to rely on smart transportation mobile applications’ services providers reputations”	3.83	.778	4.00	.606	1.6	2.3	23.5	56.4	16.2
TR2: “I expect that smart transportation mobile applications to have enough safeguards to make me feel comfortable using”	3.84	.807	4.00	.651	1.0	4.4	22.5	54.0	18.0
TR3: “In general, I expect that smart transportation mobile applications to be a robust and safe environment in which to transact”	3.86	.811	4.00	.657	1.8	3.1	20.6	56.4	18.0
TR4: “I expect to be confident that the data I submit through smart transportation mobile applications will not be misused and will be treated confidentially”	3.66	.880	4.00	.775	2.3	6.5	27.7	49.6	13.8
Overall TR	3.7963	0.71009							

Note: TR: Trust; SD: Strongly Disagree; D: Disagree; N: Neutral; A: Agree; SA: Strongly Agree.

It is noted from Table 7.10 that the level of trust in accepting smart transportation mobile applications in the Omani context was estimated to a high degree according to the approved rating scale, as the overall average mean reached 3.796 with a standard deviation of 0.71009. The overall means of the items ranged from 3.66 and 3.86, indicating that, on average, respondents did not dispute that using smart transportation mobile applications raises trust difficulties. According to the above table, the highest mean value was computed by the item “In general, I expect that smart transportation mobile applications to be a robust and safe environment in which to transact”, with a mean equal to 3.86 and a standard deviation of 0.811. This means that citizens agreed that smart transportation mobile applications are trustworthy to be used and adopted. The descriptive analysis of the trust construct shows that Omani citizens agree that they are expecting to find smart transportation mobile applications reliable, secure, and trustworthy.

- **Former Practice**

Table 7.11: Descriptive statistics of measures of Former Practice construct

Former Practice (FP)	Mean	Standard Deviation	Median	Variance	Percentages				
					SD	D	N	A	SA
FP1: “I have used mobile applications similar to smart transportation mobile applications before in other countries”	3.56	1.161	4.00	1.347	6.5	14.4	17.0	41.3	20.9
FP2 “Previous familiarity with similar mobile applications will drive me to use smart transportation mobile applications”	3.74	.909	4.00	.827	1.6	9.1	20.9	50.7	17.8
FP3: “I would be willing to try out a trail version of smart transportation mobile applications services”	3.87	.808	4.00	.653	1.3	4.2	19.6	56.1	18.8
Overall FP	3.7215	.82758							

Note: FP: Former Practice; SD: Strongly Disagree; D: Disagree; N: Neutral; A: Agree; SA: Strongly Agree.

The overall mean and standard deviation assigned with the former practice is 3.72 and 0.827, respectively. Since the mean values of the items are above 3, a neutral point of the five-point Likert scale, this finding shows that most citizens agreed with the items used to measure the concept of former practice. This is noticed by the percentage distribution of the Likert scale used to measure each item designed to measure this construct. For instance, around 56.1% of participants agreed with both statements “I would be willing to try out a trial version of smart transportation mobile applications services”, and around 50.7% of the total sample size agreed with “Previous familiarity with similar mobile applications will drive me to use smart transportation mobile applications”. The above table also indicates that the mean values of all items are above 3 which reflects that the sample size agreed that their former practice contributes to their perceptions of the smart transportation mobile applications.

- **Awareness**

Table 7.12: Descriptive statistics of measures of awareness construct

Awareness (AW)	Mean	Standard Deviation	Median	Variance	Percentages				
					SD	D	N	A	SA
AW1: “I am aware of smart transportation mobile applications in Oman”	3.46	1.017	4.00	1.034	3.9	15.4	23.8	44.9	12.0
AW2: “I am aware of smart transportation mobile applications using benefits”	3.68	0.868	4.00	0.754	1.3	9.4	23.0	53.0	13.3
AW3: “I have come across camping/advertisements of smart transportation mobile applications in Oman”	3.49	1.031	4.00	1.062	5.2	12.8	21.7	48.3	12.0
Overall AW	3.5413	0.80028							

Note: AW: Awareness; SD: Strongly Disagree; D: Disagree; N: Neutral; A: Agree; SA: Strongly Agree.

Table 7.12 indicates that the overall mean of the awareness construct was 3.54, and the standard deviation was 0.800. Around 44.9% of the citizens agreed with the statement “I am aware of smart transportation mobile applications in Oman”, and 48.3% of the total sample size agreed with the item “I have come across camping/advertisements of smart transportation mobile applications in Oman”. The overall mean of all the attributes was higher than 3, which indicates that Omani citizens are aware of the smart transportation mobile applications. The item “I am aware of smart transportation mobile applications using benefits” recorded the highest mean (mean= 3.68) compared to all other measurements. This means that most of the participants are aware of the benefits and advantages assigned to smart transportation mobile applications.

7.5 Structural Equation Modelling (SEM) data analysis

7.5.1 Measurement Equation Modelling Data Analysis

The measurement model is conducted to discuss the reliability and validity of the constructs used in the current research before drawing conclusions about the relationship between the proposed model constructs (Indrawati and Amalia, 2019). This analysis is concerned with evaluating the outer model and testing the measurement model's reliability and validity via using Smart-PLS. Reliability analysis tests the accuracy and consistency of the measurement instrument, while validity tests whether the measuring instruments measure the construct it is intended to measure (Hair *et al.*, 2014).

7.5.1.1 Internal Reliability Analysis

The researcher used SPSS software to calculate Cronbach's alpha of each variable to verify the internal reliability of the questionnaire. Jones-Smith and Popkin (2010) categorised Cronbach's alpha values above 0.6 as acceptable to very consistent and those below 0.6 as having doubtful consistency. However, it is agreed that the lower value for Cronbach's alpha to be accepted is 0.7, despite Jones-Smith and Popkin (2010) and Malhotra, Birks and Wills (2010) recommendation that a value greater than 0.6 is considered a good degree to confirm the internal consistency for a measure (Bryman and Hardy, 2004; Bryman, 2016). The researcher has decided to choose 0.7 as the cut-off value in the current research. Table 7.13 displays the outcomes identified for each factor involved in the model. Cronbach's alpha values for most factors were above 0.7, indicating that all variables reached internal consistency between very good and excellent. The satisfaction factor is recorded to have the highest value of Cronbach's alpha as 0. 909.

Table 7.13: Reliability statistics of Cronbach’s Alpha for each factor

Constructs	Number of items	Cronbach’s alpha
Performance Expectancy	4	0.884
Effort Expectancy	4	0.900
Social Influence	4	0.886
Price value	3	0.830

Facilitating Conditions	4	0.845
Habit	3	0.855
Trust	4	0.889
Satisfaction	4	0.909
Former Practice	3	0.812
Awareness	3	0.758
Behavioral Intention	3	0.881

7.5.1.2 Validity Analysis

Validity is "*the degree to which a test measures what it claims, or purports, to be measuring*" (Brown, 1996, p. 231). Validity comprises two main tests: convergent and discriminate, as explained in the paragraphs below.

7.5.1.2.1 Convergent Validity

Convergent validity is used to "*measure a particular construct is actually measuring that construct*" (Barati *et al.*, 2019, p. 225). This test is used to measure the extent to which items of a specific construct are correlated. The higher the correlation, the better the items can measure the designed construct. There are two main tests conducted to ensure the convergent validity: Composite Reliability (CR), which should be at least 0.7 for each construct (Hair *et al.*, 2014), and the Average Variance Extracted (AVE), which should be greater than 0.5 for each construct (Fornell and Larcker, 1981).

Table 7.14: Results of Convergent Validity

Constructs	AVE	CR
AW	0.673	0.859
BI	0.801	0.927
EE	0.769	0.930
FC	0.687	0.898
FP	0.743	0.896
HB	0.785	0.916
PE	0.745	0.921
PV	0.754	0.902
SAF	0.786	0.936
SI	0.746	0.921
TR	0.755	0.925

Note: PE: Performance Expectancy; EE: Effort Expectancy; SI: Social Influence; FC: Facilitating Conditions; PV: Price Value, HB: Habit; TR: Trust; SAF: Satisfaction; FP: Former Practice; AW: Awareness; BI: Behavioural Intention.

Table 7.14 shows that the AVE value for all the constructs achieved the minimum convergent validity value as all the values are above 0.5. Also, the Composite Reliability (CR) values of the listed constructs are higher than their corresponding AVE values. Therefore, the convergent validity of the measurement model is achieved.

7.5.1.2.2 Discriminant Validity

Discriminant validity is considered an important test used to assess the degree to which constructs have a strong relationship with their own indicators (Fornell and Larcker, 1981). According to them, this test is used to confirm that the construct of each factor is divergent. Discriminant validity measures "*the extent to which constructs are distinctive from one another*" (Al-Rahamneh and Bidin, 2022, p. 8). There are three main tests used to assess the discriminant validity: the Fornell- Larcker technique (Fornell and Larcker, 1981), cross-loading, and the heterotrait-monotrait ratio (HTMT) (Henseler, Ringle and Sarstedt, 2015).

- **Fornell-Larcker technique**

According to Fornell-Larcker, discriminant validity is achieved if the square root of each AVE construct is greater than the inter-factor correlation indicators (Fornell and Larcker, 1981). Table 7.15 presents the results of the Fornell-Larcker test. The lowest square root of AVE's is 0.821. The table indicates that the square root of each construct correlates more strongly with its own construct than other constructs.

Table 7.15: Results of Discriminant Validity-Fornell-Larcker

Constructs	AW	BI	EE	FC	FP	HB	PE	PV	SAF	SI	TR
AW	0.821										
BI	0.411	0.899									
EE	0.330	0.322	0.877								
FC	0.346	0.462	0.636	0.829							
FP	0.463	0.536	0.434	0.515	0.862						
HB	0.319	0.702	0.305	0.435	0.473	0.886					
PE	0.305	0.474	0.580	0.541	0.423	0.525	0.863				
PV	0.267	0.473	0.490	0.578	0.450	0.479	0.440	0.868			
SAF	0.423	0.514	0.534	0.510	0.481	0.477	0.462	0.548	0.887		
SI	0.373	0.597	0.427	0.544	0.434	0.596	0.590	0.439	0.424	0.864	
TR	0.403	0.525	0.537	0.614	0.472	0.454	0.490	0.575	0.734	0.435	0.869

Note: PE: Performance Expectancy; EE: Effort Expectancy; SI: Social Influence; FC: Facilitating Conditions; PV: Price Value, HB: Habit; TR: Trust; SAF: Satisfaction; FP: Former Practice; AW: Awareness; BI: Behavioural Intention.

- **Cross-loading technique**

Cross-loading was also used to assess the discriminant validity, as each construct should load higher on its own construct than on the other indicators. This test examines each item to determine items loading on the same construct and those loading on more than one construct. According to Chin (1998), discriminant validity is obtained if items of a construct load much greater on its own construct than other constructs. Table 7.16 indicates that each item loads more highly on its own latent variables than other variables. Therefore, the discriminant validity using cross loading technique had also been confirmed.

Table 7.16: Results of Discriminant Validity-Cross-loadings

Constructs	AW	BI	EE	FC	FP	HB	PE	PV	SAF	SI	TR
AW1	**0.886**	0.349	0.255	0.271	0.351	0.258	0.215	0.179	0.303	0.330	0.318
AW2	**0.872**	0.406	0.356	0.376	0.492	0.346	0.345	0.297	0.460	0.384	0.400
AW3	**0.688**	0.219	0.160	0.157	0.251	0.132	0.153	0.159	0.236	0.149	0.250
BI3	0.366	**0.905**	0.254	0.388	0.474	0.688	0.434	0.447	0.460	0.542	0.473
BI1	0.330	**0.885**	0.330	0.452	0.481	0.615	0.439	0.418	0.488	0.566	0.481
BI2	0.414	**0.908**	0.288	0.408	0.493	0.587	0.403	0.409	0.439	0.501	0.463
EE1	0.283	0.246	**0.846**	0.511	0.416	0.243	0.479	0.374	0.411	0.366	0.409
EE2	0.295	0.259	**0.887**	0.523	0.372	0.265	0.505	0.386	0.476	0.362	0.443
EE3	0.309	0.318	**0.912**	0.599	0.356	0.291	0.549	0.468	0.518	0.390	0.522
EE4	0.270	0.296	**0.860**	0.583	0.387	0.266	0.496	0.476	0.455	0.378	0.495

FC1	0.258	0.373	0.564	**0.854**	0.448	0.337	0.498	0.481	0.407	0.439	0.538
FC2	0.278	0.389	0.484	**0.852**	0.419	0.360	0.406	0.446	0.403	0.443	0.491
FC3	0.298	0.366	0.464	**0.762**	0.398	0.354	0.390	0.437	0.405	0.460	0.445
FC4	0.312	0.402	0.591	**0.844**	0.440	0.390	0.500	0.548	0.473	0.461	0.560
FP1	0.317	0.339	0.295	0.300	**0.777**	0.351	0.275	0.301	0.330	0.268	0.303
FP2	0.410	0.493	0.408	0.489	**0.920**	0.456	0.409	0.430	0.454	0.427	0.452
FP3	0.452	0.524	0.403	0.505	**0.884**	0.408	0.389	0.414	0.442	0.401	0.441
HB1	0.274	0.666	0.287	0.400	0.435	**0.929**	0.470	0.485	0.423	0.547	0.392
HB2	0.294	0.623	0.347	0.470	0.460	**0.894**	0.553	0.489	0.470	0.514	0.460
HB3	0.281	0.574	0.170	0.279	0.358	**0.833**	0.367	0.285	0.374	0.526	0.354
PE1	0.282	0.375	0.477	0.407	0.350	0.401	**0.838**	0.319	0.373	0.446	0.340
PE2	0.263	0.425	0.499	0.480	0.387	0.483	**0.908**	0.367	0.412	0.554	0.439
PE3	0.267	0.449	0.445	0.461	0.358	0.512	**0.866**	0.375	0.383	0.541	0.413
PE4	0.243	0.378	0.595	0.522	0.365	0.403	**0.838**	0.461	0.428	0.487	0.502
PV1	0.182	0.446	0.340	0.427	0.344	0.457	0.358	**0.848**	0.479	0.393	0.473
PV2	0.245	0.353	0.450	0.495	0.398	0.344	0.342	**0.856**	0.448	0.338	0.482
PV3	0.274	0.420	0.495	0.588	0.435	0.431	0.439	**0.899**	0.496	0.405	0.542
SAF1	0.417	0.460	0.481	0.435	0.449	0.414	0.395	0.508	**0.894**	0.368	0.653
SAF2	0.375	0.422	0.496	0.442	0.400	0.402	0.413	0.445	**0.892**	0.364	0.626
SAF3	0.383	0.487	0.423	0.454	0.418	0.460	0.395	0.501	**0.896**	0.404	0.639
SAF4	0.323	0.450	0.498	0.479	0.436	0.413	0.436	0.486	**0.864**	0.364	0.686
SI1	0.353	0.535	0.331	0.438	0.366	0.567	0.473	0.376	0.367	**0.888**	0.379
SI2	0.366	0.523	0.346	0.460	0.376	0.513	0.536	0.377	0.342	**0.892**	0.368
SI3	0.299	0.529	0.317	0.436	0.378	0.530	0.492	0.355	0.336	**0.901**	0.332
SI4	0.266	0.475	0.496	0.555	0.380	0.445	0.545	0.414	0.426	**0.766**	0.429
TR1	0.344	0.447	0.476	0.552	0.456	0.429	0.450	0.569	0.640	0.370	**0.861**
TR2	0.360	0.482	0.496	0.546	0.434	0.411	0.474	0.476	0.660	0.394	**0.896**
TR3	0.327	0.479	0.513	0.588	0.433	0.420	0.462	0.506	0.649	0.382	**0.915**
TR4	0.376	0.415	0.374	0.441	0.309	0.312	0.306	0.450	0.601	0.365	**0.800**

Note: PE: Performance Expectancy; EE: Effort Expectancy; SI: Social Influence; FC: Facilitating Conditions; PV: Price Value, HB: Habit; TR: Trust; SAF: Satisfaction; FP: Former Practice; AW: Awareness; BI: Behavioural Intention.

- **Heterotrait-monotrait ratio (HTMT) technique**

As cross-loadings and the Fornell-Larcker criterion have been criticised for being unable to identify the problems in discriminant validity, HTMT has been introduced as a recent method employed in spotting discriminant validity. If the value of HTMT is above the assigned threshold, it is argued that there is a problem with discriminant validity. The value of 0.9 is set to be the stated threshold to be used with the technology acceptance model to investigate the validity (Henseler, Ringle and Sarstedt, 2015). The table below (7.17) presents the outcomes of the HTMT test, and it can be noticed that HTMT values are identified to be lower than 0.85 and range from 0.816 to 0.324.

Table 7.17: Results of Heterotrait-Monotriat ratio (HTMT)

Constructs	AW	BI	EE	FC	FP	HB	PE	PV	SAF	SI	TR
AW											
BI	0.482										

EE	0.377	0.359									
FC	0.406	0.534	0.723								
FP	0.550	0.613	0.498	0.596							
HB	0.369	0.803	0.342	0.506	0.554						
PE	0.352	0.533	0.652	0.625	0.484	0.594					
PV	0.324	0.544	0.563	0.687	0.533	0.551	0.510				
SAF	0.486	0.572	0.588	0.581	0.545	0.538	0.516	0.624			
SI	0.425	0.676	0.483	0.633	0.496	0.683	0.667	0.509	0.475		
TR	0.479	0.592	0.593	0.704	0.535	0.517	0.549	0.666	0.816	0.493	

Note: PE: Performance Expectancy; EE: Effort Expectancy; SI: Social Influence; FC: Facilitating Conditions; PV: Price Value, HB: Habit; TR: Trust; SAF: Satisfaction; FP: Former Practice; AW: Awareness; BI: Behavioural Intention.

7.6 Structural Model Analysis: Assessment of Collinearity for the Structural Model

7.6.1 Collinearity test

The collinearity test is adopted to start the structural model analysis to identify if the structural model has any issues with collinearity between independent variables. This test helps identify cases where more than two constructs in the structural model are linearly related. A Variance Inflation Factor (VIF) of an independent variable should be below 5 to approve that the threat of collinearity does not exist and that the regarrison is stable with low standard errors (Hair *et al.*, 2014). The researcher used the Variance Inflation Factor (VIF) values produced by the SmartPLS software to evaluate the structural model's collinearity issue among the predictor constructs. Two kinds of VIF are reported: the outer VIF, which is used to examine the collinearity within the items of a particular construct. The values of outer VIF are presented in Table 7.18. The inner VIF "*shows the severity of collinearity among constructs (latent variables) in the model*" (Jones-Smith and Popkin, 2010, p. 6). Table 7.19 presents the inner VIF values of the current study. The researcher conducted the Collinearity test to assess a set of predictor constructs regarding each part of the structural model and the dependent variable (Behavioral Intention). The assessment of the predictors used to identify the acceptance of smart transportation mobile applications, including FC, EE, SI, PE, PV, HB, TR, FP, AW, and SAF and the dependent variable BI presented in Table 7.19 show that all VIF values were lower than 5. This indicates that collinearity does not make any critical threats regarding the current study.

Table 7.18: Results of Collinearity test (Outer VIF values)

Constructs items	VIF
AW1	1.987
AW2	1.669
AW3	1.403
BI3	2.529
BI1	2.248
BI2	2.747
EE1	2.277
EE2	3.101

EE3	3.321
EE4	2.230
FC1	2.395
FC2	2.323
FC3	1.565
FC4	1.975
FP1	1.724
FP2	2.648
FP3	2.037
HB1	3.136
HB2	2.650
HB3	1.813
PE1	2.236
PE2	3.136
PE3	2.206
PE4	2.160
PV1	1.661
PV2	2.230
PV3	2.493
SAF1	3.053
SAF2	3.094
SAF3	2.789
SAF4	2.385
SI1	2.883
SI2	2.868
SI3	3.075
SI4	1.614
TR1	2.383
TR2	3.157
TR3	3.467
TR4	1.920

Note: PE: Performance Expectancy; EE: Effort Expectancy; SI: Social Influence; FC: Facilitating Conditions; PV: Price Value, HB: Habit; TR: Trust; SAF: Satisfaction; FP: Former Practice; AW: Awareness; BI: Behavioural Intention.

Table 7.19: Results of Collinearity test (Inner VIF values)

Constructs	VIF
AW	1.421
EE	2.176
FC	2.464
FP	1.742
HB	1.982
PE	2.095
PV	1.896
SAF	2.553
SI	2.058
TR	2.727

Note: PE: Performance Expectancy; EE: Effort Expectancy; SI: Social Influence; FC: Facilitating Conditions; PV: Price Value, HB: Habit; TR: Trust; SAF: Satisfaction; FP: Former Practice; AW: Awareness; BI: Behavioural Intention.

7.6.2 Path coefficient

To evaluate the structural model, the path coefficient between the latent variables is calculated regarding their significance and magnitude (Russell *et al.*, 1998). A path coefficient is considered a kind of partial regression used to evaluate the direct effect of one variable on another (Saunders, Lewis and Thornhill, 1959). The path of coefficients indicates the hypothesised relationships in the model. In the current study and as advised by Hair, Ringle and Sarstedt (2013), the path coefficients for the structural model were obtained using 5000 samples in Bootstrapping test with 383 sample size. The structural model was designed to assess ten paths (H1 to H10), excluding the moderators. The t-test values and their significance p-values are calculated using the path coefficients as they demonstrate the significant and insignificant relationships and identify the nature of these relationships (Kock, 2016). Table 7.20 represents the finding of path coefficients of each hypothesis along with their t-values and p-values to be used in evaluating the significance of each main hypothesis. As can be observed from the table, apart from three pathways (FP -> BI, HB -> BI, SI -> BI), almost all of the paths were identified to be insignificant as their p-values were not less than 0.05.

Table 7.20: Path Coefficients, t-value, and P-value of the hypothesis

Relations	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics	P Values
AW -> BI	0.078	0.079	0.045	1.742	**0.082**
EE -> BI	-0.106	-0.102	0.054	1.953	**0.051**
FC -> BI	-0.005	-0.005	0.056	0.096	**0.924**
FP -> BI	0.156	0.156	0.055	2.817	**0.005**
HB -> BI	0.406	0.406	0.054	7.515	**0.000**
PE -> BI	0.002	0.002	0.047	0.051	**0.959**
PV -> BI	0.039	0.040	0.056	0.689	**0.491**
SAF -> BI	0.061	0.059	0.065	0.941	**0.347**
SI -> BI	0.201	0.199	0.053	3.785	**0.000**
TR -> BI	0.141	0.141	0.074	1.897	**0.058**

Note: PE: Performance Expectancy; EE: Effort Expectancy; SI: Social Influence; FC: Facilitating Conditions; PV: Price Value, HB: Habit; TR: Trust; SAF: Satisfaction; FP: Former Practice; AW: Awareness; BI: Behavioural Intention.

7.6.2.1 Coefficient of Determination R^2

According to Chin (1998), R^2 is calculated to identify the predictive power of the proposed model by evaluating the link between the latent variable variance and the total variance of the dependent variables. Chin (1998) also stated that R^2 values greater than 0.67 are considered to have a high amount of variance, whereas values between 0.33 and 0.67 are classified as having a moderate effect. Values ranging between 0.19 and 0.33 are weak, and those less than 0.19 are very weak. The R^2 value of the endogenous construct (BI) in the proposed model was calculated by employing SmartPLS. The R^2 value of the BI in the current study was 0.609, reflecting that the proposed model explains around 60.9 % of the variance in BI. This finding was obtained without the inclusion of the moderators. Table 7.21 shows that the structural model, with R^2 of 60.9 %, can explain the variance for the dependent latent variable of the behavioural intention satisfactorily or moderately.

Table 7.21: R-Square value of the proposed model

Determination of coefficient R^2 value		
Construct	**R^2**	**Result**
Behavioural Intention	0.609	Moderate

7.6.2.2 Effect Size f^2

The p-value highlights the effect's existence, yet it tells nothing about the effect size (Sullivan and Feinn, 2012). As cited in Kline (2004), "*statistical significance is the least interesting thing about the results. You should describe the results in terms of measures of magnitude -not just does a treatment affect people, but how much does it affect them*" (Kline, 2004, p. 95). As a result, the researchers must consider the effect size to understand the meaning and importance of the findings (Sullivan and Feinn, 2012). According to Cohen (1988), f^2 greater than or equal to 0.02 is small, greater than or equal to 0.15 is medium, greater than or equal to 0.35 is large and values less than 0.02 are considered as having no effect. Table 7.22 presents the results of the f^2 of the current study. According to the below table, most of the factors such as AW->BI, EE->BI, FC->BI, PE->BI, PV->BI, SAF->BI, and TRA->BI had no effect as their f^2 values are less than 0.02. On the other hand, FP->BI and SI->BI are considered as having a small effect size as their f^2 values are between 0.02 to 0.15. The highest effect size was for HB->BI (0.213), which is considered to have a medium effect size.

Table 7.22: Results of Assessment of f2 Effect Size

Constructs	**BI**
AW	0.011
EE	0.013
FC	0.000
FP	0.036
HB	0.213
PE	0.000
PV	0.002
SAF	0.004
SI	0.050
TR	0.019

Note: PE: Performance Expectancy; EE: Effort Expectancy; SI: Social Influence; FC: Facilitating Conditions; PV: Price Value, HB: Habit; TR: Trust; SAF: Satisfaction; FP: Former Practice; AW: Awareness; BI: Behavioural Intention.

7.6.2.3 Predictive Relevance $Q2$

Q^2 is used to assess the predictive relevance of complex models (Geisser, 1975; Stone, 1976; Chin, 1998). Predictive relevance is "*a synthesis of cross validation and function fitting with the*

perspective that the prediction of observables is of much greater relevance than the estimation of what are often artificial construct – parameters” (Geisser, 1975, p. 320). It is used to assign the predictive relevance of latent variables by calculating the Q^2 values by employing the blindfolding process in Smart PLS. The blindfolding approach is an incremental process that iteratively runs until the model is re-estimated when each data piece is excluded. This test is also determined by the Stone-Geisser criteria (Hair, Ringle and Sarstedt, 2013), which tests whether the model can accurately predict the measuring items for the endogenous constructs. To be predictively relevant, the Q^2 values must be greater than zero, otherwise, the model lacks being predictively relevant. According to Hair et al. (2014), the Q^2 values of 0.02, 0.15, and 0.35 indicates that the predictive relevance is small, medium, and large, respectively.
Regarding the current study, the predictive relevance was conducted only for BI as it is the only endogenous variable in the model. As the sample size was 383, the researcher chose the default value of 7 as the D value to prevent generating an integer value. Table 7.23 displays the model's Q^2 values. The table indicates that the predictive relevance values for the paths in the model ranged between 0.626 to 0.362, which indicates that the predictive relevance is reported to be above the threshold of 0.02 for all the variables. Table 7.23 also approves that all the constructs achieved considerable predictive relevance.

Table 7.23: Results of Assessment of Q^2

Constructs	SSO	SSE	Q^2 (=1-SSE/SSO)
AW	1149.000	732.740	0.362
BI	1149.000	479.288	0.583
EE	1532.000	613.706	0.599
FC	1532.000	814.524	0.468
FP	1149.000	598.743	0.479
HB	1149.000	523.587	0.544
PE	1532.000	670.619	0.562
PV	1149.000	593.027	0.484
SAF	1532.000	573.394	0.626
SI	1532.000	661.656	0.568
TR	1532.000	640.953	0.582

Note: PE: Performance Expectancy; EE: Effort Expectancy; SI: Social Influence; FC: Facilitating Conditions; PV: Price Value, HB: Habit; TR: Trust; SAF: Satisfaction; FP: Former Practice; AW: Awareness; BI: Behavioural Intention.

