FACTORS AFFECTING THE ADOPTION OF GEOGRAPHIC INFORMATION SYSTEMS IN THE PUBLIC SECTOR OF SAUDI ARABIA AND THEIR IMPACT ON ORGANIZATIONAL PERFORMANCE

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DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged.

14 February 2023

NOUF ABDULAZIZ ALZAHRANI
P103841

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ABSTRAK

Kebolehan Sistem Maklumat Geografi (SMG) untuk mengurus, menganalisis, menggambar serta menyepadu data spasial telah menjadi penggunaan utama di kalangan industri profesional seperti perdagangan, pertanian, geologi, perancangan bandar dan kesihatan. Merujuk kepenggunaan Sistem Maklumat yang meluas dalam sejarah menangani isu bencana alam, didapati bahawa Sektor Organisasi Awam (SOA) masih tidak mengemaskini dengan penggunaan sistem SMG. Kajian terhadap model/kerangka kerja SMG yang terdahulu, terutamanya di negara-negara membangun, menunjukkan kurang mempeduli faktor-faktor tekanan pandemik, daya saing, dan perubahan pengurusan serta ciri-ciri keselamatan. Justeru, kajian ini dijalankan untuk menganalisis kesesuaian dan ciri-ciri tersedia SMG dalam memacu penggunaannya di dalam SOA. Satu kerangka kerja yang meneliti kesan ciri-ciri penggunaan SMG dalam SOA di negara Arab Saudi perlu dikemukakan. Kerangka kerja tersebut perlulah bersifat komprehensif, sekaligus mempunyai nilai kritikal serta berlandaskan teori yang kukuh. Sehubungan itu, kajian ini mengemukakan model penggunaan SMG yang mampu meningkatkan prestasi SOA di negara Arab Saudi dengan menggunakan Model Penerimaan Pengguna (TAM) dan De Lone and Mc Lean Information Success Model. Kaedah Kuantitatif digunakan untuk mengumpul data melalui satu soal selidik yang telah dijalankan terhadap 350 responden dalam kalangan SMG, namun hanya 272 soal selidik sahaja didapati berasas. Data terkumpul telah dianalisis secara menggunakan SPSS 25. Pintar Perisian Pemodelan Persamaan Struktur SEM-PLS 3.8 juga telah digunakan dalam membangun kerangka kerja ini. Data kuantitatif menunjukkan bahawa semua indeks padanan memenuhi julat nilai yang ditetapkan dengan andaian kerangka dibangunkan boleh diterima. Dapatan menunjukkan bahawa kualiti sistem, kualiti perkhidmatan, pengurusan perubahan, tekanan daya saing, tanggapan penggunaan, tanggapan kegunaan dan faktor keselamatanadalah signifikan dan memberi kesan positif terhadap penggunaan SMG. Kajian juga menunjukkan bahawa penggunaan SMG adalah besar dan memberi kesan positif kepada prestasi SOA. Kajian ini juga mampu membentuk hala tuju kajian teori dan empirikal mengenai SMG, khususnya terhadap penggunaan, dalam menyokong prestasi SOA menerusi model yang dicadangkan. Model cadangan turut memberi gambaran tentang bagaimana penggunaan SMG mampu meningkatkan prestasi di kalangan SOA. Pada asasnya, hasil kajian menyumbang secara praktikal terhadap perlaksanaan SMG dalam SOA serta keputusan yang diambil oleh para pembuat dasar.

ABSTRACT

The ability of Geographic Information System (GIS) to organize, analyze, visualize and integrate spatial data has been at the top of its primary uses among professional industries such as business, agriculture, geology, urban planning, and healthcare. Considering the extensive adoption of Information System (IS) throughout history for the government organizations/citizens' disaster response, it is brought forward that government agencies are not as up-to-date with their GIS adoption. Previous studies on GIS models/frameworks, particularly in developing countries, were devoid of pandemic pressure, competitiveness pressure, change management, and security factors. This study seeks to analyze the applicability of the existing factors associated with GIS adoption that might enhance the performance of Public Sector Organizations (PSO). A new conceptual framework to examine the effects of factors on GIS adoption which impact performance among PSOs in Saudi Arabia is then necessary to be proposed. The framework needs to be comprehensive, including critical factors, and be based on solid theories. Hence, this study aims to present a model for the adoption of GIS to support the performance in PSOs of Saudi Arabia using the Technology Acceptance Model (TAM) and De Lone and Mc Lean Information Success Model. Quantitative methods were used to collect data through a questionnaire that was distributed to 350 respondents from PSO, and only 272 were found to be valid. The collected data was analyzed using SPSS 25. Smart Partial Least Square Structural Equation Modelling SEM-PLS 3.8 software was used to propose the framework. Quantitative data reveals that all the fit indices satisfy the recommended range of values, assuming the developed framework is acceptable. The finding revealed that system quality, service quality, change management, competitiveness pressure, perceived ease of use, perceived usefulness and security factors were significant and positively affected GIS adoption. The study also showed that GIS adoption was substantial and positively affected PSO performance. This study could help shape the direction of both theoretical and empirical studies on GIS, specifically on adoption, to support the PSO performance through the proposed model. The proposed model provides insight into how GIS adoption can eventually lead to enhancing performance among PSOs. In essence, the study practically contributes to the running of PSO and the decisions taken by policymakers.

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LIST OF ABBREVIATIONS

SEM	Structural Equation Modelling
TAM	Technology Acceptance Model
SYSQ	Service Quality
INFQ	Information Quality
SRVQ	Service Quality
CMGT	Change Management
CMPT	Competitiveness Pressure
PNPR	Pandemic Pressure
PEUS	Perceived Ease of Use
PUSE	Perceived Usefulness
SECU	Security
BHVI	Behavioral intention to adopt
PERF	perceived performance
PSO	Public Sector organizations
KSA	Kingdom of Saudi Arabia
GIS	Geographic Information System

CHAPTER I

INTRODUCTION

1.1 OVERVIEW

The IT description that Nikoloski (2014) proposed, which refers to it as a train at full speed to reach its only destination, which is advancement and development, could not be truer than in the current times. This is because IT is capable of transforming the competitiveness of business and firms (Nikoloski 2014), as a result of which the financial institutions like public sector organizations are impacted in a way that time and effort is saved, and results obtained are real-time and accurate; there is enhanced performance and informed decision-making because of the significant data amount (Alzighaibi 2017). For this reason, institutions have to reap and leverage opportunities and adopt new innovations in order to be competent and gain viable advantages and long-run sustainability.

In the context of public sector organizations, the critical contributions stem from their supply of services to the national economy for the purpose of development and sustainability. Thus, the presence of any deficient service may generate an economic issue that could adversely impact people's well-being. Without a doubt, those organizations have a significant part in the development of the country's economic development, particularly in the allocation of financial resources. In this regard, a developed economic system should have modern and sophisticated tools and techniques in order to achieve a balanced economy (Al-Fayoumi & Abuzayed 2009).

Thus, it is a must for public organizations to implement and adopt new technologies for enhanced work processes effectiveness and efficiency. However, reality shows that several technology-based items and services have been employed to their full potential, while others are even discarded (Mukred et al. 2019). In relation to this, failed technological investments incur financial losses and eventually result in employees' lowered satisfaction (Venkatesh et al. 2003), which lays stress on the importance of providing insight into and predicting users' new innovation adoption.

Among the many new IT innovations that are currently in use is the geographic information system (GIS), which supports decision-making and is hailed among the most robust technologies. GIS is basically a data base and a set of operations for data processing, with stress on the use of spatial data (information concerning positions). It refers to a computer system that has been developed to acquire, supply, operate, analyze, manage and display different kinds of data (geographic and spatial) (Gordon 2017). Pandey et al. (2013) explained that GIS primarily aims to maximize the decision-making efficiency involving planning, providing efficient data distribution and handling methods, getting rid of duplicated data, integrating information from various sources, and analyzing queries entailing geographical reference data to produce new information, timely data updates, all at the least amount of cost.