7.7 Assessing the Moderators’ Effects

There are intervening factors that have a moderating influence on the impact of the independent variables on the dependent variables, as shown in the study model in Chapter 3. Hayes (2013) states that moderation analysis is utilised when the purpose is to expose the border conditions for a relationship between two variables. Concerning the ongoing research, age, gender, and experience are the intervening variables that can result in moderate interactions. Therefore, moderation analysis is used when a specific intervening variable is thought to impact the link between the independent and dependent variables (Gall, Borg and

Gall, 1996). Researchers usually test the moderating effect after looking at the direct paths in the study's model. Moderators may be either qualitative or quantitative variables.

There are two approaches for analysing the moderating influence in structural models; while the first strategy uses multigroup analysis (MGA), the second technique uses the interaction effect. A new structural link is shown when a moderating effect is introduced to the route model in the interaction effect technique. The first tactic is typically used when the independent variable or moderator is categorical and is advised in categorical moderator circumstances (Baron and Kenny, 1986; Sauer and Dick, 1993). All of the moderators evaluated in this study were factors rather than continuous variables. They all are assigned to categorical moderators. Thus, this thesis uses the MGA to examine how moderators affect the paths in the current model. This led the researcher to choose the MGA technique over the interaction approach. The PLS-MGA tool in SmartPLS software was used to compare the groups and highlight their disparities. The outcomes of evaluating the impacts of the three moderators are discussed in the below sections.

7.7.1 Moderation Effect of Gender

The gender moderator is a categorical variable as the questionnaire is designed to be either male or female and does not require any refinement. Based on the demographic data analysis, around 228 of the 383 respondents (around 59.5 %) were female, and 155 (about 40.5%) were male. Table 7.24 provides a summary of the moderating effect of gender. The results of the PLS-MGA test revealed that none of the relationships seemed to be impacted by the moderator's gender. Thus, gender was not identified as a major moderator explaining the variation in behavioural intention to embrace smart transportation mobile applications. Table 7.24 indicates no significant differences between males and females within all of the relations.

7.7.2 Moderation Effect of Age

Although there were seven options for the age construct in the questionnaire, the researcher grouped them into two groups since some of these categories had fewer replies. Group 1 represents the younger people, those between 18 and 30 years old (n=127), whereas Group 2 represents the older people, those between the ages of 31 and above (n=256). Table 7.25 shows the summary of the moderating effect of age. According to the PLS-MGA findings, only two relationships were significantly different between the two subsamples. First, EE->BI (p value=0.048), in which the effect of EE on BI was stronger among the group of higher than 31 years old than the less than 30 years old users' group. Second, TR->BI (p value=0.032), in which the effect of TR on BI was also stronger among the subsample of higher than 31 users than the younger user group.

7.7.3 Moderation Effect of Experience

The experience moderator variable was divided into ‘less experienced users’ (less than ten years) with 121 users and ‘high experienced users’ (more than ten years) with 262 citizens. Table 7.26 presents the summary of the moderating effect of experience. The results of the PLS-MGA test indicated that experience moderated two of the model's hypothesised relationships: SI->BI and TR- >BI, where p-values = 0.041 and 0.041, respectively. The results indicated that the effect of SI on BI was stronger among highly experienced users, which was anticipated. In contrast, the impact of TR on BI was stronger among the low-experienced users.

Table 7.24: Summary of the Moderating Effect of Gender

Hypothesis	Relation	Subsample Female users				Subsample Male users				Path coefficient differences	P-value (Female users) vs (Female users
		Path coefficient	SD	t-value	P-value	Path coefficient	SD	t-value	P-value		
H2b	**EE -> BI**	-0.069	0.077	0.901	**0.368**	-0.154	0.089	1.739	**0.083**	0.227	**0.453**
H4b	**FC -> BI**	-0.051	0.075	0.684	**0.494**	0.094	0.093	1.003	**0.316**	0.888	**0.223**
H6b	**HB -> BI**	0.471	0.069	6.850	**0.000**	0.358	0.085	4.200	**0.000**	0.147	**0.294**
H1b	**PE -> BI**	-0.014	0.066	0.218	**0.828**	-0.006	0.071	0.083	**0.934**	0.538	**0.924**
H5b	**PV -> BI**	0.012	0.083	0.143	**0.886**	0.040	0.082	0.484	**0.628**	0.600	**0.800**
H8b	**SAF -> BI**	-0.037	0.083	0.448	**0.654**	0.194	0.107	1.816	**0.070**	0.962	**0.076**
H3b	**SI -> BI**	0.191	0.071	2.702	**0.007**	0.190	0.085	2.226	**0.026**	0.499	**0.998**
H7b	**TR -> BI**	0.187	0.108	1.739	**0.083**	0.119	0.115	1.036	**0.301**	0.328	**0.657**

Note: PE: Performance Expectancy; EE: Effort Expectancy; SI: Social Influence; FC: Facilitating Conditions; PV: Price Value, HB: Habit; TR: Trust; SAF: Satisfaction; FP: Former Practice; AW: Awareness; BI: Behavioural Intention.

Table 7.25: Summary of the Moderating Effect of Age

Hypothesis	Relation	Subsample Higher than 31				Subsample Less then 30				Path coefficient differences	P-value (Female users) vs (Female users
		Path coefficient	SD	t-value	P-value	Path coefficient	SD	t-value	P-value		
H2a	**EE -> BI**	-0.209	0.070	2.998	**0.003**	0.011	0.088	0.129	**0.897**	-0.220	**0.048**
H4a	**FC -> BI**	0.066	0.073	0.899	**0.369**	-0.073	0.104	0.701	**0.484**	0.139	**0.274**
H6a	**HB -> BI**	0.369	0.069	5.343	**0.000**	0.480	0.089	5.416	**0.000**	-0.111	**0.321**
H1a	**PE -> BI**	0.076	0.057	1.333	**0.183**	-0.084	0.081	1.044	**0.296**	0.160	**0.110**
H5a	**PV -> BI**	0.083	0.069	1.204	**0.229**	-0.047	0.091	0.511	**0.609**	0.129	**0.255**
H8a	**SAF -> BI**	-0.012	0.072	0.161	**0.872**	0.220	0.109	2.024	**0.043**	-0.231	**0.083**
H3a	**SI -> BI**	0.184	0.064	2.874	**0.004**	0.200	0.090	2.221	**0.026**	-0.016	**0.875**
H7a	**TR -> BI**	0.239	0.085	2.814	**0.005**	-0.076	0.119	0.642	**0.521**	0.316	**0.032**

Note: PE: Performance Expectancy; EE: Effort Expectancy; SI: Social Influence; FC: Facilitating Conditions; PV: Price Value, HB: Habit; TR: Trust; SAF: Satisfaction; FP: Former Practice; AW: Awareness; BI: Behavioural Intention.

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Table 7.26: Summary of the Moderating Effect of Experience

Hypothesis	Relation	Subsample Less than 10 years				Subsample More than 10 years				Path coefficient differences	P-value (Female users) vs (Female users
		Path coefficient	SD	t-value	P-value	Path coefficient	SD	t-value	P-value		
H2c	**EE -> BI**	-0.029	0.088	0.332	**0.740**	-0.151	0.071	2.120	**0.034**	0.121	**0.278**
H4c	**FC -> BI**	-0.036	0.098	0.362	**0.718**	0.060	0.073	0.814	**0.415**	-0.095	**0.427**
H6c	**HB -> BI**	0.422	0.107	3.956	**0.000**	0.368	0.065	5.650	**0.000**	0.054	**0.683**
H1c	**PE -> BI**	-0.053	0.084	0.626	**0.531**	0.058	0.058	0.998	**0.318**	-0.111	**0.273**
H5c	**PV -> BI**	-0.065	0.097	0.664	**0.507**	0.074	0.065	1.136	**0.256**	-0.139	**0.233**
H8c	**SAF -> BI**	-0.045	0.128	0.352	**0.725**	0.082	0.064	1.267	**0.205**	-0.127	**0.382**
H3c	**SI -> BI**	0.017	0.101	0.168	**0.867**	0.259	0.062	4.191	**0.000**	-0.242	**0.041**
H7c	**TR -> BI**	0.398	0.151	2.647	**0.008**	0.043	0.075	0.583	**0.560**	0.355	**0.041**

Note: PE: Performance Expectancy; EE: Effort Expectancy; SI: Social Influence; FC: Facilitating Conditions; PV: Price Value, HB: Habit; TR: Trust; SAF: Satisfaction; FP: Former Practice; AW: Awareness; BI: Behavioural Intention.

7.8 Results of Hypotheses Testing

A summary of the results of the current research's hypothesises testing is presented in Table 7.27. An explanation of each hypothesis testing result is identified in the following sections.

- **Performance Expectancy and Behavioural Intention (H1)**

Based on the literature review, performance expectancy is classified as one of the main factors influencing end users' acceptances in organisational and consumer contexts within the UTAUT2 model. Therefore, this study hypothesised that performance expectancy positively affects citizens' behavioural intention to adopt smart transportation mobile applications. However, this hypothesis was not supported in the current study as the results suggest no statistical significance between the two variables as the t-value is 0.051, lower than 1.96. The p-value is 0.959, which is greater than 0.05.

- **Effort Expectancy and Behavioural Intention (H2)**

Effort expectancy has been hypothesised to positively impact the behavioural intention to accept smart transportation mobile applications in the Omani context. This has also been recognised in various studies in the literature to positively influence behavioural intention within the UTAUT2 model. However, the extended model within the sample data did not support this hypothesis. The path was insignificant as the p-value equals 0.051, and the t-value equals 1.953. The standardised estimate path coefficient is -0.106. These results suggest that the effort expectancy of smart transportation mobile applications has no relation with Omani's behavioural intention to use them. Therefore, H2 is empirically not supported.

- **Social Influence and Behavioural Intention (H3)**

Social influence was also considered a critical factor influencing end users' acceptance of the new technologies. It has been investigated in previous studies in both organisational and consumer contexts. In the current research, this construct has been hypothesised to positively influence citizens' acceptance of smart transportation mobile applications. This path's results are significant as the t-value is 3.785, and the p-value is 0.00. The standardised path coefficient is 0.201, indicating the positive relationship between social influence and behavioural intention. This means the more social influence citizens get, the more behavioural intention to accept the smart transportation mobile applications.

- **Price Value and Behavioural Intention (H4)**

This hypothesis represents the relation between price value and behavioural intention. Price value has been hypothesised to positively influence the behavioural intention to adopt smart transportation mobile applications. However, the results of the standardised coefficients are 0.039, t-value = 0.689 and p-value= 0.491. This indicates that the price value negatively influences behavioural intention, and the relationship is not statistically significant; accordingly, this hypothesis is not supported.

- **Facilitating Conditions and Behavioural Intention (H5)**

This hypothesis explains the relation between the facilitating condition and behavioural intention. As reported in the literature review chapter, this construct has been classified as one of the main factors impacting end users' acceptance, especially in the organisational context in UTAUT2 models. This relation was also recognised in the consumer context in the UTAUT2 model. Accordingly, this research hypothesised the relationship between facilitating conditions and behavioural intention to positively impact the Omani context. Table 7.27 shows that the standardised path effect is - 0.005, the t-value is 0.096 < 1.96, and the p-value is 0.924> 0.05. As a result, these statistics suggest that facilitating conditions is statistically insignificant, and thus this hypothesis is not supported. Thus, facilitating conditions do not influence citizens' behavioural intention to adopt smart transportation mobile applications in -

- **Habit and Behavioural Intention (H6)**

The structural model results indicate that the relationship between habit and behavioural intention to accept smart transportation mobile applications is significant (p=0.000, t=7.515). This finding is in line with the UTAUT2 model. This construct is accordingly assigned as one of the main influential factors on the citizen's behavioural intention to accept smart transportation mobile applications in Oman. Therefore, the results supported this hypothesis.

- **Trust and Behavioural intention (H7)**

Trust has been proposed as a new construct influencing citizens to accept smart transportation mobile applications in the Omani context. This construct has been explored from the literature review and was hypothesised to significantly influence Omani's perceptions of adopting smart transportation mobile applications. However, the structural model result shows that the relationship between trust and behavioural intention is not significant (p-value=0.058, t-value= 1.897). This implies no strong relation between behavioural intention to use smart transportation mobile applications and trust. Therefore, this hypothesis is not supported.

- **Satisfaction and Behavioural Intention (H8)**

The literature review chapter also explored the satisfaction construct as a new factor used to extend the UTAUT2 model as a new factor influencing Omani's acceptance of smart transportation mobile applications in the Omani context. It was assumed that citizens more satisfied with the smart transpiration applications would be more willing to use them. Thus, this research hypothesised that satisfaction positively influences citizens' perception of accepting smart transportation mobile applications. However, the statistical results of the structural model rejected this hypothesis as p-value =0.347, t-value=0.941.

- **Awareness and Behavioural Intention (H9)**

Awareness is considered a new factor influencing citizens' acceptance of the smart transportation mobile applications in Oman and is used to extend the UTAUT2 model in the current research context. The hypothesis of awareness and the behavioural intention was added as it has been introduced based on the qualitative study. Table 7.27 shows that the positive relationship between awareness and behavioural intention was not supported as the path coefficient was insignificant as it equals 0.078 with t-vale = 1.742 and p-value= 0.082.

- **Former Practice and Behavioural Intention (H10)**

The former practice is another predictor proposed as a new factor resulting from the qualitative study to influence behavioural intention. The sample data supported the positive relation between former practice and behavioural intention (t-value= 2.817, p-value=0.005). Therefore, this finding indicates that the higher the former practice of the citizens, the more behavioural intention users will generate.

Overall, the above discussion of the main hypothesis suggests a positive effect from only social influence, former practice, and habit. On the other hand, a1impact on awareness, effort expectancy, facilitating condition, performance expectancy, price value, satisfaction, and trust.

Table 7.27: Path Coefficients, t-value and P-value of the proposed model

Relation	STDEV	T Statistics	P Values	Result
AW -> BI	0.045	1.742	**0.082**	**Rejected**
EE -> BI	0.054	1.953	**0.051**	**Rejected**
FC -> BI	0.056	0.096	**0.924**	**Rejected**
FP -> BI	0.055	2.817	**0.005**	**Supported**
HB -> BI	0.054	7.515	**0.000**	**Supported**
PE -> BI	0.047	0.051	**0.959**	**Rejected**
PV -> BI	0.056	0.689	**0.491**	**Rejected**
SAF -> BI	0.065	0.941	**0.347**	**Rejected**
SI -> BI	0.053	3.785	**0.000**	**Supported**
TR -> BI	0.074	1.897	**0.058**	**Rejected**

Note: PE: Performance Expectancy; EE: Effort Expectancy; SI: Social Influence; FC: Facilitating Conditions; PV: Price Value, HB: Habit; TR: Trust; SAF: Satisfaction; FP: Former Practice; AW: Awareness; BI: Behavioural Intention.

7.9 Summary

A suggested framework of factors directly impacting user acceptance of smart transportation mobile applications was built based on the UTAUT2 model, the literature on adopting the UTAUT2 model in other settings, and the preliminary interviews with service providers of smart transportation. Later it was evaluated by expected Omani users of smart transportation mobile applications. The variables included in the suggested framework were validated using several validity and reliability tests to attain an acceptable model fit before testing the key hypotheses. Later, an SEM technique was used to validate the main and sub-main hypotheses of the study.

The findings of the tests conducted on the hypotheses showed that H3, H6, and H10 were supported. This indicates that behavioural intention is positively influenced by Habit, former practice, and social influence. In contrast, as is observed from Table 7.28, all remaining hypotheses were rejected. Additionally, the moderating effects of the primary determinants on behavioural intention were investigated. The findings of all proposed hypotheses tests are shown in Table 7.28.

Table 7.28: Path Coefficients, t-value and P-value of the proposed model

Hypothesis No	IV	DV	Moderators	Results
H1	PE	BI	None	Rejected
H1a	PE	BI	Age	Rejected
H1b	PE	BI	Gender	Rejected
H1c	PE	BI	Experience	Rejected
H2	EE	BI	None	Rejected
H2a	EE	BI	Age	Supported found effect stronger for people higher than 31
H2b	EE	BI	Gender	Rejected
H2c	EE	BI	Experience	Rejected
H3	SI	BI	None	**Supported**
H3a	SI	BI	Age	Rejected
H3b	SI	BI	Gender	Rejected
H3c	SI	BI	Experience	Supported with effect stronger for high experienced users
H4	FC	BI	None	Rejected
H4a	FC	BI	Age	Rejected
H4b	FC	BI	Gender	Rejected
H4c	FC	BI	Experience	Rejected
H5	PV	BI	None	Rejected
H5a	PV	BI	Age	Rejected
H5b	PV	BI	Gender	Rejected
H5c	PV	BI	Experience	Rejected
H6	HB	BI	None	**Supported**
H6a	HB	BI	Age	Rejected
H6b	HB	BI	Gender	Rejected
H6c	HB	BI	Experience	Rejected
H7	TR	BI	None	Rejected
H7a	TR	BI	Age	Supported found effect stronger for people higher than 31
H7b	TR	BI	Gender	Rejected
H7c	TR	BI	Experience	Supported with effect stronger for low experienced users
H8	SAF	BI	None	Rejected
H8a	SAF	BI	Age	Rejected
H8b	SAF	BI	Gender	Rejected

H8c	SAF	BI	Experience	Rejected
H9	AW	BI	None	Rejected
H10	FP	BI	None	**Supported**

Note: PE: Performance Expectancy; EE: Effort Expectancy; SI: Social Influence; FC: Facilitating Conditions; PV: Price Value, HB: Habit; TR: Trust; SAF: Satisfaction; FP: Former Practice; AW: Awareness; BI: Behavioural Intention

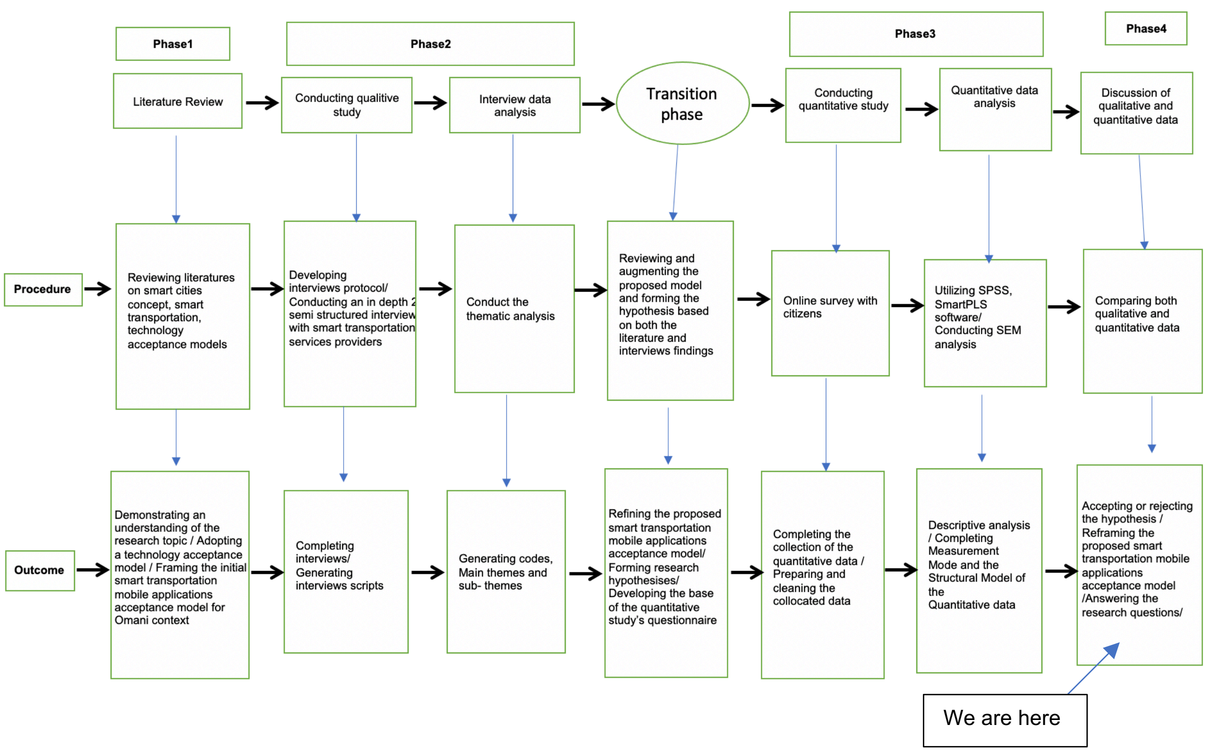
Chapter 8: Discussion

8.1 Introduction

This study is focused on identifying the factors that could influence citizen acceptance of smart transportation mobile applications in Oman. It also aims to identify the factors with the most significant influence on the Omani citizen's behavioural Intention toward the acceptance of smart transportation mobile applications. This chapter will discuss the results of the analysis conducted earlier in Chapters 6 and 7, contextualising them from the perspective of service providers and citizens. It will discuss the outcomes from qualitative and quantitative studies to answer each research question identified in chapter one. It will also justify the significance or insignificance of each relationship proposed in the conceptual model.

The findings show that most of the results are inconsistent with the initial expectations suggested at the beginning of the thesis. In particular, the reported results indicate differences between the perceptions of the service providers and the public about the factors facilitating the acceptance of the end users of smart transportation mobile applications in the Omani context. The following sections will discuss the research findings, and a conclusion will be executed based on the discussion. Figure 8.1 shows the position of the current discussion within the overall thesis.

Figure 8.1: The current phase (visual model of the exploratory, sequential mixed method designed for the present study)



8.2 Overall Presentation of The Proposed Acceptance Framework of Smart Transportation Mobile Applications in Oman

This study has proposed a framework for accepting smart transportation mobile applications in the Omani context. This framework is mainly based on the main UTAUT2 model. Then a literature review was conducted on the adoption of the UTAUT2 model in the context of smart cities and other settings to expand the original model with additional factors to better address the research questions with regards to the Omani contexts. Later a qualitative study was carried out to explore smart transportation services providers' perceptions of the factors influencing Omani citizens' acceptance of smart transportation mobile applications. This helped investigate the service providers' views on each factor assigned from the UTAUT2 model and the literature review chapter. This also contributed to better exploring the missing factors expected to influence the citizens' acceptance of the smart transportation mobile applications in the Omani context from the services providers' perceptions. As a result, based on the UTAUT2 model, literature review and interviews, the author extracted a proposed model of the factors expected to influence Omani citizens' acceptance of the smart transportation mobile applications to be examined in the quantitative study by the actual users of these applications.

Thus, the baseline model includes the main factors obtained from the UTAUT2 model: facilitating conditions, price value, effort expectancy, performance expectancy, habit, and social influence. To this, trust and satisfaction were added due to the literature review of the adoption of UTAUT2 in the previous contexts as factors affecting citizens' behavioural intention to accept smart transportation mobile applications. Moreover, additional elements, including former practice and awareness, were also added based on the understanding of the services providers of the factors impacting the acceptance of the smart transportation mobile applications in Omani contexts.

The current research finding found a different understanding between the service providers on the one hand and the public understanding on the other regarding the factors influencing citizens' acceptance of the smart transportation mobile applications in Oman. The following sections discuss the views of both the users and services providers, considering the literature on the acceptance, Omani context, and smart cities concept. As the survey findings are quantitative in nature, it does not offer an in-depth explanations of the results and answers to the research questions. Therefore, in addition to the literature review, the researcher conducted four interviews to explore the relationship between the conceptual model constructs. These interviews aimed to confirm the current research findings further and explain the investigation's unexpected results. The interviews were carried out with four experts from the qualitative study. One member from each organisation has been chosen to validate and substantiate the study's findings. By including the literature review and these interviews, the researcher explains the outcome of the current investigation through complete observation.

This chapter is divided into three main sections based on the factors incorporated into the research model. The first section will discuss the main UTAUT2 model factors. The second section will explain the expanded factors added by the literature review and the qualitative study. Later, a separate section will be added to discuss the findings of the moderator's impacts on each contextual factor.

8.3 Factors Expected To Influence Citizens' Acceptance Of Smart Transportation Mobile Applications In Oman

8.3.1 Performance Expectancy and Behavioural Intention

Performance expectancy is one of the main factors in the UTAUT2 model, which has received considerable attention in most studies in different contexts of human activities (Faqih and Jaradat, 2021). It has been stated by many researchers that performance expectancy is one of the main factors influencing citizens' acceptance and determining the adoption and usage of the information systems (Kim, Mirusmonov and Lee, 2010). Performance expectancy refers to "*the degree to which an individual perceives that using a system will help him or her to attain a gain in job performance*" (Venkatesh *et al.*, 2003, p. 447). This means that people who firmly believe that new technologies are valuable are more likely to have the desire to use them compared to those who think that they are less valuable. Therefore, hypothesis H1 suggested that PE positively affects Omani citizens' intention to adopt smart transportation mobile applications. Four items were designed to measure the performance expectancy construct: usefulness, quality, productivity, and better access. Most measurements were mainly adopted from (Venkatesh *et al.*, 2003; Venkatesh, Thong and Xu, 2012; Fleury *et al.*, 2017). The questions from the main model of UTAUT2 were modified to the context of the smart transportation mobile applications to make them more grounded in the context of this research.

Surprisingly, the current research finding indicates that performance expectancy is not considered a silent element associated with the acceptance of smart transportation mobile applications in the Omani setting, as indicated in the outcomes of the quantitative data analysis ($p = 0.959$, $t = 0.051$). As a result, the performance expectancy hypothesis is not supported as Omani citizens do not depend on it in deciding to adopt smart transportation mobile applications. Performance expectancy cannot predict how Omani users would behave toward smart transportation mobile applications. This result is not in line with the finding from the traditional UTAUT2 model and Venkatesh et al. (2012) assumptions, which emphasise that performance expectancy positively impacts the adoption process. Many previous studies have also concluded that performance expectancy is a critical factor influencing the acceptance of technologies. For instance, Naser Alraja et al. (2016) conducted research to investigate the effect of performance expectancy on the acceptance of the electronic government in the Sultanate of Oman and illustrated that performance expectancy is considered a silent factor affecting the adoption of electronic government in the Omani context. Similarly, many other studies such as (Almuraqab, Jasimuddin and Mansoor, 2021; Ferreira Barbosa *et al.*, 2021; Gharrah and Aljaafreh, 2021; Shatta and Shayo, 2021; Popova and Zagulova, 2022) have also approved the positive impact of performance expectancy in many contexts. While the current study outcome of the insignificance relationship between performance expectancy and behavioural intention contradicts the results of many previous studies in other contexts, the finding of the current research is in line with some other studies, such as Attuquayefio and Addo (2014), who conducted a study to explore students intention to accept information communication technologies and found that performance expectancy does not influence their acceptance. Similarly, performance expectancy was proved to have an insignificant effect on Taiwanese acceptance of e-invoice services (Lian, 2015).

Comparing services providers and customers of the smart transportation mobile applications, the finding indicates that citizens' perceptions of performance expectancy were different to those of services providers. With the introduction of smart transportation mobile applications in the Omani market, their providers were expecting to add value to their users, for example, in terms of saving time, improving the quality of commuting, and supporting the enjoyment of more productive days. They identified performance expectancy as one of the main factors relevant to their end users' intentions to use smart transportation mobile applications. This is because they expect that citizens can rely on smart transportation mobile applications to access adequate information needed for daily commuting and travelling. Service providers have also stated that with improved smart transportation mobile applications’ search capabilities, citizens are empowered with greater abilities to retrieve instant information in different transportation disciplines, such as the arrival and departure timing, congestion, and best routes. Therefore, service providers assumed that if citizens perceive the adoption of smart transportation and mobile applications will enhance their commuting and travelling; they may be favourably disposed to using them. Yet, Omani citizens confirmed a contrary finding to the opinion of the service providers in which they might not take such advantages into account when deciding whether to adopt a smart transportation mobile application. The quantitative finding implies that citizens were not impressed by the effectiveness and instant access of the transportation services and, accordingly did not encourage them to adopt. Consequently, in the context of this study, performance expectancy yielded an insignificant impact on the acceptance of smart transportation mobile applications. This indicates that Omani citizens do not depend on performance expectancy to adopt smart transportation mobile applications. This also implies that Omani citizens believe that smart transportation mobile applications will not benefit in improving their mobility quality and saving time.

This discrepancy may be explained by the fact that most Omani citizens rely highly on their private cars (Belwal and Belwal, 2010). In contrast, taxis and public buses are common only among expats (Didero, Nebel and Pfaffenbach, 2019). Therefore, most Omanis are not interested in information about public buses and taxis. The benefits of using smart transportation mobile applications vary depending on the citizen; mainly those without access to private vehicles can truly benefit from these applications' features. For this reason, some residents who own privet vehicles believe that smart transportation mobile applications do not significantly affect their productivity or regular mobility activities.

Since smart transportation mobile applications are still in their infancy stage in Oman, a user's understanding of the technology may substantially impact their desire to embrace it. This insignificance impact can also be understood by the fact that smart city applications in Oman are still in their initial stage (Sameer *et al.*, 2022). Therefore, most of the applications are restricted to a limited number of services, such as paying fees and ordering taxis, rather than providing advanced services. On the other hand, citizens in Oman expect to receive a high level of services by adopting complicated technologies as what is utilised in other neighbouring countries. For instance, although most Omanis prefer using public transport for long journeys, they also desire other faster and more convenient transportation methods, such as trains and trams, in addition to taxis and buses (Belwal and Belwal, 2011). Moreover, most Omani citizens are happy with the current methods of getting transportation services and, accordingly, are not willing to change in this respect. Citizens are hesitant to switch from traditional methods of getting transportation services to smart transportation mobile applications.

Additionally, Oman has two main highways: Sultan Qaboos Road and Muscat Express. As a result, getting live information about congested roads and accidents makes little difference as they have no other option except to use one or the other. Thus, citizens believe that the advantages of these smart applications are not reachable. Moreover, the availability of other transportation websites that may give users access to data and information for mobility-related needs gives them the impression that using smart transportation mobile applications to get the services they seek does not add value to them. Thus, they do not count the performance expectancy when adopting smart transportation mobile applications.

The researcher asked the interviewed service providers to give reasons why users might not show interest in the benefits provided by their smart transportation mobile application. According to two interviewees, the usefulness of smart transportation mobile applications should be coupled with the development of basic infrastructure, including proper road networks and public transportation systems throughout the country. They believe that the full advantages of the smart transportation mobile applications mentioned by the service providers can be obtained only after implementing proper infrastructure. Without it, these applications may not function properly. One of the services providers said:

> "*Smart transportation mobile applications may not be as effective as they may be with lack of infrastructure, which would prevent their adoption. I believe that if smart transportation is fully implemented, it will only lead to qualitative commuting in Oman. Then only citizens will be able to get the full advantages expected by them*" (SAS1).

Moreover, the Public Service Supervisor (PSS1) argued that in particular regions and countries, cultural constraints could make it challenging to integrate smart transportation mobile applications. To successfully deploy new technologies and enhance mobility options for everyone, it is critical to recognise and remove these barriers. He stated:

> "*The Omani culture dislikes change and always chooses the traditional modes of transportation. Because of this, persuading individuals to use new technologies may be challenging*" (PSS1).

8.3.2 Facilitating Conditions and Behavioural Intention

Facilitating conditions are "*the degree to which an individual believes that the organisational and technical infrastructure exists to support the use of the system*" (Venkatesh *et al.*, 2003, p. 453). This construct addresses citizens' abilities to use smart transportation mobile applications in daily commuting. The finding of both Venkatesh and Zhang (2010) and Venkatesh, Thong and Xu (2012) were used as a base to select the measurements of facilitating conditions factor to be involved in the quantitative questionnaire. This dimension was tested through four items which mainly focused on whether participants felt they had access to the support, resources, and knowledge and whether the services provided were compatible with other technologies they were using.

Technological, social, and economic constraints in developing countries have caused a lack of fundamental technical abilities and resulted in citizens who are less used to modern technology (Ndou, 2004). The digital divide and resource availability are serious issues in developing countries. Accordingly, facilitating conditions will likely be a critical factor influencing the adoption of smart transportation mobile applications (Shareef *et al.*, 2011; Al-Hujran and Migdadi, 2013). Thus, it was anticipated earlier in this study that Omani citizens' intentions to use smart transportation mobile applications will be strongly influenced by the construct of facilitating conditions and the availability of relevant resources. Facilitating conditions is, therefore, likely to be a key determinant impacting the adoption of smart transportation mobile applications in Oman, too, as the digital gap is more pronounced in underdeveloped nations like Oman (Shareef *et al.*, 2011). It was anticipated that this study would also find that the accessibility to the necessary resources has a significant impact on citizens' intent to use smart transportation mobile applications.

However, the result of this study has shown that facilitating conditions factor surprisingly does not affect the citizen's adoption of the smart transportation mobile applications in Oman. This result contradicts many previous studies which underlined the importance of facilitating conditions in consumer's behavioural intentions to adopt new technologies such as (Venkatesh, Thong and Xu, 2012; Lancelot Miltgen, Popovič and Oliveira, 2013; Attuquayefio and Addo, 2014; Chauhan and Jaiswal, 2016; Lau *et al.*, 2020; Akinnuwesi *et al.*, 2022; Park *et al.*, 2022). Yet, this result further supports other technology acceptance studies such (Thompson, Higgins and Howell, 1991; Gallivan, Spitler and Koufaris, 2005; Indrawati and Haryoto, 2015; Bervell *et al.*, 2022) which came up with a similar result. The result obtained in the current research is also similar to Tristiyanto, Fiska and Ardiansyah, (2019), who also concluded that facilitating conditions has no impact on the acceptance and use of the online taxis in Indonesia

This result also contradicts the finding of the qualitative study in which the service providers of the smart transportation mobile applications strongly believe in the importance of the availability of the resources such as the internet, rules and regulation, professional workers, and capital as a vital prospect to facilities smart transportation mobile applications acceptance. They also addressed the importance of developing smart transportation mobile applications compatible with citizens' devices and technologies. They also considered the availability of rules and regulations and the skilled workers to manage the quality of the services delivered as essential requirements in facilitating the successful implementation of smart transportation mobile applications. Additionally, they also insisted on providing high-speed internet access at a reasonable price to enhance acceptance. These were considered essential in implementing smart transportation mobile applications from the service providers' perspective. However, the findings indicate that citizens are not seriously concerned about the resources available to adopt smart transportations mobile applications. The results suggested that customers might not be bothered by the guidance, resource availability, or assistance the smart transportation service providers offer when adopting smart transportation mobile applications.

This conclusion could be justified by the fact that smart transportation mobile applications are designed to be used similarly to other mobile applications, and accordingly, facilitating conditions is considered unnecessary. Most smartphone applications are easy to use, and the network ensures support for citizens with reliable connectivity. Therefore, smart transportation mobile applications are just another smart application that seldom needs assistance. Another possible reason for the above result could be that Venkatesh, Thong and Xu (2012) hypothesised that the facilitating conditions are expected to have a non-significance impact on anticipating users' behavioural intention when the constructs of performance expectancy and effort expectancy are both introduced in a model. This result support Venkatesh et al. (2003) claim that sometimes facilitating conditions might be confused with ease of use.

Another possible argument for this insignificance might be that the citizens of Oman are not expecting to receive strong support from the transportation authorities to assist them in using the smart transportation mobile applications, which would result in the facilitating conditions having no significance. In addition, younger generations, and middle-aged people, who are the main expected users, are more comfortable and familiar with using smart mobile applications technologies and thus need less assistance. Therefore, facilitating conditions have no major impact on their behavioural intentions in the current study context. According to Alba and Hutchinson (1987), having a wide experience with technology leads to greater familiarity, understanding, and confidence, thus minimising reliance on facilitating conditions. Also, Oman is a country that is going contemporary in demand for smart cities and has invested heavily in enhancing the ICT infrastructure (Saqib, Zarine and Noor, 2022).

Consequently, the facilitating conditions' effect was unimportant as most smart service providers are enriched with the required smart technologies to implement smart transportation applications successfully. Another explanation for the insignificant effect of facilitating conditions is the frequent maintenance of the smart transportation mobile applications and login failures, which prevent smart applications from presenting the desired services. Individuals' intention to use technology will be negatively and significantly impacted if they feel that assistance is inconsistent. The idea is that facilitating conditions will directly predict and favourably affect the behavioural intention in situations where the support is not constant.

The service providers were also asked about the role of the facilitating conditions construct in implementing and adopting smart transportation mobile applications and if they, as service providers, are aware of the reasons behind the insignificance of facilitating conditions construct to establish successful smart transportation mobile applications in the Omani context. Almost all participants were confused and did not understand why the facilitating conditions construct was unimportant in the context of the current investigation. However, according to the four service providers interviewed, other factors may be considered more important to citizens than facilitating conditions construct. The Head Of Information Technology (HOIT1) stated that when using smart transportation mobile applications, other constructs such as cost-effectiveness and price may be of greater value to the Omani users. The Senior Application Specialist (SAS1) from Organisation B said:

> "*Users may not perceive the support and the assistance to be important enough to affect their choice to use the application, even if they have the support. For instance, if the functioning and benefits of the applications are not beneficial, then having better support, help, and resources might not be a significant factor*" (ASA1).

However, the Marketing Specialist (MS1) from organisation A had a differing opinion and stated that a lack of adequate support for citizens could discourage them from adopting the technology. She mentioned an example of the Talabat application, where restaurants without real and proper photos of their menu generated little revenue compared to ones with real photos due to the difficulty users faced in expecting the type of dish they were ordering.

8.3.3 Habit and Behavioural Intention

Habit implies the perception of engaging people spontaneously in a specific behaviour due to learning (Venkatesh, Thong and Xu, 2012). Venkatesh, Thong and Xu (2012) argued that users' consistent past behaviour is one of the main determinants of their current behaviour. Hypothesis no 6 proposed that habit affects Omani citizens' intention to adopt smart transportation mobile applications. In this study, habit is explained as the extent to which Omani citizens intend to automatically adopt smart transportation mobile applications when commuting. Three items were involved in investigating the impact of the habit construct with regards to the current study, and they are adopted from (Venkatesh, Thong and Xu, 2012).

The structural model results indicated that the relationship between habit and behavioural intention to accept smart transportation mobile applications is significant ($p=0.000$, $t=7.515$). Thus, habit positively influences behavioural intention to use smart transportation mobile applications. Therefore, if smart transportation mobile applications become a habit for citizens, they will intend to use them. This indicates that passengers' habits are expected to strongly influence their intentions to utilise smart transportation mobile applications in Oman. The use of smart transportation mobile applications will become a routine for Omani citizens, who believe they will develop the habit of doing so as habit and behavioural intention are found to be positively correlated. The automatic acceptance and usage of the smart transportation mobile applications will be saved in the mind of the residents to turn into a strong habit affecting Omani citizens' behavioural intentions to adopt smart transportation mobile applications.

This finding is in line with the UTUAT2 model and other previous studies such as (Kim and Malhotra, 2005; Limayem, Hirt and Cheung, 2007; Venkatesh, Thong and Xu, 2012; Aigbefo, Blount and Marrone, 2022; Wijaya and Weinhandl, 2022; Wu *et al.*, 2022), which validates a positive and significant link between habit and behavioural intention. This finding implies that habit has a significant role in determining the engagement of smart transportation mobile applications for everyday commuting. According to Ouellette and Wood (1998), automaticity and strength of habit are the best predictors of future behaviour, with people's behaviours brought on by habit serving as a reasonable justification for a behaviour that may be deemed irrational or harmful. As a result, citizens' habit of excessively utilising smart transportation mobile applications is considered a driving force in shaping habitual and automatic behaviours about adopting smart transportation mobile applications. Information systems usage pattern is more likely to become a habit if it is both regular and extensive (Limayem, Hirt and Cheung, 2007).

The result of this study may be explained by the fact that we live in a technology revolution and that most Omanis use mobile devices or laptops for communication, education, or entertainment. Today, most citizens are using social media and other mobile applications for news information and for conducting quick searches enhanced by mobile device availability supporting the usage of such applications. Moreover, reading blogs related to one's interests, following service providers and political agencies on Twitter, or joining groups on social networks with the same interests are examples of repetitive behaviours. The statistics in Oman reported that around 4.14 million of Oman's population are active social media users (Kemp, 2021), and it is claimed that Twitter stands as the second most common platform (Statcounter, 2021). Likewise, smart transportation mobile applications might be treated as these applications by the citizens. By providing citizens with guidance, it is possible to transform such habits into the usage of smart transportation mobile applications. There is a very high chance of them becoming habitual, particularly if automated reminders are used. These applications' straightforwardness and simplicity might encourage repetitive behaviours that eventually are developed into habits. As smart transportation mobile applications are simple to use, free, convenient, supported by the instant process of obtaining a range of information, and available around the clock, their utilisation among Omani citizens may become a routine task and, therefore, can easily become automatic behaviour. Based on this discussion, it is logical to expect that using smart transportation mobile applications will be influenced by habit.

Another possible explanation for the positive link between habit and behavioural intention is that building a habit means performing the same action repeatedly. In other words, habit is expected to become significant in behaviours performed as daily activities. Thus, as accessing smart transportation mobile applications is expected to be performed daily and constantly since commuting is classified as a daily activity, accessing them will become a habit due to their repetitive nature (Ye and Potter, 2011).

Comparing services providers' and citizens' perceptions, results indicated that both share the same perceptions of habit construct, as both agreed that using smart transportation mobile applications is directly affected by habit. Both the qualitative and quantitative findings showed that the more citizens enjoy using smart transportation mobile applications while commuting, the more likely the intention towards utilising them will be positive. Most of the service providers stated that, although most citizens are dissatisfied with the current traffic and transposition system, they have become accustomed to it. As a result, they claimed that there is an excellent probability that smart transportation mobile applications will also become habitual for them too if they receive the necessary guidance and assistance.

As habit construct plays a critical role in accepting smart transportation mobile applications among Omani citizens, service providers are encouraged to support citizens and adopt smart transportation mobile applications by providing extended offers. They are recommended to build a habit and therefore demonstrate a behavioural intention of usage. For example, service providers can offer training to reduce fear and break citizens' old habits. Moreover, according to Kumar and Puttanna (2018), assigning effective rules and regulations alters users' preferences. For instance, policymakers can levy taxes on the usage of private cars during rush hours to encourage the use of smart transportation mobile applications such as Mwasalat and O-taxi. Both government and services providers need to bring changes in citizens' commuting habits by utilising short movies and advertisements on the benefits of smart transportation mobile applications to reinforce habits among citizens who use these applications sometimes and to work on inculcating the habit in the first-time user. All of the service providers interviewed approved the importance of the habit factor in the adoption of their smart transportation applications particularly in Omani context. In this respect, The Public Service Supervisor in organisation C said:

> "*Habit construct can be accomplished in several ways such as offering rewards, making the application simple to use, and incorporating it into the user's daily routine*" (PSS1).

The Senior Application Specialist (SAS1) explained that many human beings' actions are driven as part of the habit. He further argued that:

> "*Many of our actions are dictated by habit, and sometimes, these actions may not have a logical explanation. We simply perform them because they have become a habit. Thus, the impact of habit is extremely significant*" (SAS1).

Moreover, the Marketing Specialist (MS1) said that in Omani culture, developing a habit is viewed as a means of upholding self-discipline, restraint, and consistency in behaviour. He further claimed that gaining positive habits is another strategy for achieving success and happiness in life. As a result, the habit construct is emphasised in many aspects of Omani society, including education, religion, and personal growth.

8.3.4 Effort Expectancy and Behavioural Intention

According to Venkatesh *et al.* (2003, p. 450), effort expectancy refers to "*the degree of ease associated with the use of the system*". Effort expectancy in the context of the current study is defined as the extent to which citizens feel that using smart transportation mobile applications would be simple or complex. It is the amount of effort needed to use such applications. According to Venkatesh *et al.* (2003), technologies which are user-friendly and provide more flexibility are easier to be adopted and accepted by the end users. Likewise, Cheung, Chang and Lai (2000) claim that as an invention becomes more complex, its rate of adoption declines. Effort expectancy has also been recognised in various literature studies to influence behavioural intention in the UTAUT2 model positively. It has been identified as one of the critical determinants of the technology acceptance and adoption (Qasim and Abu-Shanab, 2016), and most of the previous researchers agreed that it often plays a significant role in determining how quickly technology is adopted at first (Baron, Patterson and Harris, 2006).

Consequently, effort expectancy has been hypothesised to positively impact the behavioural intention to accept smart transportation mobile applications in the Omani context. When citizens use smart transportation mobile applications to search for information or to request a public transport method, the effort they must execute influences their perceptions to adopt smart transportation mobile applications. Effort expectancy construct in the current study is measured by four items, including how easy it is to learn using them, how friendly, how clear and straightforward the interaction is, and how easy it is to become skilful in adopting them. The items related to effort expectancy have been obtained from Venkatesh, Thong and Xu (2012) and Venkatesh *et al.* (2003).

However, this hypothesis was not supported in the current extended model within the sample data. The path was insignificant as the p-value equals 0.051 and the t-value equals 1.953. The standardised estimate path coefficient is -0.106. These results suggest that effort expectancy has no relation with Omani citizens' behavioural intention to use smart transportation mobile applications. Therefore, H2 is empirically not supported. The findings of this study contradict the hypothesis that effort expectancy significantly influences Omani citizens' intentions to utilise smart transportation mobile applications. The results did not support this claim, as Omani respondents who found user interfaces of smart transportation mobile applications intuitive and simple to use did not necessarily have a higher likelihood of becoming users of these applications. In this situation, understandable interactions will not impact Omani citizens' behavioural intentions to adopt smart transportation mobile applications. This also indicates that the extent of effort expectancy in utilising smart transportation mobile applications does not impact behavioural intentions in the current study context.

The result of the current research on the insignificance correlation between effort expectancy and behavioural intention is inconsistent with UTAUT2's propositions. This finding contradicts earlier studies such as Rahi et al. (2019), who found that effort expectancy significantly impacted how people utilise Internet banking. Similarly, in a research conducted by Moya et al. (2016), effort expectancy was also found to be a critical predictor of e-tax system utilisation. However, the result of the current study is consistent with the finding of the (Zhou, Lu and Wang, 2010; Faria, 2012; Baptista and Oliveira, 2015), who revealed that effort expectancy had a negligible impact on users' behavioural intention to adopt new technology. Also, the result of the current research is aligned with the finding of Mensah *et al.*, (2019) who also suggested that effort expectancy is not affecting the intention to adopt the car sharing services in China.

Qualitative findings showed that the service providers considered effort expectancy a critical factor influencing the acceptance of smart transportation mobile applications. The qualitative study revealed that most of the interviewees agreed that smart transportation mobile applications need to understand the effort needed to be used, and the 'user-friendly' concept was frequently brought up during the interviews, which suggested the importance of effort expectancy on the smart transportation mobile applications acceptance in Omani context according to the interviewees' perceptions. Therefore, most of them insist on building user-friendly applications to enhance citizens' adoption of smart transportation mobile applications. They have also confirmed the importance of understanding their users' skills and abilities and ensuring that the designed applications meet their end users' preferences. The smart transportation services providers' perceptions were in line with the findings of many previous studies that insisted on effort expectancy's critical effect on acceptance. The findings, however, showed that Omani citizens are not motivated to adopt smart transportation mobile applications based on how easy they are to use, as the results of the statistical analysis did not support the assumptions of the qualitative analysis.

This outcome can be explained by the fact that there has been a rise in the number of people utilising computers and the internet to access various services in recent years (Al-Gahtani, Hubona and Wang, 2007). The statistics show that mobile phone penetration in Oman has reached 177% (Telecommunications Regulatory Authority, 2016); therefore, almost 92% of the population have an intermediate level of mobile technology skills. According to Koenig-Lewis et al. (2015), the smartphones and mobile applications appear to be widely used by most people, and most people consider themselves experienced when it comes to mobile phone technologies. These days, technological skills have become a standard requirement in most Oman workplaces, decreasing the effect of effort expectancy on the adoption. Accordingly, citizens find smart transportation mobile applications easy to use, learn and understand, and gain the skills needed to use them smoothly and quickly. Therefore, the insignificant impact of effort expectancy on Omani citizens' behavioural intention is not surprising.

Also, many Omani citizens already use similar applications in other contexts, such as Google Maps and Waze, to monitor real-time updates on road closures, traffic congestion and accidents. The designs of these applications are almost the same as smart transportation mobile applications, and their navigation follows the same procedures. Participants in this study were accustomed to using the Internet and had prior experience with similar applications. Therefore, Omani citizens believe that the effort expectancy needed to learn how to use smart transportation mobile applications is not an issue. When a technology or an application interface is more complicated, and the users are less skilled, then the effect of effort expectancy on the new technology or systems is often stronger (Taylor and Todd, 1995; Venkatesh et al., 2003). Yet, with regards to smart transportation mobile applications in the Oman context, the manner in which these smart applications have been designed is by making them accessible to users of all technological backgrounds. Probably, smart mobile applications for smart transportation are not complicated to the extent of making them difficult to use. Participants in the study thought that the applications would be user-friendly. Thus, they did not view their utilisation as difficult.

Although numerous findings emphasise the critical need to ensure less effort while implementing new technologies, which is particularly an essential concern as the target customers vary in terms of their educational backgrounds and Internet experience (Davis, 1989; Thompson, Higgins and Howell, 1991), many other researchers argued that the importance of effort expectancy minimises over time of usage (Agarwal and Prasad, 1998). Also, it can be noticed from the qualitative study with the services providers that they have already considered effort expectancy while designing their smart transportation mobile applications. Yet, citizens claimed that effort expectancy might not be able to predict their behavioural intention in the case of smart transportation mobile applications in the Omani context. All these explain the insignificance relation between effort expectancy and behavioural intention in the current context.

The interviewees were asked about their perceptions on why friendly use and interaction with smart transportation mobile applications were not considered critical in citizens's acceptance. Even though the Head Of Information Technology (HOIT1) did not completely agree with the findings of the current research, he explained that end-user motivation may affect the effort expectancy factor. He argued that if the user is highly motivated to adopt the smart transportation mobile application, then the effort expectancy may be insignificant as they are willing to exert the effort needed to adopt it. Surprisingly The Senior Application Specialist (SAS1) made a reasonable argument that this finding is justified since social influence is approved as a critical factor in influencing Omani citizens to acceptance of smart transportation mobile applications. He clarified that in such a situation users will be motivated by their friends and families to use the application regardless of the effort required to use it. Likewise, the Marketing Specialist (MS1) said:

> "*Omani citizens may be more accustomed with utilising new technology and may not find it difficult to use smart transportation mobile applications. Moreover, the Omani government has been seriously promoting the use of smart transportation mobile applications to its citizens, which may have improved their desire to use such services. Therefore, the effort expectancy construct may not be a critical*

element in identifying the acceptance of smart transportation mobile applications in Oman” (MS1).

8.3.5 Trust and Behavioural Intention

The literature review chapter endorsed the importance of trust as a critical factor in identifying citizens' acceptance of the new technologies (Hanafizadeh *et al.*, 2014; Alalwan *et al.*, 2015). This factor is crucial due to the distinctive characteristics of electronic online services, which are famous for high uncertainty and the nature of financial services, which are described as highly risky concepts (Beldad, De Jong and Steehouder, 2010). Thus, trust was incorporated in the current research proposed model based on Venkatesh et al. (2012) recommendation to extend the UTAUT2 model to address the context of the research better. Therefore, trust has been proposed as a new construct influencing citizens to accept smart transportation mobile applications in the Omani context. Trust in the context of this research is defined as an attitude of goodwill toward others and the belief that the trustor may rely on the trustee's (Alaiad and Zhou, 2013). This construct has been explored from the literature review and was hypothesised to significantly influence Omanis citizens' intention to adopt smart transportation mobile applications.

Regarding this research, trust is explained by two main concepts: trust in the service providers and trust in the technologies (Chen, Xu and Arpan, 2017). Likewise, Aham-Anyanwu, Nnanyelugo and Li (2017) stated that the consumers’ confidence in the service providers and their confidence in the technology is essential in enhancing acceptance among citizens. In the current research, four items extracted from Acharya, Junare and Gadhavi (2019) and the qualitative interviews are used to measure the impact of the trust construct, including the service providers' reputations, availability of safeguards, safe environment to transact, and confidentiality.

However, the current research finding indicates an insignificant relationship between trust and users’ behavioural intention to adopt smart transportation mobile applications. The result from the structural models showed that the relationship between trust and behavioural intention is not significant as p-value= 0.058 and t-value = 1.897. This implies no strong relation between behavioural intention to use smart transportation mobile applications and trust. Therefore, this hypothesis was not supported. Trust is not a key driver influencing citizens' behavioural intention to adopt smart transportation mobile applications in the Omani context. Accordingly, it does not facilitate citizens' intention to adopt.

It is fair to say that citizens possibly did not seem to be bothered about the security and safety assigned with the smart transportation mobile applications and how services providers safeguard their applications, which is not in support of the earlier qualitative finding. This also indicates that citizens are not interested in how service providers treat their confidential information inserted in smart transportation mobile applications. Moreover, although the reputation of services providers is likely to affect citizens' trust, as indicated by the qualitative finding and previous studies such as (Michaelis *et al.*, 2008; Milan, Eberle and Bebber, 2015), the result from the quantitative study showed that smart transportation mobile applications' utilisation is not contingent upon their provider's reputations.

This result contradicts previous studies that stressed the importance of trust as a critical component affecting the acceptance of mobile applications. For example, many previous studies are in contrast to the current investigation, such as (George, 2004; Colesca, 2009; Chemingui and Lallouna, 2013; Montazemi and Saremi, 2013; Hanafizadeh *et al.*, 2014; Sun *et al.*, 2014; Qasim and Abu-Shanab, 2016; Alalwan, Dwivedi and Rana, 2017; Sharma *et al.*, 2018). Contrary to the finding of the current research, Mensah *et al.*, (2019), found that security and privacy were significant determinant of the acceptance and use of the car sharing services in China. However, the current study's finding is in accordance with many other studies, such as Wu and Liu (2007), who highlighted the lack of relevance of the influence of trust on behavioural intention when embracing Online games. Moreover, Lema (2017) conducted research in Tanzania to investigate the effect of trust on the adoption of mobile financial services and also found that trust is insignificant in influencing the adoption of mobile services. Mazhar et al. (2014) examined the factors prompting the usage and adoption of Internet and mobile banking in the Pakistani context. Their findings revealed that trust had a negative effect on Pakistanis' attitudes toward the adoption of Internet and mobile banking. Koksal (2016) also found that trust is not a significant factor in the adoption of the mobile banking in Lebanon. Service providers were concerned about the security and privacy within the smart transportation mobile applications as main factors controlling citizens' adoptions. However, investigating citizens' perceptions revealed that more privacy and security do not indicate more trust in these technologies. In other words, citizens will adopt these applications regardless of security concerns. This finding contradicts previous studies, such as Schuster and Habibipour (2022), who argued that security and privacy are the two main concerns affecting users' trust in adopting technologies. In addition, smart transportation mobile applications service providers also insisted that concerns about the accuracy of delivered information and application functionality and availability can undermine citizens' trust in smart transportation mobile applications. Contrary to the services providers' perceptions and expectations, reliable data and trust in technology had no direct influence on the citizen's intention to adopt. This finding contrasts with the results of the effect of trust in other consumer contexts, which claimed that end users are responsible for their actions and, accordingly, their decisions will be dominated by the trust factor. For example Inbar and Tractinsky (2012), argued that consumers' trust in the service providers is affected by the service providers' practices and principles in respecting their needs.