This chapter is allocated to cover the introduction of this study that includes the problem background, problem statement, research questions, research objectives significance of the study and scope.

1.2 THE BACKGROUND OF THE STUDY

The adoption of GIS technology means the selection of by means of the technology in the professional work surroundings, and the actual GIS technology usage refers to the level of which use for a specific purpose that literature has kept close documentation of (Lee & Bednarz 2009; Lee et al. 2011; Mollalo et al. 2020).

More importantly, the GIS technology application use effectiveness in both web-based and desktop tools has been evidenced to revolutionize the way meaning is obtained from complex data (Sharma et al. 2018; Asni et al. 2020). Notably, this is not confined to technology users characterized as advanced and professional, as it has also been noted to be effectively utilized by K-12 and post-secondary level students. Also, GIS education research is one of the sub-fields of geography developed to focus on enhancing GIS technology to acquire knowledge in different surroundings (Baker et al. 2012). Studies of this caliber have examined GIS technology's effectiveness and ability to enhance learning among students and professional development among adults (Nielsen et al. 2011).

In the context of industry professionals, GIS technology adoption for research and knowledge can be traced back several decades ago, with studies shedding light on the professionals' way of spatially understanding the world using conceptual geography basis. These studies also describe how professionals use the information for decision-making by visualizing and aggregating occurrences at various spatial scales. Although several GIS technology uses have been looked into in various fields, scarce research has been conducted on the factors influencing GIS adoption in professional workplaces, including the property assessment valuation profession (Chan & Williamson 1999; Alzighaibi et al. 2016; Alzighaibi 2017).

The ability of GIS to organize, analyze, visualize and integrate spatial data has been at the top of its major uses among professional industries such as business, agriculture, geology, urban planning, and healthcare, to name a few. These fields' use of GIS has led to novel data interaction based on geography (Fasteen 2016). Some examples of services gathered from industries - the first of which is advertising, where GIS assists in the decision-making process by analyzing areas that are likely prone to consumers' products purchase. Second is the medical field, where GIS provides information about disease spread, infections, or potential outbreak areas illustrated through models. This information assists the decision-maker as to where to focus when allocating resources to minimize the adverse impacts. Third, environmental science use of GIS furnishes scientists with the ability to manage resources, map, survey, manage forestry, and conduct impact analysis, as well as determine invasive plant areas and the impact of climates on the changes in the surroundings. Another area of GIS use is natural disaster/hazards, which assists in modelling potential impact areas, analyzing the post-destruction scenario, and visualizing and analyzing different impacts (financial and social) (bin Arshad & bin Mohd Sani 2018; Mukherjee 2018).

The aforementioned use cases illustrate why GISs are indispensable and how they continue to facilitate the making of sound, well-informed judgments regarding complicated issues worldwide. - resolution (Smelcer & Carmel 1997; Mollalo et al. 2019; Sarwar et al. 2020). Research over the past decade has shown that spatial information processing is useful in its own right, if not in its support of standard media in analysing geographical associations among various phenomena. This analysis has implications for the presentation of complex and multi-faceted information for decision-making.

The phenomenon's visual representation has become significant and has increased in popularity and use because of the simple process of data comparisons. In other words, a simple visualization method is invaluable for discerning relationships among different variables of complex data (Mukherjee 2018; Dangermond et al. 2020; Mollalo et al. 2020).

When it comes to data analysis overlay and proximity, these can encapsulate more analytical and quantitative reasoning to generate capabilities of finite decision-making. These capabilities may be exemplified by the process of deriving appropriate locations for a business, necessitating the professional's overlaying of spatial data layers comprising information on consumer preferences as a function of way of life, economic statistics derived from the census, and neighbourhood and zoning information are all used to pinpoint a potentially fruitful site. GIS can indicate the appropriate areas based on queries made to each of the variables to determine potentially suitable positions (Flemming 2014).

The application of geo-spatial modeling is expanding rapidly in the environmental sciences and municipal governments, and GIS-based analysis is now mature enough for predictive analysis. In addition, open-source technology has made it possible for web-based and integrated clustering, regression, and 3D modeling (Gordon 2017; Sharma et al. 2018).

Considering the extensive adoption of IS throughout history for the government organizations/citizens disaster response (Harrison & Johnson 2019), it is brought forward that government agencies are not as up-to-date with their GIS adoption. Added to this, IS tools development external to the government entities show that governments have yet to achieve effective and efficient responses through new information gathering and sharing tools adoption and implementation, like GIS. This underlines the need for framework development for GIS adoption among organizations in the public sector.

Due to the numerous uses of geographic information systems (GIS) in various organizations and industries, it has become one of the most popular study subjects (Alkobaisi et al. 2012). Its advancements, applications, innovations, rainfall prediction, flood control, remote sensing, urban planning, and public safety have all been studied in the context of Saudi Arabia (El-Hames et al. 2011; Kheder 2014; Mahmoud & Alazba 2014).

The five main advantages of Geographic Information Systems (GIS) are lowered expenses and enhanced productivity, superior decision-making, clearer communication, more accurate record-keeping, and control over environmental elements. GIS has assisted different sorts of organizations and industries (big and small) (Alkobaisi et al. 2012). Data can be stored and managed using GIS and other existing IS frameworks, and data can be retrieved using GIS in various ways.

Despite the wealth of literature, scarce research examined GIS adoption and its results in the Saudi environment, particularly in the country's public sector organizations. This exemplifies the motivation for the ongoing research, to contribute to the existing body of literature on models of technological acceptance. Asimilar nature study that were carried out in the context of Western countries did not provide any notable results (Cakar 2011). According to the research done by Mukred et al. (2019), adopting new technology and its transplantation to a different culture will each result in various effects. According to Alharbi (2014), a study conducted in Saudi Arabia found that UTAUT had less variance than when applied in the United States, meaning that the same model may yield different results when applied to different cultures and contexts. In the same vein of reasoning, Oliveira et al. (2014) said that to shed accurate technology adoption, a model must be tailored to the context in which it will be used. Each technology has its own set of factors, and this study provides a GIS model specifically customized to the Saudi public sector. Using GIS as an example, the research validates ideas and literature about technology uptake and acceptability.

The suggested GIS adoption study model has been created and adjusted based on current technology acceptance theories to fit the Saudi public sector setting. The study incorporates the Unified Theory of Acceptance and Use of Technology (UTAUT) as recommended in earlier studies (Venkatesh et al. 2003; Talukder & Quazi 2011; Alzighaibi et al. 2016). Many factors can affect a person's choice when embracing new technologies, which is why these hypotheses were developed. As they work together toward a common objective, individuals play a critical role in the process and their organizations.

This study aims to develop a model for Saudi public organization employees to determine the factors that might influence the behavioral intention of adopting technology, specifically GIS adoption. After a thorough assessment of the literature, the study discovers new factors for model construction, and the model is then evaluated in a government organization. GIS acceptance theory is predicted to benefit from the suggested model and its testing regarding technology acceptance.

1.3 PROBLEM STATEMENT

IT adoption and use among public organizations are driven by the effective achievement of objectives through the benefits provided by IT. Nevertheless, reality cannot be far from this assumption because not every organization adopts and uses IT (Mukred et al. 2019). Researchers widely agree that the actual use of IT in most firms falls short of its potential (Goswami & Dutta 2017; Zeng & Cleon 2018; Harrison & Johnson 2019), and this holds true for the adoption and use of GIS in public organizations context.

In the case of Saudi Arabia, theories of accepting and adoption technologies have been studied in several works. A study conducted by Al-Gahtani (2016) came up with some recommendations highlighting the urgent need to identify new factors as it’s a straightforward technique that might facilitate the adoption. Other past authors, such as Sharma et al. (2022), Satar and Alarifi (2022), and Mahdaly and Adeinat (2022) also had the same recommendation in that they mentioned using different methods to provide insight into key variables' relationships with the adoption of technology. According to Akmam Syed Zakaria et al. (2018), IT studies require the identification of factors that influence decision-making involving existing/new system usage and the necessity of such use. Additionally, aside from determining GIS adoption factors, it has been suggested that the top significant factors are examined as past literature had not examined such factors and their specific effects on adoption.