According to Wang and Emurian (2005, p. 111), trust is classified as a subjective matter which "*is directly related to and affected by individual differences and situational factors. Different people view the role of trust differently in different scenarios and have different magnitudes of trust to- wards different trustees*". Thus, the effect of trust is expected to vary from one context to another because of the nature of the trust. Regarding the Omani context, in the most recent Global Cybersecurity Index (GCI) published by the International Telecommunication Union, Oman is placed third in the Arab world and overall twenty-first in Cybersecurity (Muscat Daily, 2021). Oman stands out from other countries in the area due to its peaceful culture, which contributes to enjoying a quiet and calm life (Echagüe, 2015). Moreover, Al-Busaidy and Weerakkody (2011) conducted a study in Oman to explore factors affecting citizens' acceptance of e-government services in Oman and found that 67.9 % of the participants have trusted online transactions, and they stated that trust would not affect the adoption of e-government in Omani context.

Moreover, Oman is expected to face a growing market size in the area of online gaming, cloud gaming and mobile gaming, boosted by the increasing number of smart handheld devices at a rate of 12.2% between 2021 and 2027 (6Wresearch, 2022). Most gamers are in need to install mobile applications on their smartphones. Although some of the games are free to download, they require micro transaction purchases if the gamer wants to progress (Willson and Leaver, 2015). They further argued that such an application also captures gamers' personal information without explicit consent. According to Forbus (2002), such gaming applications are considered a form of entertainment. Yet, there is a growing demand for these mobile gaming applications in the Omani market regardless of trust issues. This may explain the insignificance of trust in influencing the acceptance of smart transportation mobile applications, which are unlike gaming applications as they are developed to add many significant benefits and values to their users and not only to entertain them.

The researcher asked the interviewees whether they endorse this finding and if they possess any justification for trust lacking significance in affecting the acceptance in the current research context. The Head of Information Technology (HOIT1) praised their organisation's well-established reputation and asserted that since their application was created by a robust reputed organisation, no surprise that trust would not pose a concern. On the other hand, the Senior Application Specialist (SAS1) argued that not knowing the actual provider of an online service, may make end users feel vulnerable. He proceeded by saying that in Oman, nearly all service providers for mobile applications for smart transportation are governmental bodies that are well-known to the local populace. The Marketing Specialist (MS1) and The Public Service Supervisor (PSS1) from organisation C, both argued that they will accept this finding under certain circumstances. With regards to the the Marketing Specialist (MS1), she claimed that trust can be irrelevant in situations where users are aware of the advantages and that the value added by the adoption are exceeding the concerns of privacy and security. She claimed:

> "*I think that once the smart transportation mobile application becomes more widely used among citizens, they become aware of its benefits, and they can feel and examine the desired genuine service provided by it and accordingly the extent of concern about trust will diminish" (MS1).*

On the other hand, the public service supervisor (PSS1) contended that the trust factor may only vanish if there is a significant need for such smart transportation applications which cannot be obtained through other methods.

8.3.6 Price Value and Behavioural Intention

In the original UTAUT2 model, price value is described as "*consumers' cognitive trade-off between the perceived benefits of the applications and the monetary"* (Venkatesh, Thong and Xu, 2012,161). It is important to note that in the current research, the cost of using applications such as the Internet and mobile devices is irrelevant to this study. Omani citizens consider smart transportation mobile applications an extra advantage of having internet access as there is no additional fee for internet users to utilise smart transportation mobile applications. This was because citizens may download smart transportation mobile applications for free. In other words, because using smart transportation mobile applications does not have an obvious cost, price value is handled differently in the current research. The preliminary qualitative findings and the discussion conducted in the literature review chapters led the researcher to alter the notion of the price value factor instead of removing it from the context of the current research. The qualitative study revealed different kinds of nonmonetary value citizens could gain by using smart transportation mobile applications in Oman. For example, smart transportation mobile applications services providers regularly offer nonfinancial rewards such as vouchers, cinema coupons and discounts by collaborating with various companies and businesses to their marketing strategies to boost the adoption and utilisation of their smart applications. These extra non-monetary values of adopting smart transportation mobile applications, such as the initiative to give users vouchers for restaurants and cinemas if they used smart transportation mobile applications, were thus the focus of the proposed concept of a price value in this research. This is in addition to the monetary value of exploring better packages and discounts over smart transportation mobile applications. Therefore, the items used to measure the pricing value construct involved three items extracted from the qualitative study in addition to items from (Indrawati and Amalia, 2019).

Price value has been hypothesised to have a positive influence on the behavioural intention to adopt smart transportation mobile applications. However, the results of the path coefficient are 0.039, t-value= 0.689 and p-value=0.491. Compared to what has been hypothesised, this research showed an insignificant link between price value and behavioural intention in accepting smart transportation mobile applications in the Omani context. Therefore, monetary, and nonmonetary values of the smart transportation mobile applications did not appear to be one of the key elements that significantly influenced individuals' decisions to accept and utilise smart transportation mobile applications in Oman. The price value was not a significant predictor of behavioural intention in the sample size, indicating that Omani citizens somehow feel that the benefits of smart transportation mobile applications do not outweigh the cost of time and effort associated with the adoption. This means that Omani citizens do not consider the value or the other nonmonetary benefits they can obtain from using smart transportation mobile applications.

This result contradicts the finding (Venkatesh, Thong and Xu, 2012; Siahaan and Nilo, 2019; Rahman, Alam and Taghizadeh, 2020; Sideiri *et al.*, 2021). On the other hand, Baptista and Oliveira (2015) studied consumer acceptance of mobile banking in an African country. They found that the price value negatively impacts the consumer's intention to adopt. Similarly, price value was said to be insignificant in adopting e-learning in Qatar (El-Masri and Tarhini, 2017). The finding is aligned with the result of Tristiyanto, Fiska and Ardiansyah, (2019), who also concluded that adoption of the online taxi is not influenced by price value construct. On the other hand, this result is in line with the fact that in the voluntary setting and when a technology is free for people to use, price value may not be a critical element influencing the citizen's impression of adjusting their behaviour to utilise a new technology (Tamilmani *et al.*, 2018).

A possible reason for this discrepancy may be due to the different economic development levels among the countries. Alrawabdeh, Salloum and Mingers (2012) assert that cost as a hinder to adoption will decrease with increasing GDP per person. Given that Oman has one of the highest per capita incomes in the world, this study suggests that price value is not a major barrier for Omani consumers to adopt smart transportation mobile application (Al Kurdi, 2021). Also, because there are no variations in tangible advantages between getting transportation services through smart mobile applications or websites and the traditional ways, citizens do not recognise a price-value gain (Boksberger and Melsen, 2011). On the other hand, citizens' nonmonetary cost, such as effort, may also affect their perceptions of the price value factor. As mentioned earlier, citizens in Oman are limited to two highways, so spending time exploring transportation applications and seeking information will not add much to their decisions.

This study’s investigation of the service providers’ views regarding the price value of smart transportation mobile applications and the finding shows that the majority of them believed that the price value of smart transportation mobile applications was highly appreciated by them as a main factor enhancing citizens' acceptance. Nevertheless, the citizens asserted that the price value of the smart transportation mobile applications was not important in their decision to utilise these applications, and thus did not affect their behavioural intention for adopting these technologies. The service providers reported several justifications that could explain the insignificance of the price value construct in using smart transportation mobile applications. For example, according to the Senior Application Specialist (SAS1) from organisation B, price value factor may be insignificant if some cases where users are willing to pay to enjoy a better convenience and improve the quality of their life. On the other hand, the Marketing Specialist (MS1) in the organisation A objected and said that she is not sure to which extent this result applies to the Omani citizens, as they keep receiving regular calls complaining about the prices of their services and demanding the organisation to provide offers and discounts of the services. Similarly, the Public Service Supervisor (PSS1) from organisation C shared the same opinion, stating that his organisation provided a free transportation route for universities students in exchange for downloading and using the organisation's smart mobile application to access the free service. He stated that the organisation witnessed a unique rush and unexpected demand from both the students and the lecturers too.

8.3.7 Satisfaction and Behavioural Intention

The current research does not use the UTAUT2 model only as a theoretical foundation; instead, it has also extended it by incorporating some new factors, such as satisfaction, explored in the literature review chapter. The degree to which a company's product or service performance meets the customer's expectations is known as the customer satisfaction (Roberts-Lombard, 2009). Clients' level of satisfaction determines their tendency to repurchase. Thus, marketers must prioritise customer satisfaction since it promotes system loyalty and referral (Siyal, Hongzhuan and Gang, 2021). This factor was measured using four items extracted from (Marinkovic and Kalinic, 2017) and (Chao, 2019).

Surprisingly, the satisfaction construct had no discernible effect on citizens' behavioural intentions to adopt smart transportation mobile applications. The insignificance result regarding the impact of satisfaction on behavioural intention reflects that the probability of adopting smart transportation mobile applications does not increase by improving the quality of information, quality of services, and quality of the applications of the smart transportation mobile applications. This implies that the chance to adopt smart transportation mobile applications will not be enhanced by continuously improving accessibility, providing accurate live information, or even providing high-quality services. This finding was not in line with the finding from previous studies such as (Singh, Srivastava and Sinha, 2017; Arain et al., 2019; Estriegana, Medina-Merodio and Barchino, 2019; Sanny et al., 2020) who confirmed that end users satisfaction is considered as a direct influencer of the user's behavioural intention to adopt a technology. This result was also inconsistent with the initial qualitative findings, which demonstrated that service providers believed the important to directly please citizens by assuring high-quality applications, information delivered, and services provided. Smart transportation services providers agreed that the information provided to the citizens through the applications must be up-to-date, prompt, well-structured, and accurate. Their perception was also in line with Choi et al. (2004), who confirmed the importance of service quality on acceptance. Moreover, like Shareef *et al.* (2009), Wang (2009) and Ruan et al. (2020), smart transportation services providers also claimed that the issues of shutdown problems, routine applications maintenance, and speedy damage recovery are critical in influencing users' satisfaction and accordingly their intention to adopt smart transportation mobile applications. As a result, it can be noticed that in the current research, there are similarities between both the previous literature and services providers' perceptions expressed in the qualitative study that users' satisfaction with the quality of the service and information provided by the smart transportation mobile applications directly influence citizens' attitudes toward behavioural intentions of the adoption. However, the finding revealed that citizens were not worried about the services quality issues, information quality issues or even applications quality issues provided by the smart transportation mobile applications. Consequently, satisfaction did not influence their intention to use smart transportation mobile applications.

This discrepancy could be explained by the fact that the consideration of the other elements strongly influences Omani citizens' behavioural intention, making the impact of the satisfaction factor in the entire sample group insignificance. However, it seems that when deciding whether to utilise smart transportation mobile applications or not, individuals give more weight to other considerations, including habits, social influence, and former practices. The fact that satisfaction is one of the critical elements emphasised when a service provider implements a public service is another explanation for the negligible influence of satisfaction. Perhaps another possible justification for this surprising finding is that the applications involved in this study are classified as optional applications, where citizens' consideration of them is optional, and the usage of these applications is not the citizens' priority when it comes to their mobility decisions issues. Thus, the quality issues assigned to them are not important. This insignificance of the relationship between satisfaction and behavioural intention could also be explained by the fact that smart transportation mobile applications are in their initial stages in Oman. Therefore, their implementation might not need services of high quality. However, satisfaction can be a critical influencer affecting the adoption after these services become more complex.

Research conducted by Pappas *et al.* (2014) found that performance expectancy had a positive impact on satisfaction. Similarly, Park (2020) looked at how the performance expectancy of online music services affected consumer satisfaction and stated that customer satisfaction and performance expectancy are correlated. Also, performance expectancy has been reported to considerably impact customers' satisfaction with online banking (Ling *et al.*, 2015). Thus, it can be said that performance expectancy and user satisfaction are correlated (Ling *et al.*, 2015). Accordingly, it is predicted that citizens' satisfaction with smart transportation mobile applications will increase by increasing their performance expectancy. In the case of smart transportation mobile applications acceptance in the Omani context, it has been found that the performance expectancy factor is negatively correlated with behavioural intention. As a result, this can explain the insignificance of the satisfaction construct in the current research. In other words, since citizens find that smart transportation mobile applications are not contributing to improving their commuting process, it is expected that their satisfaction and behavioural intention toward using them are not enhanced too.

When service providers were asked about their comments on the research finding of satisfaction factor insignificance in the utilisation of the smart transportation mobile application, their opinions differed. Whilst the representative of organisation A agreed that satisfaction is not a significant factor in influencing the acceptance of the smart transportation mobile application, especially if the user has no other alternatives for this application, both the Senior Application Specialist (SAS1) and the Marketing Specialist (MS1) interviewed objected to this result as they argued that a user's satisfaction is a fundamental construct in attracting and retaining customers besides also influencing the organisation's revenue.

8.3.8 Awareness and Behavioural Intention

Awareness is another factor that has been added to the proposed smart transportation mobile application acceptance model based on the preliminary qualitative investigation. This construct is defined based on the understanding of the technology awareness concept raised by Rogers (1995). It is identified as citizens' knowledge about the availability and advantages of adopting smart transportation mobile applications in their daily commuting and transportation decisions. Awareness is a construct extracted from the service providers' perception and used to extend UTAUT2 to better understand the acceptance in the Omani context. The concept of awareness in the current study matches the finding of Goodhue and Straub (1991), who stated that awareness is not only about a single product or an application, but instead, it is about the knowledge of the existing problems and being aware of them and seeking the implementation of the most suitable solutions. In this view, awareness regarding the current study is about being aware of the problems assigned with the traditional ways of the transportation system and identifying the possible solutions to be adopted to resolve the problems. In the context of the current study, three main items have been incorporated to measure the effect of this variable including: "*I am aware of smart transportation mobile applications in Oman*", "*I am aware of smart transportation mobile applications using benefits*", and "*I have come across campaigns/advertisements of smart transportation mobile applications in Oman*". The qualitative interviews with the services providers revealed these three items incorporated into the construct of awareness as elements that might enhance their abilities in supporting end users' utilisation of smart transportation mobile applications.

According to the smart transportation service providers' perceptions, there is a lack of awareness of the benefits of smart transportation mobile applications regarding the benefits related to improving the air quality, administrative benefits and benefits associated with creating job opportunities. They have also argued in support of organising campaigns and advertisements of smart transportation mobile applications in Oman. Moreover, they have also argued that involving citizens while designing and testing the applications will let them feel that they are part of the process while spreading awareness among them. Services providers considered such activities essential in promoting awareness and suggested that they contribute to better adoption of the applications. They do this by communicating and interacting with citizens through social media, such as Instagram, Facebook, and Twitter, besides traditional media, such as TV and radio. This attitude was conveyed by the service providers in this study in a manner that is similar to that reported by (Reddick, Chatfield and Ojo, 2017; Mustafa *et al.*, 2022).

The analysis has revealed various similarities between service providers and the literature review. The preliminary investigation of the smart transportation services providers' perceptions has shown that the lack of awareness might be one of the main reasons why smart transportation mobile applications are not accepted among Omani citizens. This perception obtained from the analysis of the interviews is in line with the finding of some previous literature. There is a similarity between the perception of the smart transportation service providers and between studies conducted by Putnam, Feldstein and Cohen (2004) and Belanche et al. (2014), who stated that if the public were engaged in municipal activities, they would have more opportunities to socialize and speak with others, which may result in them having a tremendous influence to adopt new ideas. Rogers (2003) insisted on the importance of the involvement of customers in the learning process to improve their awareness level about innovations. Such involvement will contribute to building awareness, enabling users to make subjective norms regarding adopting these smart applications. Moreover, It has been acknowledged that customers' acceptance or rejection of innovation begins only after making customers aware of them (Peng, Nunes and Zheng, 2017). Mofleh, Wanous and Strachan (2008) defined awareness as the public's knowledge about an innovation's presence and advantages. Similarly, many service providers interviewed advised designing programs to raise public and individual awareness of innovations and services and encourage their adoption and utilisations. Safeena (2011) argued that awareness helps reduce the risk associated with adopting the new systems. Awareness was also addressed as an essential element influencing the acceptance in many previous studies such as (Almaiah et al., 2022; Majumdar and Pujari, 2022).

However, the survey designed to explore Omani citizens' perceptions about the factors influencing their behavioural intention to adopt smart transportations mobile applications did not validate the link between awareness and behavioural intention; therefore, the influence of this construct was not significant in the Oman context. This finding from the citizen's views suggests that they are not concerned about the information published by the services providers about the gains and advantages of smart transportation mobile applications. This also indicates that the public is not bothered about the campaigns and promotions programs offered by the service providers in determining their intention upon adopting the smart transportation mobile applications. Thus, their opinion does not support the service providers' aspect of spreading awareness to increase the recognition of smart transportation mobile applications.

This contradiction can be explained by the fact that the social influence construct is expected to influence citizens' awareness to adopt smart transportation mobile applications (Zhou, Lu and Wang, 2010). As social influence is one of the critical factors affecting Omani citizens' acceptance of smart transportation mobile applications in the current context, the awareness factor is considered not to have a direct impact as citizens rely mainly on the information they gather from people surrounding them. In other words, social Influence plays a dynamic role in enhancing the citizens' awareness and intention toward smart transportation mobile applications adoption (Alalwan, Dwivedi and Williams, 2016). This suggests that promoting awareness of smart transportation mobile applications by service providers through awareness campaigns will not help citizens become more aware of the benefits. Instead, they should promote an information-sharing environment among citizens to enhance acceptance.

Moreover, Shareef et al. (2011) argued that awareness alone is not enough for adoption and that psychological and technological assistance is also required to support the acceptance of an innovation. Omani citizens are known to resist changes and always try to keep the current status quo (Al-Karaghouli, Al Azri and Al Salti, 2012). Therefore, Omani citizens might be aware of this application's existence and benefits, yet psychologically they might not be ready to change. According to van Dijk, Peters and Ebbers (2010), one of the biggest mistakes service providers make is assuming that users would quickly accept new technology as soon it is released in the market. Instead, citizens will remain loyal to their traditional mode of getting mobility services until they come across a more convenient system. Therefore, citizens might be aware of smart transportation mobile applications but not necessarily adopt them. Awareness of new technology benefits and existence is important, but they are not direct influencers of the citizen's behavioural intention. This result needs to be further investigated, given the Omani context. In light of enhancing the usage of smart transportation mobile applications in Oman, it will be worthwhile to carry out more detailed investigations of awareness impact in the future.

The researcher requested service providers' opinions about this result and the researcher also asked them if they had any explanation for the insignificance of the awareness construct on accepting smart transportation mobile applications in an Omani context. Most of the service providers interviewed agreed somewhat with the result and commented that it is logical to some extent, as when a person needs an application to simplify their life, they always do what is required to obtain that application. The Public Service Supervisor (PSS1) commented that:

> *"Merely being aware of the existence and benefits of smart transportation mobile applications may not be enough to motivate citizens to use them. Other factors may come into play, causing individuals to rely on other factors to decide on utilising these applications"* (PSS1).

Likewise, the Marketing Specialist (MS1) argued that these days, with the overcrowding of advertisements besides citizens' saturation with the vast number of mobile applications and ease of access to them, citizens do not have enough time to fully understand and explore them due to the abundance present of them.

8.3.9 Former Practice and Behavioural Intention

Former practice refers to the previous familiarity with similar applications and their effect in driving citizens to accept smart transportation mobile applications. This construct is not an original factor in the UTAUT2 model but instead has been incorporated into the model based on the analysis of the service providers' interviews. The former practice is another predictor proposed as a new factor resulting from the qualitative study to influence behavioural intention. The analysis revealed that consumers' experiences with similar applications in other sectors or even within the same sector but in other countries might influence their adoption decision. The sample data supported the positive relation between former practice and behavioural intention (t-value= 2.817, p-value=0.005). The good or bad impression they had formed when they were introduced to similar applications might drive them to accept or reject the current smart transportation mobile applications. Therefore, this finding indicates that the higher the positive former practice of the citizens, the more behavioural intention they will generate. This means that Omani citizens' behavioural intention is influenced by their previous familiarity with using similar applications in other smart contexts or countries. Omani citizens usually link their earlier experiences with similar applications to their future intention of adopting new smart transportation mobile applications. In particular, as Omani citizens become more familiar with similar transportation mobile applications based on their previous interactions, they are more likely to adopt them. This finding confirms Rogers's (1983) argument that the extent of experiencing an innovation is directly affecting its adoption. This finding is consistent with Komiak and Benbasat's (2006) work, which found that using familiar features will positively influence the behavioural intention to adopt a samely innovation. This significance is also supported by Pierpaoli et al. (2013), who demonstrated that users with trialability and familiarity with innovation are more confident and more likely to adopt it compared to those who do not use it.

The service providers claimed that citizens might not realise the actual advantages of the services brought by the smart transportation mobile applications, yet getting the chance to use similar applications in other sectors or countries directly contributes to realising the improvement they may gain by adopting smart transportation mobile applications in their transportation and commuting. They have also discussed that some citizens might prefer directly using similar applications to get real evidence of positive experiences. As a result, some service providers strongly recommended implementing the free trial period for new customers to facilitate acceptance. The service providers' perceptions align with other studies conducted in the smart city context. The idea of the smart city is seen as a very successful technique to improve the city's infrastructure and make it safer, healthier, and more environmentally friendly (Dameri and Rosenthal-sabroux, 2014). To create a smart city that allows its residents to enjoy smart services across various domains meant to achieve multiple sustainable economic, social, and environmental levels. The findings suggested that individuals' experiences with smart services in one domain might affect how they see smart technology in other areas, which is consistent with how the smart city idea has been characterised by (Bélissent, 2010; Neirotti *et al.*, 2014; Yigitcanlar and Lee, 2014).

The perceptions of the service providers support the quantitative finding, showing that citizens will adopt smart transportation mobile applications and are willing to employ them in their daily commuting if they are familiar with similar applications. The citizens also approved the former practice as a significant factor influencing their acceptance of smart transportation mobile applications. The former practice was essential for them because, for example, it contributed to acknowledging the advantages and effortlessness of similar applications. This construct also helps them build a perception in forming possible expectations of such applications.

This implies the importance of citizens' involvement in smart transposition services design and implementation and motivating them through offering free public trials to raise their familiarity with the usability and benefits of these applications. Smart transportation service providers should also focus on designing applications using familiar features and functions like those used in other countries and sectors to enhance adoption and acceptance. Although the former practice was not assigned as a critical factor in the original UTAUT and UTAUT2 models or other new technology adoption research, it can be incorporated as one of the main predictors to facilitate the acceptance of smart technologies in general and smart transportation particularly. Given the importance of the former practice, it is useful to add it to future investigations in the context of smart transportation mobile applications and other smart domains.

It is interesting to note that all services providers who have been interviewed also agreed on the importance of the former practice factor and its significant impact on accepting new innovations. For instance, the Senior Application Specialist (SAS1) stated that most of the citizens are very concerned about the familiarity factor when it comes to the smart mobile applications as most of them feel more comfortable using traditional mode of getting transportation services that they are familiar with, rather than experiencing new and unfamiliar mobile applications. The Head of Information Technology (HOIT1) mentioned that former practice is indeed very critical as it helps save time and effort by providing users with quick and easy access to the service. The Marketing Specialist (MS1) also added that it is possible for the former practice construct to help improve the security and safety toward the provided applications, as users can verify mobile application's validity, effectiveness, quality, and ensure that they do not pose any risk to their information and data as they experienced their usage and benefits in other context.

8.3.10 Social Influence and Behavioural Intention

In the current research, this construct has been hypothesised to positively influence citizens' acceptance of smart transportation mobile applications. This means the more social influence citizens get, the more behavioural intention to accept the smart transportation mobile applications. Social influence was also considered a critical factor influencing end users' acceptance of the new technologies. It has been investigated in previous studies in both organisational and consumer contexts. This construct was examined using four questions: the influence of family members and relatives, the influence of people whose opinions are important, people who influence the behaviour and the influence of the service providers. The statistical analysis of the social influence has approved the significance of this construct as t-value is 3.785 and the p-value is 0.000. The standardised path coefficient is 0.201, which indicates a positive relation between social influence and behavioural intention to adopt smart transportation mobile applications. This suggests that Omani citizens are directly influenced by whether their friends are utilising smart transportation mobile applications. This also indicates that Omani citizens' intention towards smart transportation mobile applications is directly affected by the opinions of those in the citizens' social network. Moreover, this finding also means that Oman citizens must be motivated and encouraged by smart transportation service providers to employ smart transportation mobile applications. The results also strongly support the idea that Omani people regularly refer to their social networks to allay any anxiety brought on by the ambiguity surrounding new smart transportation mobile applications. Therefore, the influence of others is a significant factor too in the adoption of smart transportation mobile applications in the Omani context. This significant relationship between social influence and citizens' intentions to adopt smart transportation mobile applications supports the expectation from the Oman cultural perspective that, in a collectivist society, social influence is most likely to influence citizens' intentions significantly because one characteristic of a collectivist culture is to be concerned about the opinions of other people in the same community. Accordingly, the results demonstrated that Omani citizens' decisions to use smart transportation mobile applications are impacted by word-of-mouth or the perceptions of others in their social network.

This result matches the expectation of (Al-Shafi and Weerakkody, 2010; Leon, 2018; Neto, Luis and De, 2022), who also observed the relationship between social influence and behavioural intention to use new technology is strong. Similarly, social influence has been shown to positively influence Chinese intention to adopt Robo-taxis (Liu *et al.*, 2020). Also, Joe, Kim and Zemke (2022) found that social influence can contribute to increasing the number of adaptors of customer self-service kiosks in hotels. This outcome is also consistent with service providers' perceptions, which demonstrated that consumers are more likely to be influenced by the opinions of other adopters, whether those opinions are positive or negative, and whether other family members used or did not use the smart transportation mobile applications. The finding of the current research is in line with Madigan et al., (2016) who concluded that the social influence is a useful predictor of behavioural intentions to use Automated Road Transport Systems.