Owing to this gap in the literature, researchers in the IT and IS field have mentioned the necessity to identify the main factors that influence and encourage the adoption and use of technology (e.g., GIS) and its relationship to the organization's performance. In light of the many applications of GIS in various fields, this study examines its adoption in the public sector of Saudi Arabia by proposing a GIS adoption model. Literature dedicated to the GIS adoption models, particularly in the Saudi public sector, is sadly lacking, which is why it needs examination (Kheder 2014; Mahmoud & Alazba 2014; Elkhrachy 2015; Abousaeidi et al. 2016; Alharbi et al. 2016; Alzighaibi et al. 2016; Alqarni 2017; Murad & Khashoggi 2020). Past studies developed and proposed several models, which primarily stressed the development of a model that covers factors affecting GIS adoption and use. Because GIS implementation or adoption models for improving the performance of organizations are still limited and thus, this study aims to propose a model that could promote successful GIS adoption in the context of Saudi Arabia's public sector, to enhance organizational performance.

1.4 RESEARCH QUESTIONS

This study aims to determine the answers to the following questions;

RQ1: What are the factors that influence the adoption of GIS?

RQ2: What is the role of GIS in enhancing public sector organizational performance?

RQ3: How can a GIS adoption model be developed?

RQ4: How can a GIS adoption model be validated?

1.5 RESEARCH OBJECTIVES

A research objective refers to a statement summarizing what is expected to be achieved from the study. In this study, the main objective is to develop and propose a GIS adoption model.

The above major objective can be divided into the following sub-objectives for systematic achievement.

1. To determine the factors that influence GIS adoption.
2. To determine the GIS role in enhancing public sector organizations' performance.
3. To develop a GIS adoption model for Saudi public sector organizations.
4. To validate a GIS adoption model for Saudi public sector organizations.

1.6 SIGNIFICANCE OF THE STUDY

Prior literature employed existing technology acceptance theory and their modifications, with some of them employing the original versions of the theories (Cakar 2011). Some other studies addressed and examined the factors that affect user acceptance and the failure to accept new technologies in the public sector context, while yet others looked into the factors that may influence the adoption of GIS, keeping its infrastructure and production into consideration (Chan & Williamson 1999; Alzighaibi et al. 2016; Alzighaibi 2017). The present work focuses on a developing nation, Saudi Arabia, rather than any countries of the West, with specific emphasis on public sector organizations. Saudi Arabia has its own unique culture, which could lead to distinct outcomes and provision of different benefits from those documented in Western countries.

Several acceptance models have been developed throughout the years to tackle technology acceptance, but Oliveira et al. (2014) claimed that each technology should have its tailored model for the optimum understanding of its adoption. It occurs as a result of the fact that technology can provide varied results when investigated in various situations, cultures, and implementation procedures. For instance, Saudi Arabia has a particular culture and tribal background compared to the countries in the West, and thus, logically, different attitudes may be harbored towards adopting technology. Developing a GIS adoption model in the context of Saudi Arabia is expected to contribute to the literature on the topic. GIS adoption studies of the West are discussed in the literature review, but because Saudi Arabia lacks this study type, it is necessary to examine the phenomenon based on its culture and situation. In this regard, acceptance models proposed based on the Western case are not always appropriate for countries with contrasting cultures owing to differences in beliefs, backgrounds, civilizations, and even tribal systems or the lack thereof. The study data is gathered through a web-based survey, with the participants familiarising themselves with the GIS system usage and interaction. The survey contains items on the determinants of GIS adoption that can affect the adoption success in the PSO and the outcomes thereof.

1.7 SCOPE OF THE RESEARCH

This study is concerned with developing a GIS implementation model for Saudi public sector organizations. The study targeted the Ministry of Transport and Logistics Services. The respondents comprise employees and CEO that extensively use GIS technology.

The study adopts the quantitative method, using a survey questionnaire as the study objectives mainly entailed the collection of perceptions in numerical data to examine the independent-dependent variables relationships statistically.

1.8 ORGANIZATION OF THE THESIS

This thesis is organized into five chapters with specific contents and focus. Chapter one contains the study introduction, background, problem statement, research objectives and questions and the Scope.

Chapter two presents the literature review of concepts, definitions and the GIS fundamentals. It also reviews studies and works dedicated to the factors of GIS, Saudi Arabia, Adoption theories and the research gap. This is followed by chapter three, which presents the study model used to examine the factors affecting GIS use and its impact on the performance of Saudi private sector organizations.

Chapter three describes the research method phases used in the study comprising research design, data collection and data analysis strategies. It includes an overview of the proposed model with the hypotheses.

Chapter four goes through the data analysis procedures and interprets the results obtained from the analysis. The chapter tests data-model fit and ensures data purity, after which it tests the proposed hypotheses through suitable statistical tests including validity and reliability tests and regression analysis. The chapter provides the outcome of the hypotheses testing and validates the success model. Lastly, the findings are interpreted and discussed in terms of hypotheses testing, construct verification and research findings interpretation on the basis of the underpinning theories.

Lastly, chapter five summarizes the study objectives' findings, the study's contributions to theory and practice, study implications, limitations and finally, before concluding the study, the chapter lists recommendations for future avenues of research.

CHAPTER II

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter presents the context of GIS adoption by examining the literature, particularly its use and benefits in the public sector. As mentioned, the study primarily aims to examine variables and determinants that can influence the perceptions of GIS in the public sector and how such perceptions influence the actual GIS adoption. The chapter provides relevant studies concerning the topic in literature.

2.2 GEOGRAPHIC INFORMATION SYSTEMS (GIS)

To put it simply, a Geographic Information System (GIS) is a computer system designed for geospatial applications responsible for the acquisition, storage, integration, manipulation, analysis, and presentation of data with geospatial references. Additionally, it is utilized to standardise data for creating and presenting new maps and reports (output) (Murad & Khashoggi 2020).

In addition to the aforementioned, GIS includes software, hardware, data administration, analysis, and reporting for other spatially related information. The comprehension and exchange of data help companies find answers to problems (Margolis & Pauwels 2011; Mukherjee 2018).

A system that saves, retrieves, analyses, and displays data geographically or spatially is one definition of GIS that may be found in the literature. Information systems that manage geospatial or geo-spatial data for spatiotemporal application and exploration of geography are comparable to this more extended idea. Geography refers to the study of land, its properties, its human occupants, and the study of Earth's natural events (The American Heritage Dictionary, 2006). A broader term for geographic knowledge (GI Science) is used in this study instead of the GIS abbreviation for systems and technology (Goodchild 2018).

The term GIS is often used as an umbrella term for a wide range of software programs that perform various functions related to managing and presenting geographical data. The subsequent sub-sections will be devoted to describing the applications, components, and benefits of the GIS system.

2.2.1 Domains Where GIS Is Applied

All fields that have to do with the position of things on Earth consider GIS as a vital component. This field includes temperature differences between regions, climate change, population distribution, and disease distribution, which can be measured and managed (Longley et al. 2005). The use of GIS technology to better understand and helps to identify criminal distribution throughout diverse locations and regions. Knowing where criminals are most likely to be found in relation to other factors, such as the distribution of plants and animals, can be facilitated by GIS analysis (Murad & Khashoggi 2020).

Using GIS is also useful in the construction, excavation, burying and monitoring of pipes and cables, as well as in the search for oil. Since all activities and functions in a specific region must be identified, the processes tracking approach helps compile relevant and useful data that can be saved in GIS. When it comes to solving problems related to economic regions, healthcare and infrastructure projects, GIS is an essential tool. There is no alternative way to distribute data and information except by collecting it from a single individual (Longley et al. 2015).

Over the past decade, countless businesses in virtually every sector have embraced GIS as a powerful tool for creating maps that can be used for various purposes, including data exchange, analysis, and problem-solving. The application called Google Maps, a web-based GIS mapping solution, is an example of how GIS is used to visualize data. Organizations can incorporate geographic information into creating, optimizing, planning, and maintenance. Utilizing pertinent information would improve location services and customer relationship management in the telecom industry. Through the application of data intelligence, data collected and distributed by GIS is facilitated by the application and used to determine and improve roads, which helps to maintain the safety of the roads and improve traffic management (Othman et al. 2020)

GIS data is also used to assess urban growth, the direction of that expansion and the effective use of that growth to lay the basis for development in the future. By combining environmental and current affairs data with the GIS platform, businesses can build new roads and train routes, another application for such data in transportation management. GIS applications gather data that is used for natural resource protection. Impact reports, for instance, are crucial for determining the extent to which GIS integration contributes to environmental problems (Sztubecka et al. 2020).

Additionally, GIS data is used to analyze soil data and develop more effective farming techniques, which could increase food production in various parts of the world. An effective GIS system helps manage catastrophic events, decrease risks, and protect the environment. Information is also used in online navigation maps to give users useful directions. By using GIS data, web maps are regularly maintained up to date and are frequently used (Villacreses et al. 2017). Overall, GIS is helpful for organizations for many purposes. That includes enhancing their performance, decision making and sustainability (Villacreses et al. 2017; Murad & Khashoggi 2020).

GIS data consumption has been having a huge impact not only on sectors and enterprises but also on the entire society, and if there is no access to GIS data, there would be a significant difference in both personal and professional life on a day-to-day basis. There has been a gradual shift in the role of GIS technologies from a simple tool to manage restricted application issues to an element of territorial growth in public administration sectors in developing countries. In the past, problems with constrained uses were addressed using GIS technologies (Lytvynchuk et al. 2020).

2.2.2 Geographic Information System Components

The GIS comprises different components, with the network being the most important. This is because the transmission of data and other forms of digital information can only occur through a network connection. Hardware refers to all the physical tools required to operate a geographic information system (Longley et al. 2015). Third, a GIS requires software, which may be purchased from several different sources. These programs might vary greatly from one GIS provider to the next when it comes to applications, level of complexity, and amount of data. The GIS database stores all the information that can be utilized for making decisions and addressing problems, making it the system's fourth component. The budget, the fifth GIS's component, includes approaches for GIS administration that fulfil the stakeholders' needs. To ensure that the GIS's functionalities are effective and up-to-date, the GIS's sixth component consists of its users and the people who provide and update the digital data used by the GIS (Longley et al. 2015; Hossain et al. 2020).

ESRI is one of the most well-known providers of GIS software, and the company is responsible for the production of the ArcGIS types. ESRI developed GIS that is web-based and known as ArcGIS online. It is also used as a server to offer solutions made possible by advanced technology (Bolstad 2016). The term "Geographical Information Systems Science" has been cited as having a variety of characteristics, both intellectual and technological, as well as aspects (Azeez 2013).

The most widely used kind of GIS software is desktop software, although other popular kinds include web mapping, GIS server software, virtual globe software, developer software, and handheld GIS software. Desktop GIS software was initially introduced on PCs running the Microsoft Windows operating system. It has been claimed that competing GIS systems offer equivalent capabilities and functionality (Longley et al. 2015; Bolstad 2016).

2.2.3 The Benefits of Geographic Information System (GIS)

GIS integrates many components such as the software, the hardware, and the data. GIS role is to capture, manage, and analyze data and then present the resulting information that is geographic in a way to facilitates quick and easy comprehension of the data and informed decision-making (Ali et al. 2020). Furthermore, GIS is an important tool utilized for the study and visualization of the Covid-10 spread, which is crucial in combating pandemics and improving the quality of care provided to those affected (Mollalo et al. 2019; Mollalo et al. 2020).

GISs and its many modalities have been used in scientific investigation and planning of strategic healthcare operations and decision-making to track the spread of Covid-19 in light of its regional and temporal dispersion and diffusion. In order to better advice and lead the healthcare industry's plans and actions, the system's geographical, geospatial, and geo-statistical studies and applications have generated a plethora of important data. This is due to the fact that the web's synergistic nature of information sharing and dissemination has resulted in an explosion of similar apps. Given GIS's good benefits on IT development, public safety, and healthcare response, it stands to reason that healthcare institutions and organizations might employ it to monitor diseases and plan calamities (Dangermond et al. 2020).

Additionally, GIS can be used to make a spatial model of the presence of environmental factors related to disease and map the disease's geographical distribution and transmission patterns. Also, in Jeddah, Saudi Arabia, Murad and Khashoggi (2020) employed a GIS to create a mapping and cluster modelling of the prevalence of diabetes, asthma, and hypertension. The authors showed that GIS could aid in surveillance and decision-making for disease and condition and demonstrated that GIS could assist in the updating and mapping of health occurrences.

The rapid development and prototyping that comes with a GIS adoption environment, the approach's applicability for patient tracking and treatment, and the adoption of preventative measures are all advantages of the GIS adoption environment. Moreover, the GIS method can disseminate information on the disease's progression (Sarwar et al. 2020). The benefits of geographic information systems (GIS) can be broken down into five main groups: financial savings, increased productivity, better data analysis, better communication, and better geographical record keeping and management (Margolis & Pauwels 2011; Flemming 2014). Margolis and Pauwels (2011) state that GIS and an IS model can be combined.

Using GIS, information about roads, oceans, buildings, and other features may be stored, managed, and retrieved. With the help of spatial joins between datasets, layers that share the same geographic location in a geographic information system (GIS) database can be linked together to facilitate data-driven decision-making. One example is the potential flooding of roads due to the same river's location (Alkobaisi et al. 2012). 2011).

2.3 SAUDI ARABIA

The Saudi Arabia's PSO are the focus of this study, and under this sub-section, the background, the need to adopt GIS and the advantages expected from such adoption are presented and discussed. Accordingly, the use of GIS in public organizations is also discussed in the following sections.

2.3.1 Background

Saudi Arabia is the largest country located in the Arabian Peninsula and its capital city is Riyadh. It is a Middle Eastern country that covers an area of 2.24 million sq. km, lying in the southwest of the Asian continent, between 18 ° latitudes, 35 ° north of the Equator, and 36 ° to 48 ° longitudes lying east of Greenwich. The country occupies a large portion of the Arabian Peninsula, boasting a total area of approximately 2 million sq. km., surrounded in the west by the Red Sea and in the east by the Arabian Gulf, the UAE and Bahrain. Its neighbouring countries to the northern frontier, lying from east to west, include Kuwait, Iraq and Jordan, while to the south are Oman and Yemen (Kadi 2018; Zielhofer et al. 2018).

While Saudi Arabia's official language is Arabic, English is spoken by many people, particularly in the education and business sectors. Saudi Arabia is characterized by a monarchial government system with the Royal Family as the head rulers (Alqurashi et al. 2020).

There are 13 main administrative regions in Saudi Arabia, each led by a government-appointed governor. The regions are broken down into several governorates and centers or sub-governorates, each having their capital/headquarters located in the largest city in the region (refer to Table 2.1 for details).

Table 2.1 Administrative divisions of the Kingdom of Saudi Arabia

Region	**Headquarter**	**Number of governorates**	**Number of centers**	**Area - Km2**
Riyadh	Riyadh City	20	454	380,000
Makkah Al-Mokarramah	Makkah City	16	111	137,000
Al-Madinah Al-Monawarah	Al-Madinah City	8	90	150,000
Al-Qaseem	Buraydah City	12	153	73,000
Eastern Region	Dammam City	11	107	540,000
Aseer	Abha City	15	102	80,000
Tabouk	Tabouk City	6	73	136,000
Hail	Hail City	8	84	120,000
Northern Borders	Arar City	3	17	104,000
Jazan	Jazan City	16	31	13,000
Najran	Najran City	7	59	130,000
Al-Baha	Al-Baha City	9	35	12,000
Al-Jouf	Sikaka City	3	33	85,000

2.3.2 The Need to Adopt GIS for Organizational Performance

The majority of organizations in Saudi Arabia have been exposed to pressure from market competitiveness, which has urged their adoption of advanced technologies to have access to unlimited information and to achieve competitive advantage (AlBar & Hoque 2019).