This means Omani citizens will be inclined to adopt smart transportation mobile applications if important people within their social network users use them. As citizens use smart transportation mobile applications, they suggest that their friends, family members and colleagues adopt these applications. Accordingly, an individual believes that the smart transportation mobile applications' usability and advantages are directly affected by their peers. It has been argued that societies with collectivist culture are characterised as trustful and loyal to the group impacts (Hofstede, 1983, 1984). In contrast, individualist societies are more individual self-interest oriented (McCoy, Galletta and King, 2005). Similarly to most other countries in the middle eastern culture, Oman is considered low in individualism and more focused towards collectivism, in which families, peers and groups are critical (Al Asmi and Caldwell, 2018). Hence, social norms are expected to strongly affect this collectivist culture (Venkatesh and Zhang, 2010). They prefer to rely on their families to make decisions as they are a collective-oriented (McElwee and Al-Riyami, 2003). Therefore, peers directly affect individuals’ behavioural intention toward smart transportation mobile applications usage and employment. Also, Twaijri and Al-Muhaiza (1996) argued that Oman, with a score of 72, reports a very high level of citizens' preference for avoiding uncertainty. Once becoming regular users of smart transportation mobile applications, users may suggest their social network to activate these applications, which consequently contributes to reducing the feeling of uncertainty about the smart transportation mobile applications (Karahanna, Straub and Chervany, 1999; Hooda *et al.*, 2022). Therefore, in Oman, new users mimic the behaviours of those in their social network and use these behaviours as motivation to avoid uncertainty. This indicates that Oman citizens need to be motivated and encouraged to adopt smart transportation mobile applications by focusing on the social influence factor as it affects how efficient and effective smart city implementation is in Oman. Therefore, service providers should consider peer pressure while marketing smart transportation mobile applications.

Two of the service providers interviewed (PSS1, SAS1) emphasised the importance of the social influence factor in adopting smart applications. They claimed that word of mouth replaced a hundred advertisements due to its strong impact on increasing trust as individuals believe more in the opinions of their friends and acquaintances than in any advertisement. Likewise, the Head of Information Technology (HOIT1) agreed with this result and commented that social network recommendations have a personal touch and can take a sense of authenticity and sincerity, which is usually missed in service providers' advertisements and marketing approaches. He further emphasised that when someone recommends a smart mobile application to a friend or family member, they essentially put their reputation on the line. This means that they are more likely to recommend something that they genuinely believe in and have had a comfortable experience with.

8.4 The Role Of The Moderators Influencing Citizens' Acceptance Of The Smart Transportation Mobile Applications

Three moderators were hypothesised to moderate the relationships in the proposed model of smart transportation mobile applications in Oman. The first moderator is gender, which was hypothesised to moderate the relations between the independent factors (EE, FE, SI, HB, PV, SAF, TR and FC) and the dependent variable behavioural intention (BI) to adopt smart transportation mobile applications. With regards to the current study and according to the analysis from the previous chapter, gender was not recognised as a significant moderator contributing to the explanation of the variance in behavioural intention to adopt smart transportation mobile applications, as none of the links which are between the independent factors and behavioural intention is seemed to be affected by the gender moderator. Various studies have investigated the adoption behaviour of smart cities services, technologies and applications and the moderating impact of gender in their contexts, such as (Morienyane and Marnewick, 2019; Hou *et al.*, 2020; Rajmohan and Johar, 2020; Gumz and Fettermann, 2021; Park, Hong and Le, 2021; Beştepe and Yildirim, 2022; Popova and Zagulova, 2022). Yet, the outcomes of the studies examining the connection between gender and smart technologies have been conflicting. Despite that considerable prior research highlighting that there is a significant gender impact on the acceptance of new technologies among the users such as (Alam *et al.*, 2020; Mamonov and Benbunan-Fich, 2021), many other studies have reported that there is no variance among gender effect to accept new technologies such as (Baker, Al-Gahtani and Hubona, 2007; Li, Glass and Records, 2008; O' Callaghan and Kerry, 2016; Roy *et al.*, 2018; Ženka *et al.*, 2021). This research argued that there is no difference between men and women in accepting smart transportation mobile applications in the Omani context. This result tends to be opposite to the predictions as the findings indicate that gender does not affect the constructs assigned to influence the acceptance of smart transportation mobile applications.

Current research also predicted that age would moderate the relationships between eight incorporated factors and the behavioural intentions of smart transportation mobile applications adoption. The respondents were divided into two main groups to evaluate the age moderator: younger than 30 and older than 31. The results showed that age moderated only two relationships in the model: between effort expectancy and behavioural intention and between trust and behavioural intention. The outcome of the current study is in line with the argument that the old assumption of gender and age in using technologies is outdated and that today's societies are more technologically literate (Workman, 2014). He further argued that it is safe to assume that gender and age are no more determinant moderators in technology adoption.

Like age and gender moderators, the experience was also hypothesised to moderate the relationships between eight independent and dependent variables in the proposed model. To test the experience moderator, the participants were divided into two groups: high and low levels of experience. The finding indicates that experience did not moderate the relation of all hypotheses except for the relation between trust and social influence on behavioural intention. The following paragraphs discuss the moderator's impact in relation to each construct.

First, regarding the performance expectancy construct, the results of the current study did not show any significant difference between the two age groups, the two gender groups, and the different levels of experience. Thus, differences in age, gender or experience do not appear to influence the link between performance expectancy and behavioural intention to use smart transportation mobile applications. Accordingly, age, gender and experience are not vital in moderating the relationship between performance expectancy and citizens' behavioural intention to adopt smart transportation mobile applications in the Omani context. Performance expectancy has the same impact on all citizens regardless of their age, gender, and experience. This result supports the finding of (Al-Gahtani, Hubona and Wang, 2007; Gupta and Dogra, 2017; Ragheb *et al.*, 2022), who found insignificant differences between gender groups in moderating the relation between performance expectancy and behavioural intention. On the other hand, the finding is inconsistent with the original UTAUT2 model, which suggested that men are usually more sensitive to performance acceptancy in their decision to accept new technologies as they are famous for being task-oriented (Venkatesh *et al.*, 2003; Park, Yang and Lehto, 2007). Although many studies underlined the age difference impact on the relationship between performance expectancy and behavioural intention, such as (Venkatesh *et al.*, 2003; Niehaves and Plattfaut, 2010; Ramírez-Correa *et al.*, 2023), the finding of the current research disagreed. This could be because the current study participants were the whole of Muscat, unlike other studies targeting respondents from organisational contexts such as (Venkatesh *et al.*, 2003). Similarly, although the experience was expected to impact performance expectancy positively, the finding indicates that experience does not play a major role in moderating the relationship between the independent and dependent factors. Secondly, regarding the facilitating conditions construct, the finding also indicates that the interaction between age, gender, and experience on the relationships between facilitating conditions and behavioural intention was insignificant. This result is contrary to the finding of Venkatesh et al. (2012), who argued that facilitating conditions affect older women more than younger women to accept innovations. In the current study context, both genders of all ages were not interested in the help they get from the smart transportation services providers.

Thirdly, considering the habit factor, interestingly, the finding showed no differences in the impact of habit on behavioural intention among the different gender, ages, and experiences groups. No significant differences were found for the proposed moderator's influence on the behavioural intention to adopt smart transportation mobile applications. This indicates that citizens with a habit to utilise will behave accordingly regardless of age, gender, and experience. These findings of age, gender and experience moderators' insignificance are inconsistent with the previous research on habit in other settings such as (Pratama and Renny, 2022). The finding was also inconsistent with the original UTAUT2 model, where they suggested that building new habits is generally more difficult among older people (Laukkanen *et al.*, 2007) and that men are generally more strongly affected by the construct of habit (Venkatesh et al., 2012). Moreover, the UTAUT2 model suggested that habit’s impact on behavioural intention is significant among more experienced people (Venkatesh et al., 2012). Yet, the result of this study does not support this finding of many previous studies and the original UTAUT2 model.

Fourth, a critical finding regarding the effort expectancy construct was reported, namely that moderator age could influence the relationship between it and behavioural intention. The impact of effort expectancy on behavioural intention was much more substantial among older people who were higher than 31 than those younger. This could be explained by the fact that older people are less exposed to the technologies and need more knowledge to enable them to use new technologies (Eisma *et al.*, 2003). This means that older citizens with less experience with technologies considered the importance of effort expectancy needed to shape an intention to use smart transportation applications. The citizens who are more likely to utilise smart transportation mobile applications feel that their abilities allow them to use them easily. On the other hand, the experience was reported to be insignificant in impacting Omani citizens to learn how to utilise smart transportation mobile services. Accordingly, regardless of their gender and experience level, all participants indicated that smart transportation mobile applications are easy to be adopted.

Fifth, the finding also reported that experience significantly moderates the relationship between social influence and behavioural intention. Regarding the current study, individuals are intended to use smart transportation mobile applications when coupled with a high level of experience. This means that the citizen's experience increases the social influence on behavioural intention. This finding contradicts (Tusyanah, Wahyudin and Khafid, 2021), who argued that high or low experience levels are not important in social influence impacting user behavioural intention.

Six, regarding the trust factor, the finding indicated that older people are more sensitive to the effect of trust on behavioural intention than the younger group. This finding is in line with Guo, Zhang and Sun's (2016) study, which found a difference between age levels. This distinguishing feature between those older than 31 and those younger than 30 is also consistent with the finding of (Fehr *et al.*, 2005; Moryson and Moeser, 2016; Thompson *et al.*, 2016), who demonstrated that the effect of trust on behavioural intention is stronger for older people. Moreover, the finding showed a difference between the strength of the trust on the behavioural intention, which is stronger for people with low experience. This is in line with (Moryson and Moeser, 2016). This finding is also supported by Hafizoğlu and Sen (2019), who argued that less experience would lead to a higher trust level.

8.5 Discussion Of The Whole Framework

Exploring the acceptance of technologies became very popular among researchers as many have conducted various empirical studies, especially in mobile technologies. Yet there is a limited number of research conducted in the field of smart transportation mobile applications generally and in the Omani context in particular. Accordingly, current research attempted to explore the factors influencing Omani users to accept smart transportation mobile applications by expanding the UTAUT2 model through incorporating contextual factors explored from the literature review and services providers' perceptions to enhance the successful implementation and acceptance of them in Oman. Moreover, as smart transportation mobile applications were first implemented in developed countries, most of the implementation and acceptance models were designed to meet the context of these countries. Today, given the variety of advantages that smart transportation mobile applications have approved, several countries have also aimed to implement them and convert their old transportation services into smart ones. Usually, developing countries may have various influencing factors for adopting smart transportation mobile applications with varying degrees of impact or importance compared to developed countries. However, the implementation and acceptance models created in developed countries are used as a benchmark because smart transportation mobile applications were first implemented in these nations. However, when used in other contexts and settings, the UTAUT2 factors may not necessarily be followed in all countries as their influences and impacts may vary from one context to another. As a result, one of the major reasons for this investigation was to test the applicability of the UTAUT2 model to investigate the acceptance of smart transportation mobile applications in Oman to enhance better acceptance and adoption of such applications in Oman. This study aims to explore and study the main factors that impact the adoption of smart transportation mobile applications in Oman as an example of a developing country and contributes to controlling the resistance to using them. Therefore, this research intended to propose a model for the Omani context based on the UTAUT2 to explore the factors that might lead to better acceptance of Omani citizens to smart transportation mobile applications to facilitate better transportation services, which are serious problems in Arab countries generally and Oman specifically.

This study has examined the adoption of smart transportation mobile applications in Oman by its citizens by developing and validating an integrated model based on UTAUT2 with some added variables that made it more suitable for the Omani context. These added variables were extracted from the smart transportation services providers' interviews and the literature review which considered these factors to be particularly relevant as some factors may affect the lives of citizens in developing countries to a greater extent than those in developed countries. As a result, through the development and validation of an integrated framework based on the UTAUT2 model with some additional factors that made it more appropriate for the Omani context, this study investigated how Oman's citizens will adopt smart transportation mobile applications.

Figure 8.2: The revised model of smart transportation mobile application acceptance in the Omani context

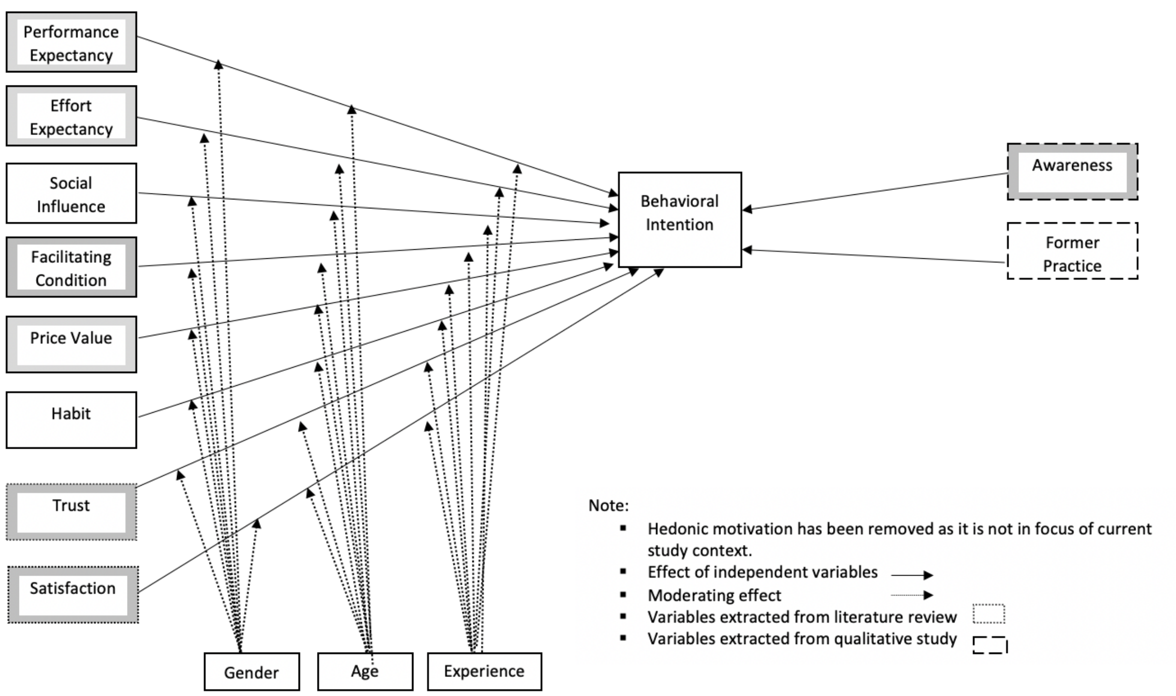


Figure 8.2 presents the results of the sample in this study. This research adopted the Cronbach alpha test to measure internal reliability, and the Cronbach alpha value was over 0.872, showing a high internal reliability coefficient. Also, the construct validity of the data was confirmed by the discriminate and convergent validity tests. The sample used in this

investigation produced results different from those hypothesised. As seen in Figure 8.2, the insignificance predictors of adopting smart transportation mobile applications in Oman are illustrated in grey boxes. Factors that are measured to be significant determinants are presented in white boxes in the model. Figure 8.2 is a tentative presentation of the model of the factor influencing the acceptance of smart transportation mobile applications in the Omani context, yet it needs further evaluation and testing. It can be concluded that the outcomes of the current investigation differ from those of other organisational and consumer contexts.

The context of the smart transportation mobile applications is different from the setting of the UTAUT model used in the organisational context and the UTAUT2 model used in the consumer context in three main ways, which may explain the different findings reported in the current research from the outcomes of the other studies' contexts. Firstly, the target users of smart transportation mobile applications are considered to be unlike the other users examined in previous research. They are considered different from the users of mobile gaming applications, mobile hotel applications or other mobile banking applications in which the adoption of the UTAUT2 and UTAUT models are identified to be more homogenous situations. For instance, studies conducted on the acceptance of hotel and gym applications are usually undertaken in defined communities among users who might have similar variables controlling their behavioural intention to accept. For example, target users of mobile gym applications are most probably citizens who are directly interested in staying fit or even those who are planning to lose weight. These users usually share similar needs, interests, and requirements, encouraging them to use these applications. Comparing this to the smart transportation mobile applications designed to serve citizens across the city, their target users are all people living in Oman who want to commute by getting the support of smart transportation mobile applications. This indicates that the target sample in the current investigation is more complicated as various constructs affect the end users' perceptions of acceptance. This might result in different results than previous research in other contexts.

The second difference contributing to generating the different results in the current study is that of the differences between the applications designed to serve integrated functions and those built for specific functions. In various settings, the UTAUT2 and UTAUT models are implemented in studying citizens' acceptance of a particular technology with specific functionalities such as mobile health applications (Schomakers *et al.*, 2022) and mobile payment applications (Migliore *et al.*, 2022). However, smart transportation mobile applications are considered more complicated applications with integrated functions, including checking congestion, payment of parking fees, payment of driving fines, renewing the driving license, and checking the arrival time of public buses. These applications involve users from both public transportations' users and private's car owners. As a result, the users of the smart transportation mobile applications are heterogenous; accordingly, their assessment of the factors influencing the acceptance might differ from other users in other contexts with specific tasks. Another difference between smart transportation mobile applications and other mobile applications is that citizens usually use smart transportation mobile applications in everyday commuting and travelling regularly. This is also considered true for the different domains of smart cities, such as smart education and smart health, which are considered part of citizens' everyday needs. Being necessary and critical for citizens' daily lives makes these applications unique and different from other mobile applications. Accordingly, the acceptance factors of such applications may have different levels of importance from their users' perspectives compared to other contexts.

Out of ten hypotheses, only three (H3, H6, and H10) were supported by this research. Surprisingly, none of the hypotheses added to the model based on the literature review has been supported, as both factors, satisfaction and trust, has been rejected. Moreover, out of the two constructs incorporated into the model based on the service providers' perceptions, only one (former practice) has been accepted. Additionally, four hypotheses added based on the original UTAUT2 model have been rejected. The analysis found that performance expectancy, effort expectancy, price value, and facilitating conditions do not influence the behavioural intention to accept smart transportation mobile applications in the Omani context. On the other hand, the analysis revealed that only the social influence and habit constructs from the original UTAUT2 model statistically affect the citizens' behavioural intention to adopt smart transportation mobile applications.

To summarise, habit, former practice, and social influence were assigned as the three main factors influencing the citizens' intention to utilise smart transportation mobile applications. The former practice is a contextual factor incorporated into the model, particularly in the smart transportation mobile applications acceptance context. Omani citizens are expected to be influenced more by their previous trials of similar applications in other contexts or countries. Citizens usually link their earlier experiences with similar applications with their future intentions of adopting new smart transportation mobile applications. This also indicates that citizens' previous experiences with smart city mobile applications and other smart city domain services could impact their opinion of smart transportation mobile applications and services. This further implies the importance of citizens' involvement in the process of smart transportation mobile applications implementation, besides involving them in free trials to encourage them to explore the usability of these applications. Service providers must pay more attention to engaging them throughout the different procedures. Thus, the finding emphasized the importance of considering citizens as a critical part of implementing smart transportation mobile applications. Given the importance of the former practice, it is useful to add it to future investigations in the context of smart transportation mobile applications and other smart technologies services, including other smart city domains. Although it was not assigned as a critical factor in the original UTAUT and UTAUT2 models or other new technology adoption studies, it can be incorporated as one of the main predictors to facilitate the acceptance of smart technologies in general and smart transportation in particular. The qualitative empirical finding of the importance of the former practice factor was supported by the quantitative findings in which both service providers and citizens agreed on its significance in influencing citizens' perception of the adoption of smart transportation mobile applications. This finding is supported by previous researchers such as Khan *et al.* (2020), who argued that users' previous familiarity with the software allows for quicker adoption. Also, Lee and Ma (2012) argued that users' prior experiences with social media applications similar to smart transportation applications help them realise their benefits and improve their confidence to execute new actions easily. Consequently, it can be concluded that service providers and citizens shared the same perception of the former practice factors' impact on the acceptance of smart transportation mobile applications in the Omani context. The outcomes of previous research further supported this.

Regarding the social influence and habit constructs, both have reported the same significance and importance on the acceptance of the smart transportation mobile applications in the Omani context, as both reported p-values of 0.00. Friends and families are affecting each other in adopting smart transportation mobile applications and are significant in influencing the acceptance of smart transportation mobile applications. It has been argued in chapter three that societies with collectivist culture are categorised to be trustful and loyal to the group impacts (Hofstede, 1983, 1984). In contrast, individualist societies are more individual and self-interest oriented (McCoy, Galletta and King, 2005). Oman is a collectivism country, as has been discussed earlier. Accordingly, Omanis rely more on groups than individuals in making decisions, and this aligns with the current investigation's finding, which argued that social influence impacts Omani citizens' behavioural intention to accept smart transportation applications.

The study also found that habit is among the crucial determinants of the citizens' behavioural intention to adopt smart transportation mobile applications, and this finding further supports the earlier technology acceptance studies that generated the same conclusion (Kim and Malhotra, 2005; Bandyopadhyay and Fraccastoro, 2007; Limayem, Hirt and Cheung, 2007; Venkatesh, Thong and Xu, 2012; Pratama and Renny, 2022; Zhou, Li and Wijaya, 2022). To investigate habit construct, this was discussed in detail with the service providers. Although some of them disagreed with this construct and argued that smart transportation mobile applications as optional applications could not be compared to the other technologies, such as smartphones, that citizens regret living without them, most of them indicated that once citizens start using smart transportation mobile applications, they will become dependent on them. The quantitative data analysis of the citizens' perceptions showed a strong impact of habit factors on the acceptance of the citizens. Therefore, based on the qualitative and quantitative findings, the habit construct should be kept in the proposed model of the current study context as it is in the original UTAUT2. The findings of social influence and habit are aligned with what was recognised in the qualitative data. The qualitative and quantitative results were aligned with the current literature, where it was also found that habit and social influence are significantly associated with the behavioural intention to accept.

A comparison between the finding in each context is conducted in Table 8.1. In the current research, the UTAUT model has been adopted to investigate the influential factors in the organisational context. On the other hand, the UTAUT2 model is utilised to explore the acceptance factors in the consumer context. In addition, the study has also paid attention to the previous research conducted in the setting of the consumer mobile applications adoptions that have implemented both UTAUT and UTAUT2 models.

Table 8.1: Comparison of the impact of main factors in organisational, consumer and smart transportation mobile contexts

Key Positive Relationships	UTAUT model (Organisational context) (Venkatesh, Michael G. Morris, *et al.*, 2003a)	UTAUT2 model (Consumer context) (Venkatesh, James Y L Thong and Xu, 2012)	Smart transportation mobile applications context
Performance expectancy → behavioural intention	√	√	
Effort expectancy → behavioural intention	√	√	
Social influence → behavioural intention	√	√	√
Facilitating conditions → behavioural intention		√	
Price value → behavioural intention		√	
Habit → behavioural intention		√	√
Trust → behavioural intention		√	
Satisfaction → behavioural intention		√	
Former practice → behavioural intention			√
Awareness → behavioural intention			

Comparing the finding in Table 8.1, it can be noticed that the smart transportation context is unlike the organisational and consumer contexts. In the smart transportation mobile applications setting and in contrast to the organisational and consumer contexts, most of the original factors, including effort expectancy, performance expectancy, price value and facilitating conditions, were not considered significant factors impacting the acceptance. Interestingly, these factors were considered significant based on the service providers' perceptions. Yet, citizens have different perceptions and stated that these factors do not influence their intention to adopt smart transportation mobile applications in the Omani context. Performance expectancy, effort expectancy and facilitating condition had no significant effect on the behavioural intention. Despite the perceptions of smart transportation services providers, and the original finding from the UTAUT2 model, these factors have shown no effect on the acceptance of smart transportation mobile applications.

Regarding performance expectancy, Venkatatesh et al. (2003) argued that the higher the performance expectancy, the higher the acceptance. In the current study, performance expectancy was reported with no effect on the acceptance of smart transportation mobile applications. In the original model, Venkatesh et al. (2003) demonstrated that performance expectancy is a critical predictor of adoption. It was also found to be one of the most significant influencers in the context of the consumer (Venkatesh, Thong and Xu, 2012). It has also been found to be critical in adopting new technologies in other contexts (Naser Alraja *et al.*, 2016; Hassan *et al.*, 2022; Popova and Zagulova, 2022). However, the respondents in the current research had a negative attitude toward the performance expectancy construct, which indicates that the advantages and benefits of smart transportation mobile applications do not make citizens confident that their productivity and quality of life will be higher if they adopt these applications.

Similarly, to the performance expectancy, the results did not provide evidence that facilitating conditions and effort expectancy significantly influence the acceptance of smart transportation mobile applications. For instance, many studies have shown the importance of facilitating conditions in consumer's behavioural intentions towards getting technical support and contributing to simplifying the adoption (Venkatesh et al., 2003; Lancelot Miltgen, Popovič and Oliveira, 2013; Chauhan and Jaiswal, 2016). Also, effort expectancy has been identified as one of the key determinants of technology acceptance and adoption (Kabra *et al.*, 2018; Sair and Danish, 2018). However, the finding did not support the importance of facilitating conditions and effort expectancy as significant factors influencing citizens' acceptance of smart transportation mobile applications in the Omani context. These contradicting findings might be due to the heterogeneous nature of smart transportation mobile applications. Another possible reason for this insignificance could be that smart transportation mobile applications are designed to be used in the same ways as other mobile applications. Accordingly, both effort expectancy and facilitating conditions are recognised as unnecessary. Yet, the finding indicates that effort expectancy is considered more important among older users than younger ones.

Regarding price value, smart transportation mobile applications involved in the current research are free to download and use by the public, as discussed previously. Most of the measurement items involved in the questionnaire were elements extracted from the service providers' interviews. It involves items such as the additional nonmonetary value of vouchers and free cinema tickets and supporting them in exploring better packages. However, citizens' perceptions did not support this view, as the quantitative findings indicate that including price value in the current research was inappropriate. This conclusion may assist in understating that if technology is free for people to use voluntarily, price value may not be a critical element influencing the citizens' impression of adjusting their behaviour to utilise it.

This research has identified and incorporated a new construct called awareness. It is defined as the citizen's knowledge about the existence, advantages, and benefits of using smart transportation mobile applications. This construct was introduced to the current model based on the service providers' perceptions of the factors influencing citizens' adoption of their mobile transportation applications. However, the finding indicates differences between services providers' and citizens' perceptions of the effect of awareness on the acceptance of smart transportation mobile applications. Smart transportation service providers were concerned about spreading awareness about the existence of these applications. They have also insisted on the importance of directly informing citizens about the advantages of their application in improving their quality of life, such as improving their mental and physical health. Moreover, they have also argued for the importance of informing citizens that by adopting smart transportation mobile applications, they are contributing to reducing traffic congestion and saving their environment by reducing pollution. However, the quantitative finding indicates that citizens were not concerned about whether their commuting decisions will lead to problems including traffic, pollution, or even affecting their health. As a result, improving citizens' awareness was not considered a factor in facilitating the acceptance of smart transportation mobile applications. Awareness has been shown to be critical in previous investigations such as Charbaji and Mikdashi (2003), who proved that awareness is a significant factor strongly impacting the adoption of the e-government. To enhance citizens' adoption of new technologies, it is required to make them aware of the services and benefits (Rehman, Esichaikul and Kamal, 2012). Although many authors support the service providers' perceptions, it contradicts the understanding of the citizen's perceptions, which indicates that awareness does not contribute to building confidence in better adoption of smart transportation mobile applications. Consequently, this construct should be removed from the model in the context of smart transportation mobile adoption in Oman.

The author added two new factors based on the literature review: trust and satisfaction, which were predicted to facilitate better adoption of smart transportation mobile applications in Omani contexts. These two elements were considered smart city contextual factors mainly belonging to the smart transportation setting. The service providers also approved them as essential in adopting smart transportation mobile applications in the Omani context. For instance, they argued that citizens' perceptions of trust could enhance their view of smart transportation mobile applications. They also imply that enhancing citizens' trust by respecting citizens' privacy and improving the security level of these applications would enhance citizens' recognition of these applications and therefore motivate them to adopt them. Moreover, it is also about the level of trust citizens hold in service providers based on their reputation. Likewise, satisfaction was also approved by the service providers as a factor affecting the acceptance. They argued that the quality of information, applications and services delivered to citizens plays a vital role in their acceptance. Accordingly, the author decided to keep them as essential factors influencing citizens' adoption in Oman. Items related to the satisfaction factor have been rejected in the context of the current research. For instance, whether service providers are working hard to deliver quality services by posting updated and accurate transportation information or by ensuring the quality of the software and technologies used in developing their applications, citizens will not be enticed to adopt them. Thus, it is shown that citizens' satisfaction was not the main direction to focus on to facilitate the adoption. Moreover, the finding indicates that neither building trust through improving security and privacy nor service providers' reputations builds a hub in diffusing the acceptance of smart transportation mobile applications among Omani users. Consequently, these two elements should not be involved in the current research model context.

The above discussion has analysed the effect of the acceptance factors within three different contexts: smart city transportation context, organisational context, and citizens context. Comparing the findings to the previous literature, which has investigated these factors in other contexts, it can be noticed that the smart transportation mobile applications context in an Omani setting requires special consideration of possible contextual factors unique to it. Accordingly, this combination of findings supports building a conceptual model that better explains the acceptance of smart transportation mobile applications to be used as a base for future research. The main factors affecting citizens' acceptance of smart transportation mobile applications are former practice, social influence, and habit.

The finding also indicates that apart from very few impacts, individuals' characteristics such as age, gender and experience in a smart city context do not play a vital role in moderating the impact of the main influencers in the acceptance of smart transportation mobile applications. As a result, the segmentation of citizens and dividing them into different groups, except for the four mentioned earlier, may not enhance the better acceptance of smart transportation mobile applications.

To sum up, the above discussion reinforced the argument raised earlier in the literature review chapter that to enhance the adoption and acceptance of smart transportation mobile applications in the Omani context, it is significant to consider the perceptions of both the services providers along with the citizen's perceptions to facilities better decision and implementation of such applications in Omani context.

8.6 The Perception Of Citizens Versus The Perception Of Service Providers On Key Factors Influencing The Acceptance Of Smart Transportation Mobile Applications In The Omani Context

The above discussion showed discrepancies between how smart transportation service providers view the factors that facilitate citizens' acceptance of smart transportation mobile applications and the actual factors that affect the adoption from the perspective of the citizens who are the end users of these services. The results of the present study highlighted significant findings that may contribute to better facilitation of the acceptance of smart transportation mobile applications among Omani citizens. This result answers one of the main research questions by comparing citizens' and service providers' opinions on each factor and highlighting the difference between both perceptions.

Table 8.2 demonstrates that the perceptions of seven factors: performance expectancy, effort expectancy, facilitating conditions, price value, trust, satisfaction, and awareness were the key areas of disagreement between these two perceptions. As shown in Table 8.2, the original and fundamental factors for determining citizens' acceptance of smart transportation mobile applications in the Omani setting that have major effects are former practice, habit, and social influence. As a result, it is suggested that service providers may need to shift their emphasis to the user influencing factors, such as improving users' prior behaviour, illuminating how family, friends, and the community increase acceptance, and highlighting the degree to which people tend to perform behaviours automatically as a result of learning, rather than expending excessive effort on, for instance, spreading awareness of these applications benefits, making them user friendly or using incentives to attract citizens adoption.

Table 8.2: Differences between citizen's and services providers' perceptions about the acceptance of smart transportation mobile applications in the Omani context

Main factor	**Service providers' perspective**	**Citizens' perspective**	**Additional users' perspectives**
Performance Expectancy	- Improving the quality of the commuting - Helping in quick access to smart transportation services - Saving citizens' time. - Making citizens' days more productive - Offering more convenient transportation services - Better management of travelling processes	Rejected	Citizens were not concerned about the advantages as a main determent in changing their behavioural intention to adopt smart transportation mobile applications
Effort Expectancy	- Easy learning to use - Simple, clear, and understandable interaction - Easy to become skilful at using the applications - Meeting users' needs and preferences	Rejected	The adoption of smart transportation mobile applications apparently was not influenced by the amount of effort needed to adopt them. The effort needed to use them would not matter in the acceptance.
Social Influence	- Family members and relatives influence the acceptance - Citizens are influenced by the opinions of their valued people's recommendations - Citizens are influenced by the encouragement of the services providers	Accepted	Citizens appears to be influenced by the pressure of other users around them, and their desire to use smart transportation mobile applications was decided by whether other individuals are utilizing them. Also, services providers encouragement plays a vital rule in enhancing their acceptance.

Main factor	Service providers' perspective	Citizens' perspective	Additional users' perspectives
Facilitating Conditions	- Availability of specialists to help with smart transportation mobile applications - Are compatible with other devices citizens use - The availability of rules and regulations to control the services - Availability of internet at good speed and price - Availability of the capital needed to implement such projects	Rejected	Citizens believe in their skills to use smart transportation mobile applications. They do not expect to get the required support they are looking for from the service providers. Accordingly, facilitating conditions make no impact on their acceptance.
Price Value	- Saving citizens' money - Involvement of other benefits, such as vouchers - It helps in exploring the best deals and best commuting routes	Rejected	The extra benefits assigned with the adoption of the smart transportation mobile applications did not appear to have advantages on the acceptance as there are some other external factors that might influence their acceptance of these applications.
Habit	- Addicted to the use of their old ways of transportation methods - Be used to living in the current transport situation in Oman	Accepted	Once the usage of smart transportation mobile applications becomes a habit, then citizens will use them automatically.
Trust	- Trust between services providers and citizens: meeting citizens' needs/ service providers' reputations - Trust in technologies: perceived privacy/perceived security	Rejected	keeping citizens' needs and preferences and meeting their daily travelling needs by the services providers is not critical in enhancing the adoption.
Satisfaction	- Meeting the expectations of the citizens - Having a positive experience while using them - Efficient services quality - Efficient transportation information received - Enjoyment of high application quality	Rejected	Citizens apparently were not influenced by the service quality, information quality, and application quality delivered by the smart transportation mobile applications to start using them.
Former Practice	- Offering citizens, a free trial period of the new applications - Designing of applications similar to other applications used in other same contexts or other countries	Accepted	The more positive experience citizens gain from using pervious similar applications the more they will be enhanced to adopt the new applications. The more familiar they are the more they accept.
Awareness	- Aware of the existence of the smart transportation mobile applications - Aware of the indirect benefits of adopting them - The importance of the proper advertisement for them	Rejected	The adoption of smart transportation mobile applications is not affected by citizens' awareness level.

8.7 Summary

In this chapter, the finding of both qualitative and quantitative results has been discussed. A comparison between citizens' and services providers' perceptions of acceptance was conducted to gain a holistic view of the acceptance of smart transportation mobile applications in the Omani context. The main attempt of the current investigation was to explore the critical factors expected to significantly impact the Omani citizen's acceptance of smart transportation mobile applications by using an extended UTAUT2 model. The results from the interviews supported the significance of both the original factors of the UTAUT2 model and the one extracted from the literature review, besides highlighting new factors which were believed would facilitate better acceptance if incorporated into the model. The research discussed three main factors influencing the acceptance of smart transportation applications in Oman: the original factors of the UTAUT2 model, the contextual factors extracted from both literature review chapters and the services providers' perceptions. The main findings of the research indicated that only three factors were assigned to be significant in Omani citizens' intention to adopt smart transportation mobile applications: social influence, habit, and former practice. The discussion also revealed that experience and age had been approved to moderate only four links between the independent factors and the behavioural intention. The next chapter summarises the whole thesis, highlighting the research's main contributions and limitations. Moreover, answers to the main research questions will be illustrated as well.

Chapter 9: Recommendations and Conclusion

9.1 Introduction

This study aimed to investigate services providers' and citizens' perceptions of factors influencing the adoption of smart transportation mobile applications in daily commuting-related activities. The current research finding was presented earlier in the previous chapter. This chapter is intended to provide a recapitulation of the previous chapters and tries to crystallise the most important findings of the current research. It also answers the research questions and relates them to the literature review. It later highlights the research's main contributions and explains the study's main limitations. Finally, it introduces some suggestions and improvement areas for future research.

9.2 Summary of The Current Research

The study is designed to explore smart transportation service providers' experiences and perceptions regarding using smart mobile applications in transportation to determine the acceptance of transportation mobile technology among Omani citizens. Smart transportation service providers play an important role in enhancing citizens' acceptance of these applications. On the other hand, engaging citizens as end users is also important to facilitate an effective acceptance of smart transportation mobile applications in Oman. Therefore, this research is designed to investigate the end user's understanding of the factors that enhance their acceptance and compare it to the end users' perceptions of acceptance to provide recommendations as a guide to help service providers better facilitate their acceptance. The initial stage of carrying out this investigation was to explore the related literature on acceptance worldwide, particularly in smart cities. This review looked at scholarly research on the acceptance of smart cities and smart transportation services by examining technology acceptance models, emphasising the UTAUT2 model. This gave the researcher direction to develop the research contextual proposed model. Later, the smart transportation mobile application's end users evaluated the proposed model. The following were the study's key research questions:

RQ 1: What are smart transportation service providers' beliefs and perceptions regarding the contextual and main factors affecting the acceptance and adoption of smart transportation mobile applications among Omani citizens?

RQ 2: What are the factors that actually affect citizens' acceptance of smart transportation mobile applications?

RQ 3: What should be done to improve and facilitate the acceptance of smart transportation mobile applications among Omani citizens?

To answer these research questions, the researcher followed a sequential mixed method to examine the perspectives and experiences of smart transportation service providers and Omani citizens on the factors enhancing the acceptance of smart transportation mobile applications in their daily commuting. This has been implemented by considering both quantitative and the qualitative data collection through semi-structured interviews and questionnaires. To direct the investigation of the study, the researcher adopted the UTAUT2 model as a base for exploration. Smart transportation services providers of four organisations were invited to be interviewed and participate in the current research. The researcher used the thematic analysis technique to analyse the data collected from the interviews. Later, 383 Omani citizens participated in the data collected through the survey to explore citizens' perceptions of factors influencing their acceptance. Various statistical tools and techniques have been used to analyse the quantitative data collected. The following section will summarise the significant findings and conclusion of the current research.

9.3 Responses To The Research Questions

RQ 1: What are smart transportation service providers' beliefs and perceptions regarding the contextual and main factors affecting the acceptance and adoption of smart transportation mobile applications among Omani citizens?

At the outset of the study, it was anticipated that services providers' expectations of the factors influencing citizens' adoption of smart transportation mobile applications are most likely to vary from those of citizens, which may lead to problems in the evolution of the best ways to enhance the successful implementation of smart transportation mobile applications in Oman. The study's findings have confirmed this expectation and indicated that smart transportation service providers view the elements influencing residents' acceptance of the smart transportation mobile applications for facilitating that acceptance from a different angle than the citizens themselves. It was recognised that service providers were almost exclusively focusing on their own understating of the acceptance and ignoring consumers as the center of the acceptance process. Kim (2015) argued that the success of innovations mainly relies on paying more attention to building a better understanding of the users' needs. In particular, the study discovered that service providers' perceptions of how to promote acceptance of smart transportation mobile applications were based on their experience and intuition rather than systematically taking end-user perceptions of acceptance into account. Awareness and former practice are two factors explored by the service providers. They believed that improving these two factors could help citizens adopt smart transportation mobile applications effectively in an Omani context. They assumed that the key factors for the acceptance of the smart transportation mobile applications were compatibility, internet availability, rules and regulations and skilled professional workers, guidance and support. They have also tried to persuade the public to adopt by building user-friendly interfaces meeting end users' preferences, knowledge levels and abilities. They believed in the abilities of the rewards and additional benefits from third parties in convincing Omani citizens to employ smart transportation mobile applications. They have also tried to persuade citizens by raising public awareness of smart transportation benefits. They felt it was important to make an effort to promote the smart transportation project. This included fundamental details on the advantages of using smart transportation mobile applications, such as the threats to one's health and the environment posed by current modes of transportation. It also involved information pertinent to the life quality enhancement for smart transportation mobile applications adopters by posting precise information on the advancements gained by the usage. They also believed that citizens' high expectations about smart transportation projects put additional pressure on them to meet their expectations and maintain their good reputations.

Moreover, they believed in the importance of employing secure payment methods besides requesting less personal information from end users to boost citizens' trust. Furthermore, they also believed that the kind of feedback citizens receive from their families and friends affects their perceptions of adoption. Also, service providers claimed that the confidence gained by adopting similar applications in other countries and contexts enhances citizens' perceptions of such applications' importance and consequently encourages adoption. Therefore, they believed in providing a free trial period to improve successful adoption. Moreover, service providers also insist on delivering on-time services, accurate information, and quality applications perusing citizens adopt. Finally, they have also claimed that once the usage of smart transportation becomes a habit for citizens, they will use them automatically.

They believed that by focusing on all factors mentioned above, they would succeed in encouraging citizens to accept using smart transportation mobile applications in their daily commuting to facilitate taking better informed commuting decisions.

RQ 2: What are the factors that actually affect citizens' acceptance of smart transportation mobile applications?

The quantitative study looked at how consumers of smart transportation mobile applications perceived the factors expected to affect their usage and acceptance of such applications. The results showed that only social influence and habit from the traditional factors of the UTAUT2 model had positive effects on citizens' behavioural intentions to adopt. Moreover, only former practice construct from the extended components has been shown to influence citizens' intentions to utilise smart transportation mobile applications.

The study also wanted to understand the influence of three primary variables: age, gender, and experience, on moderating the relationship between behavioural intention and the main independent variables. These three demographic variables were used to categorise smart transportation users into three main distinct groups. The finding indicates that effort expectancy was moderated by age, with citizens higher than 31 is more likely to be influenced by effort expectancy to accept the smart applications. Social influence was moderated by experience as citizens with high experience are more likely to be affected by social influence construct to use smart transportation mobile applications. The effect of trust on behavioural intention was more substantial for citizens older than 31 and those with low experience. Apart from these effects, age, gender, and experiences did not have a moderating effect on all other independent variables in the model.

RQ 3: What should be done to improve and facilitate the acceptance of smart transportation mobile applications among Omani citizens?

A practical model for encouraging individuals in Oman to accept smart transportation mobile applications was developed by comparing the perspectives of both smart transportation service providers and citizens in facilitating the acceptance of these applications. The findings implied some differences between the views of citizens and service providers. Moreover, the results also reported some differences from the original UTAUT2 model while indicating that other factors tailored to the smart transportation scenario in the Omani context need to be incorporated into this model to facilitate better acceptance.

Forming a long-term habit of using smart transportation mobile applications among Omani citizens is a crucial factor in boosting the overall number of users. Service providers are urged to help consumers embrace smart transportation mobile applications by giving extended offers since habit plays a crucial part in how well Omani residents use these applications. They are recommended to build a habit and therefore demonstrate a behavioural intention of usage. For example, service providers can offer training to reduce fear and break citizens' old habits. Additionally, how much citizens believe that significant individuals, including family and friends, believe they should utilise a particular technology is another significant factor that can facilitate citizens' acceptance and adoption. As a result, new users in Oman imitate the actions of others in their social network and use these actions as inspiration to steer clear of ambiguity. This suggests that individuals must be inspired and encouraged to utilise mobile applications for smart transportation to deploy smart cities in Oman effectively. This may be done by concentrating on the social influence factor. Hence, while promoting mobile applications for smart mobility, service providers should take peer pressure into account.

Moreover, only the former practice construct from the extended components has been shown to influence citizens' intentions to utilise smart transportation mobile applications. Citizens' prior experience with similar applications in other countries or contexts is also essential for persuading citizens to use the new smart transportation mobile applications in the Omani context. This suggests the significance of including citizens in the design and deployment of smart transposition services and motivating them by providing free public trials to increase their acquaintance with the functionality and advantages of these apps. To increase adoption and acceptability, smart transportation service providers should build applications with features and functionalities similar to those used in other nations and industries.

On the other hand, the findings imply that citizens are not affected by whether using smart transportation mobile applications could benefit them in being more productive, saving their time or even enhancing the organisation of their daily transportation. Also, the findings showed no effect of effort expectancy on citizens' attitudes toward adopting smart transportation mobile applications and that facilitating conditions do not impact the acceptance to use smart transportation applications. Interestingly, application, information, and service quality also do not affect the public's intention to adopt. Regarding adopting smart transportation mobile applications in Oman, two types of trust were identified: trust in the organisation and the technology or the channel. Yet, research findings indicated that trust does not affect Omanis intention to adopt smart transportation mobile applications. Additionally, contrary to previous studies' findings, the results demonstrated that price value does not significantly influence Omani citizens' behavioural intentions to accept smart transportations mobile applications. Moreover, awareness and understanding of the benefits that can be gained by utilising smart transportation mobile applications did not hinder the acceptance and adoption of these applications.

Therefore, based on the conclusion of this study, it may be necessary for Omani service providers to focus more on the acceptance factors from the citizen's perceptions rather than relying simply on their own beliefs to facilitate acceptance. Accordingly, they must improve their awareness of user acceptance and design, build and implement these applications based on these influential factors to enhance their acceptance.

9.4 Key Contributions Of The Research

This study's contributions and consequences cover both theoretical and practical aspects. By the utilisation of the UTAUT2 framework, this work contributes to the body of knowledge on smart mobile technology and associated concepts. Then, the practical contribution offers helpful information that can successfully direct and assist in adopting smart transportation mobile applications among Omanis. These two main contributions are discussed in detail in the following sections.

9.4.1 The Research Contribution

The research has several contributions achieved as follows:

1. This research adds valuable input to smart city scientists and information technology acceptance researchers. The proposed model developed in this study is expected to stand as a focal point for researchers in both smart cities and information technology acceptance to enhance the successful implementation and acceptance of smart transportation services or even examine the acceptance of other smart cities' dimensions in Oman. It is also valuable to all researchers, whether in Oman or other countries, who are curious to investigate end users' acceptance of technology generally and smart transportation technologies in particular. Accordingly, the proposed framework can be further adapted, extended and tested in other contexts.
2. The current research introduces the first conceptual framework, specifying the factors influencing citizens' acceptance of smart transportation mobile applications in the Omani context. It Generated a contextual framework about the acceptance of smart transportation services and applications in developing countries in general and Oman in specific. There is a lack of empirical studies regarding the acceptance of smart transportation services and mobile applications, resulting in an unclear understanding of the end user's acceptance and adoption of such smart services and applications. For the first time, the thesis introduces a framework designed for a desert nature developing country with oil as a main source of its income. Moreover, it provides a comprehensive framework with different factors. This research also adds to the contextual knowledge body as the developed framework is primarily for the Omani context with its unique requirements and challenges. However, with appropriate reflection, the framework can be extended to neighbouring countries with the same geographical, economic, and social characteristics as the GCC countries.
3. The current research provides valuable suggestions and recommendations for smart transportation service providers particularly and smart service providers generally. The research will produce empirical outcomes helping service providers and decision-makers in transportation sectors enhance the acceptance and adoption of smart transportation services. The built acceptance model aligned with different service providers' perceptions is in the interest of different groups such as government authorities, private companies, the public sector, ministries, and economic experts. It works as a toolkit to build smart services with high chances for acceptance and adoption.
4. This study identified the key potential and contextual factors affecting Omani citizens' acceptance of the smart transportation mobile applications from the literature on smart transportation and user acceptance besides also included service providers'

perspectives as the community who could decide how to facilitate citizen acceptance. This combination of the service providers' opinions through interviews and citizens' perceptions through a questionnaire is considered a unique combination that can be further improved and adjusted.

9.4.2 Theoretical and Methodological Contributions

This research aimed to determine the factors influencing Omani citizens' willingness to use smart transportation mobile applications in daily commuting. The suggested model in the current study contributes to the theoretical knowledge in many ways. Firstly, although in the Omani context there are very few studies have been conducted in the area of smart cities generally and smart transportation services in particular, the researcher could not identify a single study on the use of smart transportation mobile applications and the factors that might affect their acceptance in Omani context. Therefore, little is known about user acceptability and adoption of these smart applications. This research is considered the first of its kind and contributes to closing this knowledge gap by exploring what motivates Omani citizens to accept smart transportation mobile applications in Oman. Therefore, this research is unique as it provided knowledge of the main factors influencing Omani citizens' adoption of smart transportation mobile applications. This kind of empirical research, mainly focusing on the Omani context, is valuable in generating practical feedback and knowledge for better deployment of smart transportation services in Oman.

Secondly, this study also contributes to helping smart transportation services providers in Oman better understand the actual factors impacting citizens' acceptance of their services generally and their smart applications particularly. The introduction of smart transportation mobile applications in Oman is relatively new. Therefore, this study can improve the return on ICT investments by delivering more effective and efficient smart transportation services by exploring the main factors considered critical by the citizens to adopt such applications. Keeping these factors in consideration while designing, planning, and implementing smart transportation projects leads to the successful implementation and diffusion of them among various groups of Omani citizens (depending on age, gender, and experience). This study supplies smart transportation application services providers with a range of valuable recommendations that help them highlight the main factors that Omani citizens believe in supporting their adoption and acceptance rather than relying only on their perceptions of the influencers. Implications from this study can also assist smart transportation services providers in Oman in their ongoing efforts to improve mobility and the successful implementation of smart transportation projects by illuminating lessons from the current research to future projects. This study also advances the practical understanding of citizen acceptance among service providers and their understanding of the best method to follow to promote citizen acceptability. It contributes to a better understanding of the elements and expectations that affect citizens' adoption. It also assists other countries in better understanding the significant variables that should be considered while planning and diffusing smart transportation mobile applications. By knowing the influencing factors of citizen acceptance and the potential challenges affecting citizen acceptance, service providers will better grasp how to support citizen acceptance more effectively.

Thirdly, the current suggested model was mainly based on the traditional UTAUT2 model initially designed to meet western countries' contexts. Yet none of the researchers employed the UTAUT2 model to examine the acceptance of smart transportation mobile applications in Omani or other Arab countries. Thus, this study contributes to the ongoing discussion on the possibility of utilizing the UTAUT2 model, which is mainly designed to meet western countries' needs in the context of a developing country (Merhi, Hone and Tarhini, 2019). Moreover, studies on smart transportation mobile applications in developing countries are limited. This study contributes to bridging these gaps between smart transportation mobile applications and the technology acceptance models by suggesting an empirical model for smart transportation mobile applications based on the UTAUT2 model in the context of a developing country, Oman.

Fourth, in addition to the utilization of the UTAUT2 model in a new setting, which is smart transportation mobile applications, and emphasizing the significance of employing technology acceptance models in addressing the main factors influencing citizens' adoption of the smart transportation mobile applications, this research extended the UTUAT2 model to consider the contextual factors which usually technology acceptance models do not address. Incorporating contextual factors is a critical step in better understanding the situational setting (Sun and Zhang, 2006). Therefore, this research contributes to augmenting the UTAUT2 model by extending it with contextual factors. This further helps provide a framework that works as a fundamental base enriched with contextual factors that facilitate the adoption and acceptance in the smart city context generally and smart transportation context specifically. In other words, by incorporating four new variables into the model: trust, satisfaction, awareness, and former practice which were explored from both the literature review and smart transportation service providers' perceptions as independent variables, this research offers a new perspective in reconceptualization and utilization of the UTAUT2 model within the context of smart cities and smart transportation domain adoption in Arab countries and more specifically Omani context.

Fifth, most current acceptance models have been explored in either broad organizational or consumer contexts in developed countries. However, adopting and accepting smart transportation mobile applications in Omani is considered a different scenario with a wide range of factors and elements that need to be considered and examined with current research settings. Therefore, the outcome of the recent research has provided empirical examinations and confirmations of the factors that would affect the utilization of smart transportation applications in Oman. As a result, by reviewing the literature on smart cities and smart transportation adoption in both developed and developing countries, listing and organizing the relevant studies about smart transportation adoption, exploring the contextual factors from the service providers, and adding to the literature on smart cities adoption in the context of developing countries in general and Oman in particular, the findings of this research have contributed to the literature and the knowledge in the field.

Sixth, the thesis adds to the growing body of research on smart cities and smart transportation by examining the variables influencing Omanis citizens' acceptance of smart transportation mobile applications. By extending the acceptance paradigm from the organizational context and general consumer context to the particular smart transportation environment, the current study considerably adds to the knowledge of acceptance. It has addressed the gap in the literature where qualitative methodology predominates such kinds of studies by adopting a quantitative approach. Although qualitative studies are beneficial for examining factors influencing the acceptance of smart mobile applications, they tend to focus on the experiences of a small number of individuals and only the perceptions of service providers, which makes it difficult to draw generalizations about the population at large and the end users who are the subject of the study. Qualitative studies offer a solid foundation for investigating the subject, but quantitative research is also required afterwards. By following a mixed method, this thesis has identified the potential factors from the literature on smart transportation and user acceptance. Besides the thesis also includes service providers' perspectives as a community who decide how to facilitate citizen acceptance to investigate the key contextual factors that may influence citizen acceptance. As a result, it represents an important and unique contribution to knowledge. The findings point to the advantages of including service providers and end users in this type of research.

Seventh, the UTAUT2 model was used in this study to support the hypothesis that gender, age, and experience are moderating variables in the link between the ten components and citizens' behavioral intentions to adopt smart transportation mobile applications. This study thereby increases understanding of how differences in gender, age, and years of technology usage impact smart transportation mobile applications acceptance. The development of superior programs and regulations that can encourage service providers to participate more and improve the experience of travelling will be made more accessible with an understanding of these variations.

Eighth, this study is one of the few that has used the UTAUT2 paradigm in the context of qualitative research. It illustrates that the pragmatic abductive aspect may be incorporated into qualitative research and can inspire other experts in the field to try it. What can be inferred from the current study is that a qualitative study gives researchers a chance to perform further investigations using this theoretical framework.

9.4.3 Practical Implication

Besides investigating the main factors influencing citizens' adoption of smart transportation mobile applications, this study offers smart transportation service providers a practical and communicable model of integrated factors that covers not only their perspective but also citizens' perceptions of adopting smart transportation mobile applications better. The findings offer a practical guideline to the service providers of the smart transportation mobile applications by modelling the main factors that explain Omani citizens' behavioural intention toward accepting the smart transportation mobile applications. As a result, this research contributes to the smart transportation services practitioner by helping them overcome the constraints they may face while designing and disseminating their smart transportation services. The current study identified the main factors affecting customers' behavioural intention, which was critical at the operational level toward the acceptance of smart transportation services in Oman. This further enhances the smart transportation service provider and policymakers in the context of Oman, by assisting them in better diffusion of smart transportation applications among Omani citizens. While Gulf countries in general and Oman, in particular, have formed different smart transportation services, there are still many citizens who did not yet adopt these services, and the findings of the current research will help smart transportation services providers to plan better strategies to enhance faster and more effective adoption of this group of people. Moreover, the findings of the current research act as a foundation for any smart transportation services as the outcome from the citizen's survey combined with the service providers' perception delivers a more profound and practical understanding in addressing the difficulties of smart transportation project implementations in Oman. The current research finding indicates that the main factors affecting Omani citizens' acceptance of smart transportation mobile applications are habit, and social influence constructs. Service providers and citizens validated these two factors of the traditional UTAUT2 model. Moreover, the investigation also found that former practice, the citizen's previous experience of the other smart applications that impact their users, is also approved to influence citizens' acceptance of smart transportation applications in Oman. The practical implication of the current research focuses on improving the acceptance of smart transportation applications in Oman. The model helps smart transportation mobile application developers better understand the most important characteristics related to the context of Oman.