In the same line of adoption, GIS technology adoption by the government has been noted as the fastest-expanding GIS adoption area because of the data amount gathered by the local governments. In fact, data is the core element of GIS; in particular, spatial data has had a significant effect on the local governments' data creation and storage (Fleming 2014). In the past ten years, local governments have noticed the expansion requirements beyond merely mapping and parcel data inventory and more towards determining patterns and understanding data relationships (Alzighaibi et al. 2016; Zeng & Cleon 2018). In addition, GIS technology has recently become mainstream in local government, and increasingly, professionals are gravitating towards working with data, based on which decisional applications are being developed to resolve business issues and enhance efficiencies throughout government entities' departments. Local governments are using these databases for the planning of land and city, such as parks and sub-divisions, roadways and bike trails.

Environmental contamination monitoring and mapping emergency services vehicles like police cars and snowplows are just two examples of how GIS has been put to use in the realm of asset management. Also on the rise is public participation and interaction, as evidenced by the proliferation of web applications that allow citizens to report phenomena such as potholes and crimes directly to their local governments and receive updates on the status of their reports as well as provide feedback on the evolving policies that result (Ganapati 2011).

The geospatial technologies development has garnered governmental agencies and institutions adoption in managing service projects, development plans and initiatives and infrastructure. Such technologies have made their niche in businesses owing to their positive impact on the decisions being made and their role as a platform that includes different types of databases, spatially represented under one united system to bring about the decision-making process. These technologies have been notably adopted in Saudi Arabia through various governmental entities, as mentioned by prior studies in the literature (Alsultana & Rahman 2015).

This may be exemplified by the Saudi Electricity Company's (SEC) creation of a GIS centralized center for developing geospatial tools in providing extensive, accurate and unified data and information on which to base their decisions. In fact, such technological tools have resulted in several planning applications established by the company and other services such as reporting emergencies and maintenance and field teams' management. Moreover, the National Water Company (NWC) has recently taken up systems developed based on geospatial technologies for water and sanitation systems management and to provide customer services (Alsultana & Rahman 2015; Muzafar & Jhanjhi 2020).

Other public sectors have also experienced the use of such technologies, with one of the top distinct sectors being the Saudi Post in an attempt to enhance its service quality. In 2010, the National Address Project advocated for spreading such technologies by pressing other sectors to accept the project results by entering into partnerships with various government and corporate sectors. This also made easy access to spatial data particularly in the circles of systems and applications developers via the website to facilitate maps and spatial data usage from accurate and authentic sources (Alsultana & Rahman 2015; Muzafar & Jhanjhi 2020).

By 2012, Saudi Arabia welcomed the establishment of the GIS Technology Innovation Center (GISTIC) as a research entity to promote awareness and develop geospatial practices in the Kingdom. In addition, the government provided funding for the Space Research Institute (SRI), located in the King Abdulaziz City for Science and Technology. SRI comprises several centers that carry out research, applied research and development, and the implementation of initiatives that support the development of applications in remote sensing and GIS, digital studies, and aviation and satellite technology (Alsultana & Rahman 2015).

However, regardless of the significant support towards adopting geospatial technologies, development and usage, there is yet to be an integrated environment that promotes compatibility among the different agencies. This has led to compounding issues in many sectors whereby most cooperation and coordination in geospatial activities are still in their infancy. Repetitive project issues among various agencies and issues relating to accurate and standardized spatial data remain (Alsultana & Rahman 2015).

Evidently, the field of geospatial technologies adoption in the agencies has been experiencing innumerable activities, particularly those agencies providing residential infrastructure, although the majority of the adoption is designed for spatial data management decision-making development and service quality enhancement in individual delivery of tools. This confines the advantages that such technologies offer to integrated stakeholders (service providers or citizens) as several complex issues may prevent their exploitation from reaping the advantages of being used as tools to overcome the lack of services.

2.4 ADOPTION THEORIES

In professional work environments, GIS technology adoption has become essential for enhancing the performance of firms, particularly in the public sector (Yamamura et al. 2017). Literature has generated several theoretical models based on the acceptance and adoption concept, and these included the Theory of Planned Behavior (TBP) Theory of Reasoned Action (TRA), and the Innovation Diffusion Theory (DOI). Additionally, the Technology Acceptance Model (TAM) has been evidenced as the simplest and most robust model in technology adoption among professionals (i.e GIS). The last several decades have witnessed the advancements of such technologies and evidenced it as the top effective technologies used to view and analyze spatial data (FathiZahraei et al. 2015; Dangermond et al. 2020; Murad & Khashoggi 2020). The use has extended across disciplines and professional workplaces, with organizational and individual hindrances found and reported in the literature regarding the adoption of GIS technology.

This section is dedicated to illustrating and detailing the underpinning IT adoption models mentioned in the literature to provide insight into the extraction of significant factors affecting behavioural intention towards GIS use. The chapter also presents the development of the research model.

Studies on IT adoption, acceptance and use can be traced back to the launching of the computer and IT and based on Venkatesh et al. (2003) study, technology acceptance research takes first place as the most researched area, although recommendations point towards the need to evaluate IT role within organizations and the determinants of technology acceptance integration and use. The proposed theoretical models in the literature include the Technology Acceptance Model (TAM), Theory of Reasoned Action (TRA), Theory of Planned Behavior (TPB), Motivation Model (MM), Model of Personal Computer Utilization (MPCU), Combined Technology Acceptance Model (CTAM), Innovation Diffusion Theory, Unified Theory of Acceptance and Use of Technology (UTAUT), and Social Cognitive Theory. Researchers have selected their models from the above-mentioned models based on their study objectives.

GIS studies have increasingly used UTAUT and TAM as their underpinning models to examine technology adoption (e.g., (Liu et al. 2010); (Gruzd et al. 2012); (Buchanan et al. 2013); (Renda dos Santos & Okazaki 2016);(Grover 2015); (Tosuntaş et al. 2015), (Dwivedi et al. 2019)). However, both models cannot predict future technology acceptance, requiring the integration of other models and theories for prediction accuracy (Venkatesh et al. 2011). According to Ibrahim et al. (2011), the UTAUT and TAM can explain 70% and 40% of the variance of technology acceptance and adoption in businesses, respectively.

Therefore, the present study adopts TAM and De Lone and Mc Lean's IS Success models based on several reasons mentioned in the following sub-section.

2.4.1 Technology Acceptance Model (TAM)

Compared to other models in the literature allocated for adoption, TAM has seen the most usage (Davis 1989), and its various settings and iterations have been analyzed. Lee and applications (2009) argue that their intention-based model is the most commonly mentioned model for explaining technology adoption over the past two decades. This is because the model was established particularly for accepting IT, especially with the organizational level studies (Gangwar et al. 2015; Mukred et al. 2019; Hawash et al. 2020; Legiawan & Sutoni 2021).

The original technology acceptance model has several components: PU, PEOU, AT, BI and actual use (refer to Figure 2.1). Based on the above five components and considering the model's structure, there are ten relationships investigated and they are; 1) perceived ease of use-perceived usefulness, 2) perceived usefulness and attitude, 3) perceived ease of use and attitude, 4) perceived usefulness and behavioural intention, 5) perceived ease of use and behavioural intention, 6) attitude and behavioural intention, 7) attitude and use, 8) behavioural intention and use, 9) perceived ease of use and use, and 10) perceived usefulness and use.

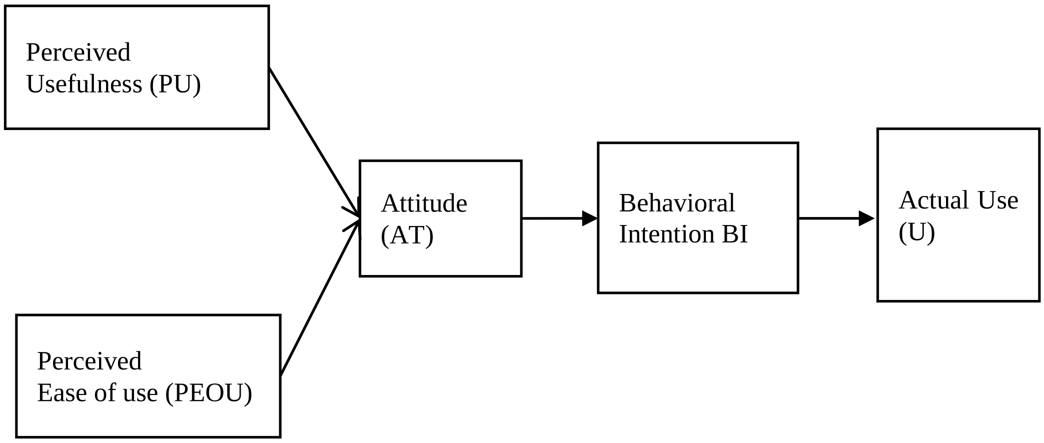

Figure 2.1 Technology Acceptance Model (TAM), (Davis 1989)

According to TAM, perceived usefulness, perceived ease of use, and attitude towards use make up the major determinants of behavioural intention to use or adoption of IT. Both perceived usefulness and perceived ease of use were connected to actual technology use without the mediating effect of attitude as proposed in TAM2 (Davis, 1989) (refer to Figure 2.2).

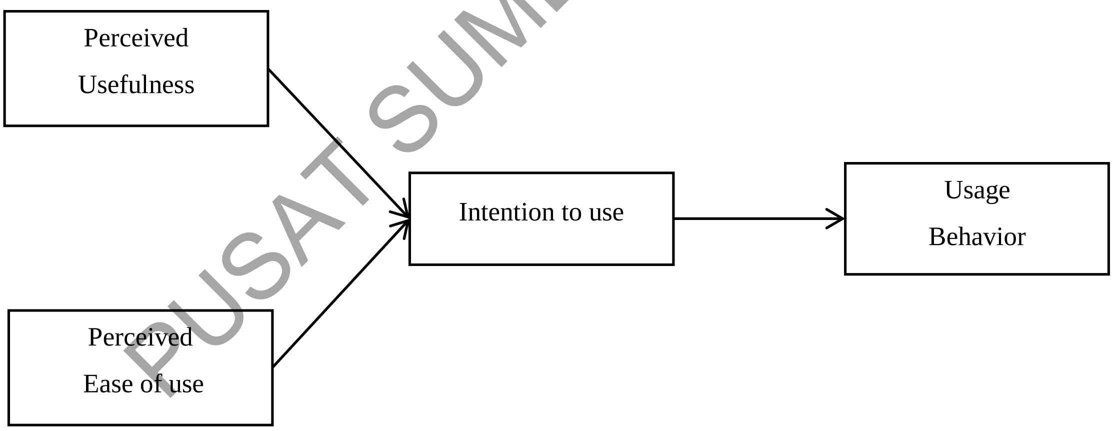

Figure 2.2 Technology Acceptance Model (TAM), (Davis 1993)

TAM proposes that the external variables indirectly affect PEOU and PU. The external variables are presented in Figure 2.3.

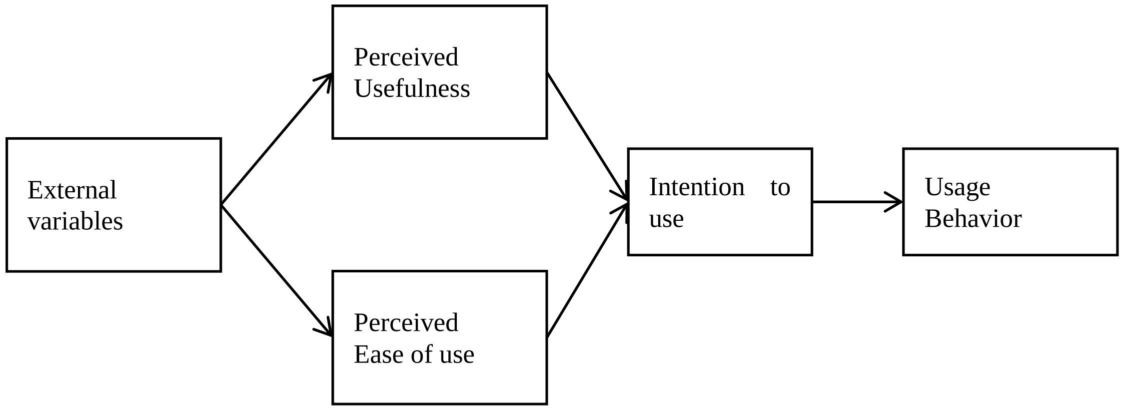

Figure 2.3 Technology Acceptance Model (TAM), (Davis & Venkatesh 1996)

The Technology Acceptance Model (TAM) is a tried-and-true method for predicting whether or not a set of users will embrace a new piece of technology (Venkatesh & Davis 2000). The Technology Acceptance Model (TAM) is a tried-and-true method for predicting whether or not a set of users will embrace a new piece of technology (Aggelidis & Chatzoglou 2009; Legiawan & Sutoni 2021).

There are numerous examples of TAM's use in the context of public sector organizations (Dhagarra et al. 2020; Winarno & Putra 2020). Specifically, TAM has been used in the study of acceptance/adoption in the context of geographic information systems (GIS), with modifications made for each study's goals (Lay et al. 2013; Häggquist & Nilsson 2017; bin Arshad & bin Mohd Sani 2018; Baraka & Murimi 2019; Legiawan & Sutoni 2021).

Therefore, the TAM (Venkatesh et al. 2003) is used as a foundational model in this investigation. Additional factors extracted from literature review and other models combined with perceived usefulness and perceived ease of use are considered factors influencing the intent to adopt GIS in this study.

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

In essence, UTAUT is a TAM extension that integrates new constructs, namely effort expectancy, social influence and performance expectancy – constructs that are assumed to influence behavioral intention and technology use as presented in Figure 2.4 (Venkatesh et al. 2003).

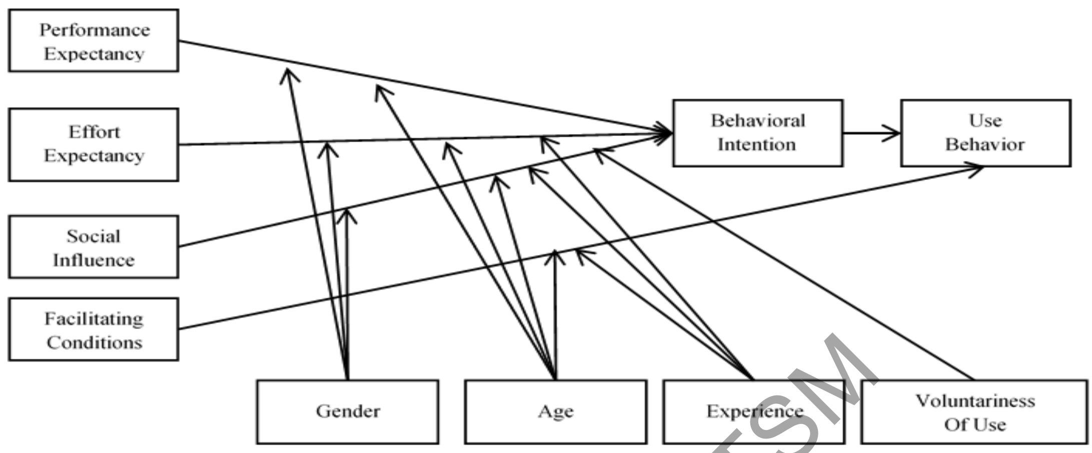

Figure 2.4 The Unified Theory of Acceptance and Use of Technology (UTAUT)

Source:(Venkatesh et al. 2003)

The development of UTAUT was based on eight main competing technology acceptance models based on conceptual and empirical commonalities. The eight models are Fishbein and Ajzen (1975) Theory of Reasoned Action (TRA), Ajzen (1991) Theory of Planned Behavior (TPB), and Taylor and Todd (1995) combined TAM and TPB, Thompson et al. (1991) and Triandis (1977) Model of PC Utilization (MPCU), Bandura (2001) and Compeau et al. (1999) Social Cognitive Theory, Davis (1989) TAM, Rogers (2002) Innovation Diffusion Theory and Davis (1989) Motivation Model (MM).