First and foremost, the finding indicates that social influence is one of the most important determinants of smart transportation mobile applications adoption in Oman. This means that it is essential that the service providers focus on how the community feels about their applications, as people in Oman are driven by their social network to adopt smart transportation applications. This means that users in developing countries will follow the opinions of the people surrounding them when deciding to adopt an innovation than the marketing and awareness programs implemented by the service providers. Therefore, service providers' first concern should be the quality of the experience of existing customers, as their feedback plays a critical role in determining whether future customers adopt these applications or search for alternatives. This calls for smart transportation mobile application developers to ensure appraising current users with the benefits these applications can bring them so they can be loyal and recommend them to their relatives and friends. Smart transportation application services providers need to understand that peers and family members can help their peers understand and adopt these new applications by directly demonstrating their importance. They need to realise that citizens value their peer's assistance and advice more effectively than other alternatives, such as official training and online guidelines. Accordingly, smart transportation mobile application services providers must ensure effective social influence by fostering interactions within social networks and maintaining a congenial environment. Given the dominant impact of social influence, service providers must prioritise creating better citizens' experiences to enhance the adoption of potential consumers.

In addition, the findings demonstrated that habit is another primary driver behind Omani's behavioural intention to use smart transportation mobile applications. This means that Omani citizens value habit in their decisions to adopt these applications and are concerned about it. Therefore, the citizen's habit of being exclusively involved in using smart transportation mobile applications for an extended period is a driving force in building habitual and automatic behavioural intention about using smart transportation mobile applications. This implies that it is essential for service providers to integrate these applications into citizens' everyday life and activities. By doing so, these applications become a lifestyle for the citizens, who intend to use them for their daily business and activities. It is essential for the services providers to understand that advertisements and conducting campaigns of the advantages and benefits of their applications through different channels are not practical in the Omani context as, at the end of the day, citizens' choices and decisions are mainly attached to their personal preferences and accordingly, it does not matter how many advertisements they come across. Instead, they should focus on creating habit-forming consumer experiences by personalising their applications, analysing the customers, and taking actions based on their insights to encourage their engagement and trust, further motivating them to return for more services.

Moreover, the strongest correlation between former practice and intentions to use smart transportation mobile applications indicated the importance of former practice as a critical factor influencing the acceptance in the Omani context. Here, citizens were most likely to accept the new smart transportation mobile applications based on their prior practice with similar applications. The more they practice using similar applications, The better understanding they shape regarding their features, benefits, and capabilities and accordingly, the higher the possibility of the acceptance they shape toward new similar applications. The finding indicates that former practice does help Omani citizens in making decisions as it has been approved that such former practice help "*when we have to make complex decisions based on uncertain or confusing information*" (Valve, 2009). Smart transportation service providers need to understand that once releasing their applications, they are considered new for citizens and that their expectations and understanding of these new applications are strongly related to their former practice. Therefore, their understanding and assessment of adoption are strongly associated with their historical practice as citizens usually assess their old approach to using similar new products and services. Service providers should not deny the significance of citizens' former practices. They must employ tools to collect, quantify and analyse to reveal citizens' experiences and expectations to demonstrate advantages over the existing ones besides acting with their former practice expectations. They should avoid a large gap between the actual new applications and the citizen's forecasting from their former practice of similar applications.

9.5 Research Limitations

Various constraints and limitations have been encountered in the current research:

- The survey used for the current questionnaire involved around 39 questions for 11 variables which might cause participants to lose patience while filling it out. This is expected further to affect the correlation among the survey's items. However, as reported earlier, the questionnaire did not report any correlation issues.
- It was strongly suggested by Saunders, Lewis and Thornhil (2009) to incorporate both positive and negative statements in a questionnaire to guarantee that respondents read and consider each item properly. However, the current research involved only positive statements.
- The online questionnaire distribution via sending the google form link via social media affected the characteristics of the possible sample involved as the users of these methods are probably younger and more educated citizens. The demographic analysis of the questionnaire indicated that most of the users were from the young generation with a high level of experience. This implies that there were very few citizens above 45 years old. This limited the study to the perceptions of the younger aged group participants, which caused limits in comparing the opinions of younger and more senior citizens and between experienced and less experienced participants. However, as it has been indicated earlier in the research in Oman, around 4.14 million users are active social media users, which reduces the bias level.
- For the qualitative interviews, the researcher faced difficulties reaching the higher-level management as most of them apologized due to their busy schedules. These levels of

management are expected to enrich the research with valuable information which add to the acceptance concept of smart transportation in the Omani context. However, these officers are less directly related to the main topic of the investigations. Moreover, two organizations were reluctant to supply the research with officers to be interviewed as they were worried about being asked for confidential information such as their strategies and budgets. However, the researcher provided them with all the documents of the approval received from Brunel University to convince them. They have also been informed that they are allowed to skip any question they feel its answer is confidential.

- This research focused mainly on the behavioral intention to adopt smart transportation mobile applications instead of their actual use of them. Several authors argued that the behavioral intention is intended to directly predict the actual usage of the new technologies (Ajzen, 1985; Al-Shafi and Weerakkody, 2010). However, it might be useful to examine actual user behaviour in the future.
- Due to the Covid-19 restrictions, this research adopted a purposeful sampling for the quantitative study. Although this sampling approach is accepted widely in the literature review, within Information System studies, a random sample is preferred to generalize the results (Aroean and Michaelidou, 2014).
- The research sample size was limited to Omani citizens only. Also, it mainly focused on new users only. Therefore, It is critical to recognize that this investigation's findings and all recommendations are applied to Omani people only. This study will help the government and organizations understand the main influencers of the acceptance of smart transportation mobile applications and how to facilitate their acceptance among Omanis.
- This study covered only the capital Muscat, due to the time limits, covid-19 restrictions, and difficulty reaching all other cities in Oman.

9.6 Future Research Possibilities

The previous section has explained the limitations associated with the current research. Therefore, the current research has thrown up the following suggestions for future research:

- Adding more items for each construct while also paying attention to the length of the questionnaire instrument to catch the respondent's attention. Also, the researcher can change the order of the questions besides involving both positive and negative items to improve the reliability of answers received from the participants. Additionally, further studies can focus mainly on the main influencers rather than incorporating all possible constructs explored in the research. More influencers mean more questions, leading to losing patient focus while answering. Moreover, it will be valuable if future studies can explore the model with another sample to validate further the links designed in the proposed model.

- Since the current research focused only on the capital Muscat, the results and conclusions are mainly designed for this city only. The finding can be generalised to other cities with similar attributes, such as economic development and infrastructure availabilities. Therefore, future studies are required to be careful with the contextual factors assigned to other cities and other smart services since this proposed framework applies mainly to Muscat and in the context of smart transportation services. Future research can test the proposed framework's applicability to other cities within Oman to produce more general findings. Validating the suggested model in a neighbouring Gulf country that shares the same cultural, political, and economical situations would deliver significant feedback for smart transportation mobile applications in developing countries and, more specifically, the Gulf region.
- As UTAUT2/ UTAUT models have been rarely used in the context of smart cities and smart transportation domains particularly, it is valuable to test the applicability of the proposed framework to the other smart city domains to determine the possibility of generalisation of the findings in other smart city domains. Therefore, future studies can emphasise more on the acceptance in other smart cities domains and other domains.
- The current research involved the demographic variables in the proposed model. Future research can expand the model by incorporating more moderators to analyse their moderating effect on behavioural intention to adopt smart transportation services. Moreover, additional investigations are needed to explore the protentional users understanding by incorporating other elements, such as the living locations of the citizens, to understand the perceptions of citizens living in rural areas without proper internet access.
- As the results of the current investigations indicate that there are differences between the perceptions of the services providers and the users of the smart transportation mobile applications of the factors influencing the adoption and acceptance of these applications, additional investigations, and comparisons between these two parties are essential as they will contribute to better adoption and facilitate the acceptance.

9.7 Summary and Conclusion

To determine the elements that affect the adoption of mobile applications for smart transportation in the Omani setting, this study built and used an enhanced UTAUT2 model. Adopting the traditional UTAUT2 model in the smart transportation services concept in Oman is lacking in the literature. By adding four new extra factors explored from the qualitative analysis and the literature, this study constructed an augmented model to solve the shortcomings of the original UTAUT2 model in addressing the Omani context. Thus, this study fills the gaps explored in the literature review chapter and represents an effort to expand the traditional UTAUT2 model. The findings demonstrated that the constructs SI, HB, and FP were significant and excellent predictors of Omani residents' adoption of mobile applications for smart transportation. To further promote the adoption and acceptance of these applications, the suggested model is anticipated to act as a guide for smart transportation service providers. The new expanded model can be used as a base by the smart transportation services providers to test their end user's behavioural intention to adopt their smart mobile applications. Although these empirical findings are concluded from Oman, they could still be used in other developing countries that have similar cultural and environmental characteristics to Oman, such as other Gulf countries. Also, the research offers a new methodology by combining smart transportation service providers' and citizens' perceptions in building the research model. Additionally, the improved questionnaire created for this study provides researchers with a unique customised survey of acceptance in non-developed countries.

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The Appendices

Appendix A: Smart city's definitions

- **Table 1.1: Smart City Definitions**

Keywords	Category	Author	Definition
High-tech, connect people, information, technologies, sustainable, innovative commerce, life quality, administration	Institution (Barcelona definition)	(Bakici, Almirall and Wareham, 2013, p. 139)	"*a high-tech intensive and advanced city that connects people, information and city elements using new technologies in order to create a sustainable, greener city, competitive and innovative commerce, and an increased life quality with a straightforward administration and a good maintenance system*".
Urban technologies, Knowledge economy	Institution (Doha definition)	(Trindade *et al.*, 2017, p. 3)	"*An interaction of urban technologies and knowledge economy activities*".
Process, citizens engagement, hard infrastructures, social capital, digital technologies, liveable,	Institution (The UK Department for Business, Innovation and Skills (BIS)	(Centre for Cities, 2014)	"*Considers smart cities a process rather than a static outcome, in which increased citizen engagement, hard infrastructure, social capital and digital technologies make cities more liveable, resilient and better able to respond to challenges*"
Partnership, technology, mobility, working, living	Institution (Amsterdam City Hall)	(Angelidou, 2014b, p. S7)	"*A partnership among businesses, authorities, research institutions, and the people of Amsterdam…... The initiative's main themes of focus are living, working, mobility, public facilities and open data*"
Interconnected information, control operation, optimizes limited resources	Commercial (IBM)	(Webwire, 2009)	"*One that makes optimal use of all the interconnected information available today to better understand and control its operations and optimize the use of limited resources*"
Human dynamics, connected devices, IoT	Institution (susCity project)	(Costa and Santos, 2016, p. 1)	"*Smart Cities are known for their human dynamics, which makes recurrent use of permanently connected devices, frequently known as Internet of Things (IoT)"*
ICT, efficiencies, quality of life	Private company (Cisco)	(Falconer and Mitchell, 2012, p. 2)	"*a scalable solution that take advantage of information and communications technology (ICT) to increase efficiencies, reduce costs, and enhance quality of life*"
Smart citizens, information, informed decision,	MDDA: Manchester Digital Development Agency	(Centre for Cities, 2014)	"*A 'smart city' means 'smart citizens' – where citizens have all the information, they need to make informed choices about their lifestyle, work and travel options*"
Integration, technology, governance, monitor aspects, Sustainability, citizens communications,	Academic	(Hall *et al.*, 2000, p. 1)	"*An urban centre of the future, made safe, secure environmentally green, and efficient because all structures–whether for power, water, transportation, etc. are designed, constructed, and maintained making use of advanced, integrated materials, sensors, electronics, and networks which are interfaced with computerized systems comprised of databases, tracking, and decision-making algorithms"*
Ubiquitous computing, economy, governance, innovation, creativity, entrepreneurship	Academic	(Kitchin, 2014, p. 1)	"*Describe cities that, on the one hand, are increasingly composed of and monitored by pervasive and ubiquitous computing and, on the other, whose economy and governance is being driven by innovation, creativity and entrepreneurship, enacted by smart people*".
Human, social capital, transport, ICT, accessibility communication infrastructure, sustainability, high quality of life, wise management, natural resources, policy governance, liveability	Academic	(Caragliu, del Bo and Nijkamp, 2011, p. 50)	"*A city to be smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance*"
Holistically, system of systems	Academic	(Bélissent and Giron, 2013, p. 2)	"*Being a smart city means looking at the issues holistically — the city as a system of systems*"

ICT, liveability, socio-economic Sustainability	Academic	(Angelidou, 2014b, p. 1)	"*Smart cities are all urban settlements that make a conscious effort to capitalize on the new Information and Communications Technology (ICT) landscape in a strategic way, seeking to achieve prosperity, effectiveness and competitiveness on multiple socio-economic levels*"
Productivity, accessibility, well performing city, governance, endowment, community, self-decisive, independents and aware citizens, governance	Academic	(Giffinger *et al.*, 2007a)	*"A city well performing in a forward-looking way in economy, people, governance, mobility, environment, and living, built on the smart combination of endowments and activities of self-decisive, independent and aware citizens. Smart city generally refers to the search and identification of intelligent solutions which allow modern cities to enhance the quality of the services provided to citizens".*
Sustained, ICT, social networking, real time data, new value-added content, convergencies, innovation of society, culture, policy, economy	Academic	(Myeong, Jung and Lee, 2018a, p. 3)	"*A city that is sustained based on highly intelligent ICTs and social networking; communication between people and things and things and things, which goes beyond time and space; convergence between ICT and real time; and convergence with other industries by which new value-added contents and services are constantly recreated accompanied by innovation of society as a whole, including work styles, lifestyles, culture, politics, and the economy*".
Integrated technology, flexible, open access	Academic	(Albino, Berardi and Dangelico, 2015b, p. 11)	*"Smart cities must integrate technologies, systems, services, and capabilities into an organic network that is sufficiently multi-sectorial and flexible for future developments, and moreover, open-access".*
Social, sustainability, environmental, productivity, governance, community		(Yigitcanlar, 2016)	*"An ideal form to build the sustainable cities of the 21st century, in the case that a balanced and sustainable view on economic, societal, environmental and institutional development is realised".*
operational data, interconnected, integrate, ICT, sense	Academic	(Harrison *et al.*, 2010, p. 1)	*"Urban areas that exploit operational data, such as that arising from traffic congestion, power consumption statistics, and public safety events, to optimize the operation of city services"*
Collaboration among: Local government, citizens, and stakeholders, better place to live	Academic	(Gil-Garcia, Pardo and Nam, 2015, p. 62)	"*As a continuum in which local government officials, citizens and other stakeholders think about and implement initiatives that strive to make a city a better place to live in, "smarter*"".
Technology, socio-political, people, wellbeing collaboration, environment, institution, economic-technical, productivity	Academic	(Nam and Pardo, 2011, p. 284)	*"A smart city infuses information into its physical infrastructure to improve conveniences, facilitate mobility, add efficiencies, conserve energy, improve the quality of air and water, identify problems and fix them quickly, recover rapidly from disasters, collect data to make better decisions, deploy resources effectively, and share data to enable collaboration across entities and domains".*
Technology advanced, intellectual ability, social, technical, economic	Academic	(Rana *et al.*, 2019b, p. 503)	"*As a technologically advanced and modernised territory with a certain intellectual ability that deals with various social, technical, economic aspects of growth based on smart computing techniques to develop superior infrastructure constituents and services*"
human capital social capital entrepreneurial capital	Academic	(Kourtit and Nijkamp, 2012, p. 93)	"Smart cities are the result of knowledge-intensive and creative strategies aiming at enhancing the socio-economic, ecological, logistic and competitive performance of cities. Such smart cities are based on a promising mix of human capital (e.g. skilled labor force), infrastructural capital (e.g. high-tech communication facilities), social capital (e.g. intense and open network linkages) and entrepreneurial capital (e.g. creative and risk-taking business activities)".
Sustainable economic and urban development, high quality of life, human and social capital, natural resources management, environmental goals, creativity,	Academic	(Thuzar, 2011)	"*Smart cities of the future will need sustainable urban development policies where all residents, including the poor, can live well and the attraction of the towns and cities is preserved. [.. .] Smart cities are cities that have a high quality of life; those that pursue sustainable economic development through investments in human and social capital, and traditional and modern communications infrastructure (transport and information communication*

			technology); and manage natural resources through participatory policies. Smart cities should also be sustainable, converging economic, social, and environmental goal"
Smart technologies, interconnected, *administration, safety, transportation, education*	Academic	(Washburn and Sindhu, 2009, p. 2)	"*The use of smart computing technologies to make the critical infrastructure components and services of a city—which include city administration, education, healthcare, public safety, real estate, transportation, and utilities—more intelligent, interconnected, and efficient*"
Digital telecommunication, network, management and organizations, environment, built infrastructure (ubiquitously embedded intelligence, sensors and tags, software)	Academic	(Chourabi *et al.*, 2012, p. 2290)	*"Smart cities — are like organisms that develop an artificial nervous system, which enables them to behave in intelligently coordinated ways. The new intelligence of cities, then, resides in the increasingly effective combination of digital telecommunication networks (the nerves), ubiquitously embedded intelligence (the brains), sensors and tags (the sensory organs), and software (the knowledge and cognitive competence"*
Knowledge, intellectual ability, *innovating* sociotechnical, socio-economic, *interconnected*	Academic	(Zygiaris, 2013, p. 2)	*"Smart city is understood as a certain intellectual ability that addresses several innovative socio-technical and socio-economic aspects of growth. These aspects lead to smart city conceptions as "green" referring to urban infrastructure for environment protection and reduction of CO2 emission, "interconnected" related to revolution of broadband economy, "intelligent" declaring the capacity to produce added value information from the processing of city's real-time data from sensors and activators, whereas the terms "innovating", "knowledge" cities interchangeably refer to the city's ability to raise innovation based on knowledgeable and creative human capital".*
Geographical area, technology, ICT, energy production, citizens, well-being, participation, environmental quality rules and policy, intelligent development, governed	Academic	(Dameri, 2013, p. 2549)	"Is a well-defined geographical area, in which high technologies such as ICT, logistic, energy production, and so on, cooperate to create benefits for citizens in terms of well-being, inclusion and participation, environmental quality, intelligent development; it is governed by a well-defined pool of subjects, able to state the rules and policy for the city government and development".
Technology, ICT, better living, sustainable economic, city attractiveness, quality of life,	Academic	(Dameri and Benevolo, 2016, p. 1)	"*A recent but emerging phenomenon, aiming at using high technology and especially information and communications technology (ICT) to implement better living conditions in large metropolises, to involve citizens in city government, and to support sustainable economic development and city attractiveness. The final goal is to improve the quality of city life for all stakeholders*".

Appendix B: The Quantitative Study

- **Questionnaire Invitation Letter**

Brunel University London

Subject: Invitation letter
Study title: Identifying the factors influencing the acceptance of smart transportation mobile applications in developing countries (Oman)
purpose: To address the main contextual factors that are influencing Omanis citizens' adoption and acceptance of smart transportation mobile applications from citizens' perspectives.

Dear participant

You are invited to participate in a survey that will be conducted as part of a PhD research to investigate the main contextual factors that are influencing Oman's citizens' adoption and acceptance of smart transportation services and applications. The survey is also targeting to explore the contextual factors influencing users' acceptance of smart transportation applications and services in Oman.

This questionnaire is designed to be answered by Omani citizens and you are allowed to forward it to other Omani citizens. As a citizen of Oman, you are in an ideal position to give as valuable information from your own perspective. I would like to invite you to answer the following questionnaire based on your understanding on the factors expected to influence you in using any smart transportation applications provided in Oman. There is a range of smart transportation mobile applications provided in Oman such as O-taxi, Royal Oman Police application, Baladiyet application and Mwasalat application. The survey will take around 10-15 minutes. Your responses to the different questions will be considered confidential.

There is no compensation for participating in this study. However, your participation will be a valuable addition to the research and the finding could lead to a greater public understanding of smart transportation applications implementation in Oman.

For any further queries or doubts please do not hesitate to contact me:

Hana Abdullah AlBulushi
Doctoral researcher
College of Engineering, Design and Physical Sciences
Department of Computer Science, Brunel University, London
Email hana.albulushi@brunel.ac.uk

Thank you for your participation

- **Participants Information Sheet**

PARTICIPANT INFORMATION SHEET

Study title

Identifying the factors influencing the acceptance of smart transportation mobile applications in developing countries (Oman)

Invitation Paragraph

You are invited to participate in a survey that will be conducted as part of a PhD research to investigate the main contextual factors influencing Omani citizens' adoption and acceptance of smart transportation mobile applications. This questionnaire is designed to be answered by Omani citizens, and you are allowed to forward it to other citizens. As an Omani above 18 years old and has not yet used any of the smart transportation mobile applications in Oman, you are in an ideal position to give as valuable information from your own perspective. There is a range of smart transportation applications provided in Oman such as O-taxi, Royal Oman Police application, Baladiyet application and Mwasalat application. The survey will take around 10-15 minutes. Your responses to the different questions will be considered confidential.

What is the purpose of the study?

To address the main contextual factors influencing Omani citizens' adoption and acceptance of smart transportation applications from citizens' perspectives.

Why have I been invited to participate?

As an Omani citizen who is yet to use smart transportation mobile applications and who is above 18 years, you are invited to share your experience on the factors influencing users' adoption of such smart transportation mobile applications. This will further enhance the successful implementation of similar projects in Oman in the future.

Do I have to take part?

Your contribution to this study is completely voluntary, and you are allowed to withdraw at any point without providing reasons. Withdrawing for any reason will not influence you in any way. However, participating in the research will help implement successful smart transportation services and applications and promote better acceptance of the smart cities' applications in Oman.

What will happen to me if I take part?

You will be requested to simply answer a few questions related to your perceptions on the factors expected to impact the acceptance and usage of smart transportation mobile applications.

Are there any lifestyle restrictions

You should not have used any smart transportation mobile applications yet and be above 18 years old.

What are the possible disadvantages and risks of taking part?

No harms or risks have been identified

What are the possible benefits of taking part?

Helping to build a better understanding of the factors influencing citizens' acceptance of smart transportation services and applications in the Omani context, and consequently improving the quality of your life by contributing to building better smart transportation services and smart mobile applications. Your contribution will enrich the research outcome and accordingly lead to a better public understanding of implementing smart transportation projects successfully.

What if something goes wrong?

You are allowed to withdraw at any time.

Will my taking part in this study be kept confidential?

Yes, the identity of the participants will be anonymous, and the collected data will be destroyed eventually after the analysis. Also, there will not be an individual referring to you as a participant, as the data will be presented as an aggregate without any remarks or individual identification.

Will I be recorded, and how will the recording be used?

No

What will happen to the results of the research study?

They will be submitted as my PhD thesis to Brunel University. The results might also be published later in scientific journals.

Who is organising and funding the research?

This PhD research is funded by the Omani government and organised by Brunel University.

What are the indemnity arrangements?

There will be no compensation for taking part in this study

Who has reviewed the study?

My PhD research supervisor and Brunel University ethic committee

Research Integrity

Brunel University London is committed to compliance with the Universities UK Research Integrity Concordat. You are entitled to expect the highest level of integrity from the researchers during the course of this research

Contact for further information and complaints

Researcher name and details:

Hana Abdullah AlBulushi, PhD researcher,
College of Engineering Design and Physical Sciences
Department of Computer Science

(If relevant) Supervisor name and details:
George Ghinea
Professor of Multimedia Computing
Brunel University London
College of Engineering Design and Physical Sciences
Department of Computer Science

For complaints, Chair of the Research Ethics Committee:
Professor Simon Taylor
simon.taylor@brunel.ac.uk
Chair of the CEDPS Research Ethics Committee.

- **Ethical Approval Of The Questionnaire**

College of Engineering, Design and Physical Sciences Research Ethics Committee
Brunel University London
Kingston Lane
Uxbridge
UB8 3PH
United Kingdom

www.brunel.ac.uk

17 February 2022

LETTER OF APPROVAL

APPROVAL HAS BEEN GRANTED FOR THIS STUDY TO BE CARRIED OUT BETWEEN 15/03/2022 AND 31/05/2022

Applicant (s): Miss Hana AlBulushi

Project Title: Identifying factors influencing the acceptance of smart transportation applications in developing countries (Oman)

Reference: 35756-LR-Feb/2022- 38063-2

Dear Miss Hana AlBulushi

The Research Ethics Committee has considered the above application recently submitted by you.

The Chair, acting under delegated authority has agreed that there is no objection on ethical grounds to the proposed study. Approval is given on the understanding that the conditions of approval set out below are followed:

- **Approval is given for remote (online/telephone) research activity only. Face-to-face activity and/or travel will require approval by way of an amendment.**
- **The agreed protocol must be followed. Any changes to the protocol will require prior approval from the Committee by way of an application for an amendment.**
- **Please ensure that you monitor and adhere to all up-to-date local and national Government health advice for the duration of your project.**

Please note that:

- Research Participant Information Sheets and (where relevant) flyers, posters, and consent forms should include a clear statement that research ethics approval has been obtained from the relevant Research Ethics Committee.
- The Research Participant Information Sheets should include a clear statement that queries should be directed, in the first instance, to the Supervisor (where relevant), or the researcher. Complaints, on the other hand, should be directed, in the first instance, to the Chair of the relevant Research Ethics Committee.
- Approval to proceed with the study is granted subject to receipt by the Committee of satisfactory responses to any conditions that may appear above, in addition to any subsequent changes to the protocol.
- The Research Ethics Committee reserves the right to sample and review documentation, including raw data, relevant to the study.
- If your project has been approved to run for a duration longer than 12 months, you will be required to submit an annual progress report to the Research Ethics Committee. You will be contacted about submission of this report before it becomes due.
- You may not undertake any research activity if you are not a registered student of Brunel University or if you cease to become registered, including abeyance or temporary withdrawal. As a deregistered student you would not be insured to undertake research activity. Research activity includes the recruitment of participants, undertaking consent procedures and collection of data. Breach of this requirement constitutes research misconduct and is a disciplinary offence.

Simon Taylor

Professor Simon Taylor

Chair of the College of Engineering, Design and Physical Sciences Research Ethics Committee

Brunel University London

- **Online Consent Form**

Online Consent Form

Brunel University London

Please confirm the following:

	Yes	No
• I have read the Participant Information Sheet included with this questionnaire		
• I am over the age of 18		
• I understand that no personal identifying data is collected in this study, therefore I know that once I have submitted my answers I am unable to withdraw my data from the study		
• I agree that my data can be anonymised, stored and used in future research in line with Brunel University's data retention policies		
• I agree to take part in this study		

- **The Questionnaire**

Part A

1. **What is your age range?**

a) Between 18-25 years old

b) Between 26-30 years old

c) Between 31-35 years old

d) Between 36-40 years old

e) Between 41-45 years old

f) Between 46-50 years old

g) Above 50 years

h) prefer not to say

2. **What is your gender?**

a) Female

b) Male

C) Prefer not to say

3. **What is your nationality?**

a) Omani
b) other

4. **What is your previous experience of using technology (including, phones, mobile application, computers, laptops, …):**

a) Less than one year

b) rom 1-2 years

c) From 2-5 years

d) From 5-10 years

e) More than 10 years

5. **Have you used any of the smart transportation mobile applications before (O-taxi, Royal Oman Police application, Mwasalat smart application and Baladiyati smart application, etc.):**

a) Yes

b) No

Part B

You are requested to identify the extent you agree with the following statements regarding the adoption of smart transportation mobile applications by putting a tick in one of the boxes for each statement. Please select one option for each statement to indicate whether you are 1 (strongly disagree) to 5 (strongly agree).