UTAUT resulted from Venkatesh and Davis' extension of the original TAM model to better understand perceived usefulness and behavioural intention to use, resulting in cognitive instrumental processes and social influence. According to the authors, user behaviour and acceptance are affected by performance expectancy, social influence, effort expectancy, and facilitating conditions. UTAUT covers two additional theoretical factors based on which subjective norm indirectly influences intention through perceived usefulness: internalization and identification. UTAUT proposes a positive influence of subjective norm on image owing to the fact that significant people can influence the person in his/her life – in that they can influence his performance or refrained performance of the behaviour (i.e., acceptance of technology), and this could result in the acceptance of technology or otherwise (Venkatesh & Davis 2000).

UTAUT was further extended to UTAUT2, where Venkatesh et al. (2012) produced enhancements in the variance explained in behavioural intention from 56-74% and technology usage from 70-72%. Figure 2.8 displays the UTAUT model with constructs and new relationships denoted by darker lines.

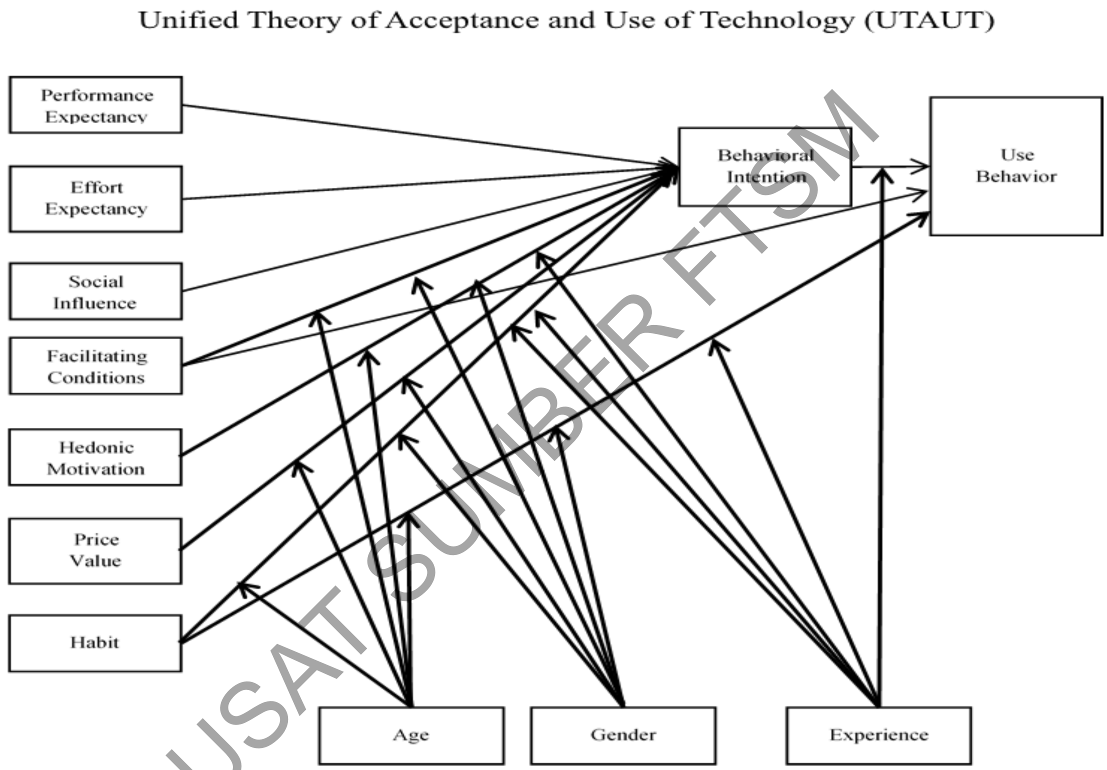

Figure 2.5 The Unified Theory of Acceptance and Use of Technology (UTAUT)
Source: (Venkatesh et al. 2012)

Prior to the adoption concept brought forward by Venkatesh et al. (2003), (Davis 1989) introduced TAM to shed light on behavior towards the use of computers, with distinct relations to the workplace/organization, based on its predecessor, the Theory of Reasoned Action (TRA) by Fishbein and Ajzen (1975). In this regard, most of the IT acceptance theories were built on TRA and TAM, as Bourdon and Hollet-Haudebert (2009) mentioned. Human behaviour that encapsulates attitude, beliefs and internal variables through external variables, which is actual behavior, can be examined through TRA (Fishbein & Ajzen 1975). TAM managed to account for 40% of technology acceptance variance in the workplace, while UTAUT, upon including TAM constructs was able to account for 70% of the technology acceptance variance (Ibrahim et al. 2011).

More importantly, the UTAUT can provide in-depth data analysis compared to the remaining model themes used in qualitative studies in m-library and staff preparedness (Saravani & Haddow 2011). It can also examine pre-service in terms of intention towards ICT use of customers on the basis of consistency (Birch & Irvine 2009). However, Venkatesh et al. (2003) suggested additional studies incorporating other UTAUT variables influencing technology acceptance.

This recommendation holds truth as TAM and UTAUT are viewed as incomplete models (Kim et al. 2015; Lewellen 2015) that do not include all the structures within the operational environment of the user. The findings showed that perceived usefulness (TAM) or performance expectancy (UTAUT) possesses a narrow definition towards describing work situations. In other words, the UTAUT is appropriate to examine individual level, which is not the focus of this study.

2.4.3 De Lone and Mc Lean's Model

De Lone and Mc Lean's model is also referred to as the IS Success Model and it is among the top-mentioned models in literature regarding IS. The model has been used to explain successful IS adoption based on organization and individual levels (Pérez-Mira 2010) and its assists in assessing occupational performance along with its structure – in what is considered as the top significant factors in applying the contingency approach, which presents the computing environment changes aligned with the occupation's strategies and objectives.

De Lone and Mc Lean's (2003) IS success model has several dimensions and interdependencies between success categories. IS success has been defined to match the current IS success definitions and measures. It classified into six major categories: information quality, user satisfaction, organizational impact, system quality, user and individual impact. Figure 2.6 presents the IS Success Model.

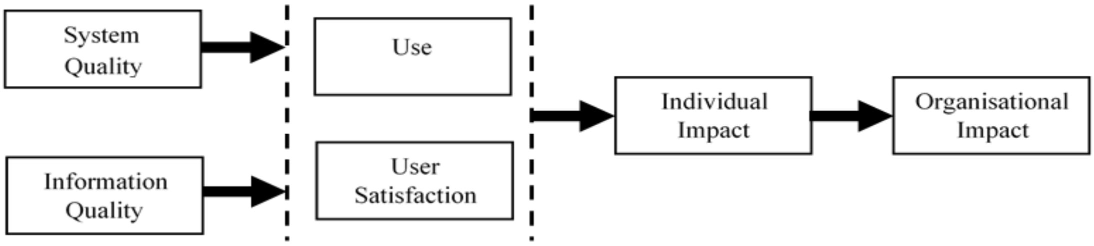

Figure 2.6 DeLone and McLean IS success model

Source: (DeLone & McLean 1992)

The original IS Success Model was further enhanced and validated by De Lone and Mc Lean (1992). In fact, ten years after the initial model, De Lone and Mc Lean (2003) proposed an updated version on the basis of several contributions as well as evaluations and the updated model is displayed in Figure 2.7.