1.PE (Performance Expectancy):

1: PE (Performance Expectancy)		Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
PE1	I would expect smart transportation mobile applications to be useful in my daily travelling life					
PE2	I would expect the use of smart transportation mobile applications to improve the quality of my commuting					
PE3	I would expect using smart transportation mobile applications will make my working day more productive					
PE4	I would expect using smart transportation mobile applications will help me in accessing transportations more quickly					

2: Effort Expectancy (EE):

2: EE (Effort Expectancy)		Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
EE1	I expect that learning how to use smart transportation mobile applications will be easy for me.					

EE2	I expect the interaction with smart transportation mobile applications will be simple, clear, and understandable.					
EE3	I expect smart transportation mobile applications will be easy to use					
EE4	I expect that it will be easy for me to become skilful at using smart transportation mobile applications.					

3: Social Influence (SI):

3: SI (Social Influence)		Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
SI1	My family members and relatives could affect my perception of smart transportation mobile applications usage.					
SI2	People whose opinion I value could affect my decision to use smart transportation mobile applications.					
SI3	People who influence my behaviour could affect my decision to use smart transportation mobile applications.					
SI4	Smart transportation applications providers might encourage me to execute tasks through it.					

4: Facilitating Condition (FC):

4: FC (Facilitating Condition)		Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
FC1	I have/expect to have the knowledge necessary to use smart transportation mobile applications.					
FC2	I have/expect to have the resources necessary to use smart transportation mobile applications.					
FC3	I expect a specific person (or group) to be available to assist me with smart transportation mobile applications.					
FC4	I expect smart transportation mobile applications are compatible with other technologies I use.					

5: Price Value (PV):

4: Price Value (Price value)		Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
PV1	I expect smart transportation mobile applications will be able to save my money.					
PV2	I expect using smart transportation mobile applications will involves other benefits such as vouchers, points, and discounts.					
PV3	I expect smart transportation mobile applications will help me in exploring deals with best prices.					

6: Habit (HB):

6: Habit (HB)		Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
HB1	I expect the use of smart transportation mobile applications will become a habit for me.					
HB2	I expect using smart transportation mobile applications will become natural to me.					

HB3	I expect to be addicted to smart transportation mobile applications usage.					

7: Trust (TR):

7: Trust (TR)		Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
TR1	I expect to rely on smart transportation mobile applications' services providers reputations.					
TR2	I expect that smart transportation mobile applications to have enough safeguards to make me feel comfortable using.					
TR3	In general, I expect that smart transportation mobile applications to be a robust and safe environment in which to transact.					
TR4	I expect to be confident that the data I submit through smart transportation mobile applications will not be misused and will be treated confidentially.					

8: Satisfaction Factor (SAF):

8: Satisfaction Factor (SAF):		Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
SAF1	I expect to be satisfied with smart transportation mobile applications efficiency.					
SAF2	I expect to be satisfied with smart transportation mobile applications services.					
SAF3	I expect smart transportation applications services will meet my expectations.					
SAF4	I expect my experience with using smart transportation mobile applications will be positive.					

9: Awareness (AW):

10: Awareness (AW)		Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
AWA1	I am aware of smart transportation mobile applications in Oman.					
AWA2	I am aware of smart transportation mobile applications using benefits.					
AWA3	I have come across camping/advertisements of smart transportation mobile applications in Oman.					

10: Former Practice (FP):

Former Practice (FP)		Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
FP1	I have used mobile applications similar to smart transportation mobile applications before in other countries.					
FP 2	Previous familiarity with similar mobile applications will drive me to use smart transportation mobile applications.					
FP3	I would be willing to try out a trail version of smart transportation mobile applications services.					

11: Behavioural Intention (BI):

11: Behavioural Intention (BI)		Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
BI1	I intend to use smart transportation mobile applications in the future.					
BI2	I plan to use smart transportation mobile applications to improve my commuting.					
BI3	I predict I would use smart transportation mobile applications in future.					

Appendix C: The Qualitative Study

- **Interviews Invitation Letter**

Brunel University London

Subject: Invitation letter
Study title: Determinants of smart transportation mobile applications adoption in Developing Countries (Oman)
purpose: To address the main contextual factors influencing Omanis citizens' adoption and acceptance of smart transportation mobile applications from services providers' perspectives.

Dear participant

You are invited to participate in interviews conducted as part of a PhD research to investigate the main contextual factors influencing Omanis citizens' adoption and acceptance of smart transportation mobile applications. The interviews also target identifying factors and challenges of implementing smart cities in Oman. As members involved in the process and designing and operating the projects of smart transportation mobile applications in Oman, you are particularly invited in this research project.

The interview will take around 40-60 minutes and is very informal. Your responses to the different questions will be considered confidential as each participant will be assigned a number code to help ensure that your personal identification is not revealed.

There is no compensation for participating in this study. However, your participation will be a valuable addition to the research, and the finding could lead to a greater public understanding of smart cities in general and smart transportation mobile applications implementation in Oman.

The interviews will be conducted online by employing different software such as Teams, and the recording will be transcribed into text, and then subsequently, the audio recording will be deleted.

For any further queries or doubts, please do not hesitate to contact me:

Hana Abdullah AlBulushi
Doctoral researcher
College of Engineering, Design and Physical Sciences
Department of Computer Science, Brunel University, London
Email hana.albulushi@brunel.ac.uk

- **Participants Information Sheet**

PARTICIPANT INFORMATION SHEET

Study title

Determinants of smart transportation mobile applications adoption in Developing Countries (Oman)

Invitation Paragraph

In the absence of an understanding of the local needs and factors of the Omani context, there is a strong need to develop a contextual Omani framework to effectively implement smart transportation projects in Oman by incorporating factors from literature and acceptance models while also considering the perceptions of smart transportation services providers in Oman. As a member involved in implementing smart transportation projects and services in Oman, you are invited to participate in this study.

What is the purpose of the study?

This research aims to address the main contextual factors influencing Omanis citizens' adoption and acceptance of smart city transportation mobile applications from both service providers and citizens' perspectives.

Why have I been invited to participate?

After identifying the factors influencing citizens' acceptance of smart city applications from the literature review, the researcher decided to conduct qualitative interviews by utilising semi-structured interviews in order to explore Omani service providers' perception of the user's acceptance and adoption of the smart transportation mobile application in Oman. As a member involved in implementing smart transportation projects and services in Oman, you are invited to participate in this study.

Do I have to take part?

Your contribution to this study is completely voluntary and you are allowed to withdraw at any point without providing reasons. Withdrawing for any reason will not influence you in any way. However, taking part in the research will help in implementing successful smart cities and promote better acceptance of the smart cities' applications in Oman.

What will happen to me if I take part?

You will be requested to simply answer a few questions related to your perceptions of the acceptance of smart transportation services you have been involved in recently.

Are there any lifestyle restrictions?

Yes, you are expected to be a member who has participated in implementing smart transportation services and projects in Oman.

What are the possible disadvantages and risks of taking part?

No harms or risks have been identified

What are the possible benefits of taking part?

Helping in building a better understanding of factors influencing citizens' acceptance of smart transportation services in the Omani context and consequently improving the quality of your life by contributing to building better cities and better smart applications. Your contribution will enrich the research outcome and accordingly lead to a better public understanding of implementing smart city projects successfully.

What if something goes wrong?

The research involves only direct questions online, and if there is a problem with it, the researcher will follow other programmes. You are allowed to withdraw at any time.

Will my taking part in this study be kept confidential?

Yes, the identity of the participants will be anonymous, and only the researchers are allowed to privy the interview and the collected records will be destroyed eventually after the analysis. Also, there will not be an individual referring to you as a participant, as the data will be presented as an aggregate without any remarks or individual identification.

Will I be recorded, and how will the recording be used?

Yes, the interviews will be conducted online through software such as Teams, and the recording will be transcribed into text, and then subsequently, the audio recording will be deleted.

What will happen to the results of the research study?

They will be submitted as my PhD thesis to Brunel University. The results might also be published later in scientific journals.

Who is organising and funding the research?

This PhD research is funded by the Omani government and organised by Brunel University.

What are the indemnity arrangements?

There will be no compensation for taking part in this study

Who has reviewed the study?

My PhD research supervisor and Brunel University ethic committee

Research Integrity

Brunel University London is committed to compliance with the Universities UK [Research Integrity Concordat](). You are entitled to expect the highest level of integrity from the researchers during the course of this research

Contact for further information and complaints

Researcher name and details:

Hana Abdullah AlBulushi, PhD researcher,
College of Engineering Design and Physical Sciences
Department of Computer Science

Supervisor name and details:
George Ghinea
Professor of Multimedia Computing
Brunel University London
College of Engineering Design and Physical Sciences
Department of Computer Science

For complaints, Chair of the Research Ethics Committee:
Prof Hua Zhao
hua.zhao@brunel.ac.uk
The Chair of the College Ethics Committee

- **Interviews' Ethical Approval**

College of Engineering, Design and Physical Sciences Research Ethics Committee
Brunel University London
Kingston Lane
Uxbridge
UB8 3PH
United Kingdom

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13 July 2021

LETTER OF APPROVAL (Conditional)

APPROVAL HAS BEEN GRANTED FOR THIS STUDY TO BE CARRIED OUT BETWEEN 24/07/2021 AND 02/09/2021

Applicant (s): Miss Hana AlBulushi

Project Title: Determinants of smart city transportation services and application adoption in Developing Countries (Oman)

Reference: 31305-LR-Jul/2021- 33282-2

Dear Miss Hana AlBulushi

The Research Ethics Committee has considered the above application recently submitted by you.

The Chair, acting under delegated authority has agreed that there is no objection on ethical grounds to the proposed study. Approval is given on the understanding that the conditions of approval set out below are followed:

- **Approval is given for remote (online/telephone) research activity only. Face-to-face activity and/or travel will require approval by way of an amendment.**
- **The agreed protocol must be followed. Any changes to the protocol will require prior approval from the Committee by way of an application for an amendment.**
- PIS: please replace Prof Hua Zhao's name with Prof Simon Taylor as he is now the Chair of CEDPS Ethics Committee
- Consent Form: please amend the study start date to bring it in line with the new study start date which is 24/07/2021

The highlighted points can be addressed outside of the BREO system

- In addition to the above, please ensure that you monitor and adhere to all up-to-date local and national Government health advice for the duration of your project.

Please note that:

- Research Participant Information Sheets and (where relevant) flyers, posters, and consent forms should include a clear statement that research ethics approval has been obtained from the relevant Research Ethics Committee.
- The Research Participant Information Sheets should include a clear statement that queries should be directed, in the first instance, to the Supervisor (where relevant), or the researcher. Complaints, on the other hand, should be directed, in the first instance, to the Chair of the relevant Research Ethics Committee.
- Approval to proceed with the study is granted subject to receipt by the Committee of satisfactory responses to any conditions that may appear above, in addition to any subsequent changes to the protocol.
- The Research Ethics Committee reserves the right to sample and review documentation, including raw data, relevant to the study.
- You may not undertake any research activity if you are not a registered student of Brunel University or if you cease to become registered, including abeyance or temporary withdrawal. As a deregistered student you would not be insured to undertake research activity. Research activity includes the recruitment of participants, undertaking consent procedures and collection of data. Breach of this requirement constitutes research misconduct and is a disciplinary offence.

Simon Taylor

Professor Simon Taylor

- **Interviews Consent Form**

CONSENT FORM

Brunel University London

Determinants of smart transportation mobile applications adoption in Developing Countries (Oman)

Hana Abdullah AlBulushi

APPROVAL HAS BEEN GRANTED FOR THIS STUDY TO BE CARRIED OUT BETWEEN 24/07/2021 AND 02/09/2021

The participant (or their legal representative) should complete the whole of this sheet.		
	YES	NO
Have you read the Participant Information Sheet?	☐	☐
Have you had an opportunity to ask questions and discuss this study? (via email/phone for electronic surveys)	☐	☐
Have you received satisfactory answers to all your questions? (via email/phone for electronic surveys)	☐	☐
Do you understand that you will not be referred to by name in any report concerning this study?	☐	☐
Do you understand that:		
• You are free to withdraw from this study at any time	☐	☐
• You don't have to give any reason for withdrawing	☐	☐
• Choosing not to participate or withdrawing will not affect your rights?	☐	☐
• You can withdraw your data any time up to 24/08/2021	☐	☐
I agree to my interview being audio recorded	☐	☐
The procedures regarding confidentiality have been explained to me	☐	☐
I agree that my anonymised data can be stored and shared with other researchers for use in future projects.	☐	☐
I agree to take part in this study.	☐	☐

Signature of research participant:

Print name:	Date:

- **Interview's Questions**

Interview Questions

Part 1: General Questions

1. Please specify your role in your department.
2. What do you understand from the term smart cities?
    - What constitutes smart cities?
    - What are your criteria for defining smart cities projects?
3. Have you been involved in the designing and implementation of your company smart transportation mobile application?
4. Can you please specify the new services offered by this smart application?

Part 2: User acceptance

1. What improvements do you think your smart mobile application is providing to consumers' mobility and travel?
    - Tell me about an instance when you think citizens will try to use your smart transportation mobile application to help them do something or an activity related to their transportation.
    - How do you feel about the usefulness of your smart transportation mobile application in your users' mobility? Is your application useful for transportation and commuting?
    - Does transport by using your smart mobile application helps citizens manage and save citizens time and money? Why or why not, and how?

2. How easy or difficult do your users find learning to use your smart mobile applications for transportation and information-seeking or travelling?
    - What kind of challenges did the end users encounter? Are there specific skills required to use these services?
    - Do you think that the efforts made by your organisation to support users of your smart mobile application were enough? What do you think are the other possible assistance?
    - Do you think that users' interaction with smart transportation services and applications is clear and understandable? Explain how.

3. Have you studied the readiness of the technical infrastructure to suit your smart services and smart transportation mobile application?
    - Have you studied the readiness of the Omani legal system to provide such smart services?
    - Have you provided training courses for your employees to develop them in the field of smart transportation services?
    - Do you think that Oman is ready in terms of the availability of technologies, resources and knowledge necessary to implement smart transportation services and applications? Explain
    - What do you think about the cost of mobile devices and internet connections? Do you think that this cost impact your use of technology in your smart mobile application and in what way?
    - Have you identified the users in terms of their readiness to use these applications? How?

- Have you implemented the smart mobile application by following a pilot application?

4. Did you support the end user by providing them with assistance?
    - What methods did you use to provide this type of support?
    - Did you encounter problems when providing this type of support?
    - Did they have a positive effect in supporting effective implementation and in improving acceptance?

5. Do you think that you have involved all the concerned parties in implementing the smart mobile application?
    - Do you think it is important for members of the public to join? and how did you manage to get their support?
    - How was the end user involved in planning and implementing the smart transportation mobile application?
    - Have you considered the influence of friends or people who are close to your users in the use of your smart transportation mobile application?

6. Do you think that your target customers will intend to use your smart transportation mobile application in commuting, and why?
    - Do you feel that using your smart mobile application will become an integral part of the citizens commuting?

7. What activities did you do to assess user satisfaction?
    - What have you done to ensure your users satisfaction with the usage of your smart transportation mobile application?
    - What are important to be done to improve your users' satisfaction?

8. What activities have you undertaken to promote user acceptance?
    - Did you distribute citizens into groups when designing these activities?
    - What preparations did you make before implementing these activities?
    - Were these preparations effective to support these activities?
    - What preparations do you think you will make in the future to enhance conducting these activities and the acceptance?

9. What are the criteria you have decided to rely on while deciding the technology to be used in building your smart mobile application?
    - Did you put the end user in your mind while deciding on the technologies such as (interface, graphic…etc)
    - What have you done to gain your customer trust to use you application?
    - What are the challenges you faced while deciding on how to design and build your mobile application?

10. Have you encountered any kind of resistance from the end user to adopt your new smart application?
    - From your point of view, what are the reasons behind this resistance and what was it impact on the implementation of your application?
    - Have you tried to educate citizens about the benefits of these smart services to resolve the resistance?
    - Do you think the factors of quality, accuracy and ease of use played a role in this resistance? How?
    - How do you address the resistance of users?

11. What types of incentives have you provided to users to encourage them to use these smart services?

- Are there any additional values a user can gain by adopting your smart transportation mobile application?

Appendix D: A Sample of Developing Codes With Interviews Extracts (Coding scheme)

Code ID	Themes-Subthemes	Reference (example)
PE	**Performance Expectancy**	
	The benefit of greater convenience	MS1: Our smart taxi application helps riders by providing them with instant access to information about their routes and trips. Moreover, the app sends passengers notifications about service changes so they can plan their journey accordingly.
	The benefit of saving time	TD1: As a driver, automation of most of the taxis requests helps in receiving requests and accepting payments online while also enhancing familiarity with the shortest and less crowded route through smart mobile applications. This automation, therefore, helps save time to serve more customers…
	The benefit of being more productive	DAO1: By enriching riders with real-time data about the traffic, seat availability, timing, the current location of the buses and the needed time to reach a particular stop, they do not need to wait at length in hot weather for their taxis or buses, but instead they can walk outside when their transportation method is only one minute away
	The benefit of better organisation of transportation services	OCCC1: Overcrowded roads in Oman are very common these days, and many people started to lose their patience and become bored, angry, and anxious in the traffic congestion points. However, some smart transportation mobile applications help passengers feel more relaxed, boost their mental health and enjoy having a longer time to complete their other tasks while on board
EE	**Effort Expectancy**	
	User friendly	SE1: The first impression is the last impression; therefore, in our organisation, we had worked hard in developing our smart application interface by enhancing our application with arrows, buttons and graphics that can improve our overall application design, interface and impression.
	Personal skills and knowledge	SAS1: I believe that our smart transportation mobile application features are basic and straightforward. However, learning new features and services takes time, depending on the end users' background and education level. […….] generally talking, users with good IT and technical backgrounds are expected to know such tools and features previously and accordingly will need less time and effort to adopt, while people with less education and technical skills may require more time to learn and explore the new features.
	Meeting users' needs and preferences	OS1: Our smart transportation mobile application offers its users options for choosing what meets their needs. For example, it allows them to choose the payment method from cash, debt, and credit cards.
SI	**Social Influence**	
	Influence from peers	PSS1: Personally, if I find a friend using a new technology or an application, this will affect my decision and encourage me to adopt it, especially if this friend advised me to do so. I will consider adopting it as I always trust my friends' feedback and recommendations
	Influence from family members	DOLTL1: People always try to rely on trusted sources to guarantee quality information. Since family members are closest people to a person and are among the most important people in any individual life, people always count on the feedback and experience they receive from them

Code ID	Themes-Subthemes	Reference (example)
	Service providers encouragement	HOTD1: Due to Covid-19, many departments and sections have been closed temporarily, and citizens were encouraged to adopt our organisation's smart mobile application along with our website to get the services. For example, vehicle registration, vehicle renewal, driving licence renewable, exchange of the eligible foreign licence, traffic offence payment and many other services are available through our organisation's smart application. Consequently, the organisation has made the usage of the smart mobile application mandatory and enforced by the top-level management to reduce the spread of the virus. However, we believe this will become a culture even after the pandemic is over. After realising their benefits, everyone will prefer to use the smart application instead of consuming time to visit the organisation.
FC	**Facilitating Conditions**	
	Call centre	BDM1: Currently, we mainly depend on the call centre tool as a main method to serve our customers. In our company, we believe that the call centre works as an ambassador to reflect and maintain a bright image of our company in the eyes of our smart application users. [……..] Our company's call numbers are available even on our taxis, and we are available 24/7, to receive calls and listen to our customer's concerns and solve them. Because we do not neglect any call we receive and due to our good reputation for quick response to our customer's calls, this makes them trust this method as the best way to communicate with us.
	Customer Dashboard	PSS1: As our smart transportation mobile application represents the first exposure to our company, we tried to make it personal and user-friendly. In other words, we focused on providing our customers with the best experience by ensuring they can utilise all our services. […….] dashboards are used to analyse the different problems accruing and the best approaches to solve them, to make better business development plans, improving the efficiency and effectiveness of the decisions taken, and to communicate with customers and coordinate their orders.
	Live tracking	MS1: With smart transportation mobile applications, passengers can easily avail a taxi by pressing a single button in which GPS systems work to direct the request to the nearest taxi. Passengers are also provided with the expected time of arrival, the driver's data and the car's data. Therefore, they are not forced to stand outside in the hot weather waiting for the taxi to arrive; instead, people decide where to wait for their taxis.
	Frequently asked questions	OM1: Customers most often keep asking the same questions, for example, doubts about our services, how to pay fees, available payment methods and order cancellation. Later we realised that if we do not answer these questions clearly, we will keep receiving the same questions repeatedly, which may affect the quality of the services and waste our time and money. Therefore, our organisation decided to create a comprehensive FAQ in which we answer the possible number of repeated questions. We also conducted brainstorming sessions to extract all other possible questions to save time and effort for both parties, we as service providers and passengers as consumers for our services.
	Compatibility	DAO1: During the trial period, we received some comments about some problems in browsing the application with specific kinds of browsers. Therefore, the mobile application has been reconsidered to solve such issues.
	Internet service availability	OCCC1: Internet in Oman is not very cheap, and currently, there are only two main service providers, Omantel and Ooredoo, which are fair enough. However, the rates of personal internet packages range from 22 to 25 OMR per month, which is considered too high compared to other GCC countries. The internet service is slow and does not cover the rural areas in Oman
	Rules and regulation availability	SAS1: Most Omani may be nervous about the privacy and security of their personal and financial data because the rules and regulations related to their right to privacy are still evolving.

Code ID	Themes-Subthemes	Reference (example)
	Capital availability	DAO1: Covid 19 pandemic coupled with the oil prices crises have caused many obstacles in implementing the planned projects not only by the government but also with private companies. The budget assigned to each sector has been reduced to the minimum level where the priority has been given to the most critical projects.
	Professional skilled worker availability	SE1: In Oman, the limited technical skills needed in developing and designing mobile applications is another problem. Securing skilled employees, especially in the technical support department, is more challenging than ever before. I strongly believe that government should put further effort into incorporating the necessary educational programmes suitable to graduate students with the technical skills needed today in the market as graduates with poor technical skills can adversely affect the quality of the services delivered by organisations
PV	**Price value**	
	Providing incentives	MS1: The intensive program within my organisation consists of three main methods: rewards points, VIP cards and referrals. The rewards points are used to keep current customers, and the more they spend, the more rewards they get. VIP customers are considered the most important customers as they bring the most value to our business; therefore, it is important to design loyalty programmes for them to keep them engaged. Recently we have included the VIP intensive program for those passengers who have taken more than ten rides per month. Such VIP passengers enjoy greater access to the highest-rated drivers and luxury cars. […….] Referrals programmes help in getting the use of our customers in motivating new users to adopt our services. By referring our smart application to a new consumer, they can get a discount for their next journey. Also, customers who give positive comments on the usage of our services are usually offered discount codes for their next order
	Saving money	CEM1: Allowing commuters to access and buy tickets through our smart transportation mobile application has made commuting flexible as it allows them to know and compare the prices to choose the super saving plans
	Cooperating with third parties to provide benefits	PM1: We are cooperating with one of the official and favourable e-Government Services Portals "Omanuna", which provides links to our smart mobile application. This portal works as a single window access to the e-services and platforms served by smartphone applications in Android and IOS in Oman. They can directly click and download our smart transportation application through this portal. Moreover, since our organisation is designed to support all other governmental entities, we have signed cooperation agreements with most of them. Consequently, customers can locate links to our smart applications within these entities to enhance customers' abilities to recognise and utilise our smart transportation application.
HB	**Habit**	
	Not interest to amending the current habits of commuting	HOTD1: Due to the busy lifestyle, most of the citizens lack the time to explore new innovations not only those introduced in the transportation sector but also in most of the other sector especially if they are used to follow a specific manner in accomplishing their work
	Addiction to the current transportation system and private cars	HOTD1: In Oman, I believe that most customers are very aware that private cars and the growing number of them on roads every year is a major source of heavy traffic and car accidents. However, most of them are used to these issues and have adjusted themselves by making important calls during traffic jams. They have adapted to the traffic jams and learnt how to use this time efficiently.
TR	**Trust**	
	Service providers reputation	ITSS1: The economic and social challenges Oman has been experiencing for the last 12 years have contributed to the citizen's scepticism in the abilities of services providers in responding to their increasing demands in planning, designing, financing, and successfully implementing new projects. [……] This includes all kinds of projects such as entertaining projects, economic projects and even transportation.

Code ID	Themes-Subthemes	Reference (example)
	Meeting citizens needs	ITSS1: Planning for smart projects specifically and building smart cities generally involve several holistic advantages including economic, environmental, and quality of life improvement. Yet focusing on the side that contributes to the government benefits while not respecting citizens' needs is unacceptable. There are direct problems facing citizens, and citizens are expecting them to be considered and solved by smart cities projects [……].
	Perceived security	OS1: We consider customer's collected data as a precious competitive asset which we need to work hard to protect them. However, end users are often very sensitive about their financial information security issues assigned with the smart mobile application.
	Perceived privacy	SAS1: Our organisation seriously deals with consumers' privacy in which no information is disclosed unless consent has been legally and officially approved. This is because we believe that the higher perceived privacy by the consumer, the higher the chance they will trust and adopt our smart mobile transportation application.
SAF	**Satisfaction**	
	Application quality	DAO1: Technology involves many critical technical challenges such as glitches, access, complexity and many other issues that are bound to happen. Such technical issues affect citizens' satisfaction with technology-based services.
	Information quality	DAO1: Smart transportation mobile applications are expected to provide innovative services compared to the old transportation systems by providing updated information about buses arrival and departure times, which represents a critical piece of information that is needed to be updated regularly.
	Service quality	MS2: Imagine one of our customers is relying on our smart mobile application to deliver him to a critical meeting. Our application did not provide him with the taxi he booked on time. Imagine how annoyed this customer will be; I do not think he will return to our application in the future.
cAW	**Awareness**	
	Benefits related to improving quality of the air	PM1: It is essential to educate citizens that the harmful gases produced by their cars contribute heavily to air pollution. They need to know that this pollution later affects their environment besides affecting the Ozon layer. As a result, considerable programs need to be implemented to educate citizens about how to minimise car pollution and enjoy fresh and clean air.
	Awareness of administrative benefits	ITSS1: For example, if a citizen wants to get a car parking permit, there is no clear explanation of the documents and procedures required to apply for such services. Citizens are forced to visit them or use their personal network to seek such information which further complicate and slow down the process. Making all the requirements and documents needed for an application posted clearly in a mobile application will save time for both service providers and citizens as well.
	Benefits related to creating job opportunities	HOIT1: High unemployment rate means that the country's economy cannot offer a aufficient number of jobs for the job seekers, which indicates an unhealthy economic situation. This will further affect family's income and the citizens' purchasing power.
	Advertisements and campaigns	SE1: Inviting experts to a discussion to evaluate and analyse with them the different traffic issues are a common task within our organisation. This is in addition to our interest in sharing reports and images sent by citizens through the application with the general public to spread awareness. For example, if one of the traffic lights breaks down or an accident occurs, as soon as we receive a notification about it, whether through the application or by calling, we share it with the public so that everyone can take their precautions.
FP	**Former Practice**	
	A trail period of the smart transportation mobile application	BDM1: Our company offered a free trial period of our smart transportation application by offering it to a range of our employees and their families as a trial for around sixty days. Our smart transportation mobile application is built professionally by using advanced technologies. Therefore, in most cases, they need essential trials by the end users to understand if they are meeting the user's requirements. We believe that a free trial helps to put us in our customer's shoes.

Code ID	Themes-Subthemes	Reference (example)
	Familiarity with similar applications	MS1: Being exposed to similar smart ride-hailing applications from other countries helps in becoming more familiar with them and accordingly enabling the adoption of a positive association to them.