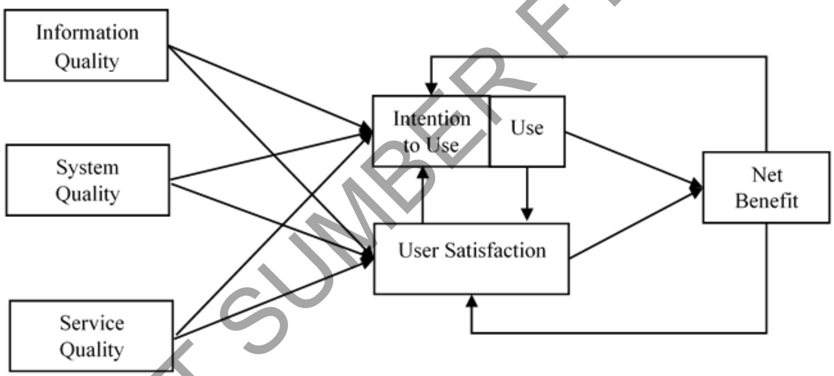

Figure 2.7 Updated DeLone and McLean IS Success Model

Source: Delone and McLean (2003)

Urbach and Müller (2012) study detailed the IS Success Model and provided an overview of its origin. De Lone and Mc Lean's (1992) model had weaknesses, which is why the authors came up with an updated version of it as a result of their work from 1992 to 2003. The major updates in the model are presented in Figure 2.7. The updated model has the quality of service, representing the significance of service in gauging the effects against the factors within the individual and organization that influences adoption.

In addition, system assessments are possible in light of the quality of systems, services and information because they influence the use of intention to use or the satisfaction of using among users (De Lone & Mc Lean 2003). This model is deemed among the more consensus models used to gauge successful IS and has been examined extensively and empirically among public sector firms (Tona et al. 2012; Pushparaj et al. 2022). Therefore, in the present study De Lone and Mc Lean's (2003) updated IS Success model is adopted as another underpinning theory, with qualities of information and service deemed as GIS adoption determinants.

In relation to this, behavioral intention towards technology use needs examination to enable organizations to achieve and sustain their competitive advantage and obtain benefits – such examination is also required to diffuse different technologies types that may contribute to learning and teaching enhancements. The lack of such understanding may lead to failure to adopt and exploit the full effectiveness of technologies, which would also lead to decreased or eliminated long-term sustainability. In a world run by technology, within which dynamic changes are taking place, organizations may lag behind or lose their significant resources if they refuse to keep up (Han et al. 2021; Zaidi et al. 2021; Sharma et al. 2022).

As a result, the present study examines the factors influencing the adoption of GIS to propose a model for improving the performance across the board of the organization. Organizations typically embrace technology for their employees' acceptance and usage. The adoption of theories and models in this study to examine GIS adoption fills the gap in the literature that prevents models from adequately explaining the adoption of GIS. The research suggests an adoption model for GIS by examining the myriad elements influencing people's decisions to use the technology. Models such as TAM and De Lone, and Mc Lean's IS success model provides the basis for the research from which the study's elements are derived.

2.5 FACTORS EXTRACTIONS

The existing literature has investigated the variables that affect people's propensity to embrace innovations (Zeng & Cleon 2018) , and various factors have the capacity to do so, as evidenced by the reviewed studies (Talukder & Quazi 2011; Alzighaibi et al. 2016). Table 2.2 lists the most common approaches used in the literature to identify the factors that influence the adoption of GIS, each of which has advantages and disadvantages, as discussed in depth by Khandelwal and Ferguson (1999) study.

Table 2.2 Techniques for factor extractions

Research method	Authors
Action-research	(Kock et al. 1999)
Case studies	(Holland et al. 1999; Sumner 1999)
Structured interviewing	(Bullen & Rockart 1981)
Scenario analysis	(Barat 1992)
Multivariate analysis	(Tishler et al. 1996)
Literature review	(Esteves & Pastor 2001)
Group interviewing	(Khandewal & Miller 1992)
Focus groups	(MacCarthy & Atthirawong 2001)
Delphi technique	(Brancheau & Wetherbe 1987; Lawley et al. 2001)
Combination of methods	(Khandelwal & Ferguson 1999; Parr & Shanks 2000)

In order to identify the factors that affect GIS technology, surveys are the most common strategy (Shah & Siddiqui 2006; Goni et al. 2012). Factor extraction is a multi-stage process from a literature review to expert interviews.

2.5.1 Factors from the Intensive Literature Review

Researchers looked at existing literature on technology adoption, namely GIS, to uncover commonalities in writers' approaches; from this analysis, they extracted the 57 characteristics listed in Table 2.3.

Table 2.3 Extracted Factors from the Intensive Literature Review

Group of Factors	Factors	Total of Factors
Individual	Attitude, Subjective Norm, Self-Efficacy, Satisfaction, Motivation, Personal Beliefs, Education, Age, Experience, Gender	10
Technological	Effort Expectancy, System Quality, Perceived Ease of Use, Perceived Usefulness, Features Used, Trust, Compatibility, Privacy, Information Technology Challenges, Service Quality, Technological Readiness, Efficiency, Reliability, IT infrastructure, Interactivity, Information Quality, Responsiveness	17

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Organizational	Resources Available , Perceived Financial Cost, Top management Support , Standardization , Change Management, Outsourcing, Social Influence, Facilitating Conditions, Training , Effective Communication	10
Environmental	Clear Vision and Planning, Laws and Legislations, Policy, Government Role, Competitiveness Pressure, Security Concerns, Pandemic Pressure	7
Behavioral Intention to Use/Adopt	Usage Intentions, Habit, Intention to Use, Intention, User Involvement, Relationship with Developers	6
Use / Adopt	Improved Efficiency, User Satisfaction, Performance, Output Quality, Organizational Competence, Perceived Benefits, Decision Making	7
Total		57”

The frequency with which a certain factor is mentioned in the literature does not necessarily reflect the significance of that factor (Finney & Corbett 2007; Ngai et al. 2008). Table 2.4 provides a frequency table for the 20 contributors to GIS adoption.

Table 2.4 Study’s Ranking of the Extracted Factors from Literature Review

No	Factor	Total	No	Factor	Total
1	Top management support	33	11	Competitiveness Pressure	23
2	User involvement	25	12	Security	23
3	Perceived usefulness	30	13	Policy	23
4	Information Quality	28	14	Service Quality	20
5	Effective communication	28	15	Government Role	19
6	Clear vision and planning	27	16	Performance	17
7	Pandemic Pressure	10	17	Intention to Use	17
8	Perceived Financial Cost	25	18	Laws and Legislations	17
9	Change management	25	19	Facilitating Conditions	16
10	System Quality	25	20	Perceived Ease of Use	28

The above table only includes the most often mentioned criteria; the most frequently mentioned factors are shown in bold.

2.5.2 Factors Ranked by Experts

This study followed Hawking and Sellitto (2010) and Ahmad and Cuenca (2013) studies to determine the significance of the factors (refer to Table 2.5). Thus, the above factors were exposed to experts to obtain their feedback on them in light of their influence on the integrated GIS system. Consequently, nine factors were viewed to be the significant factors that influence behavioral intention towards using GIS and, in fact, actual usage.

The experts are selected from related fields such as technology adoption, GIS engineers, IS data analysts, and academicians. Table 2.5 shows the profile of the experts.

Table 2.5 Experts Biography

No	Gender	Field and Expertise	Affiliation
1	Female	Information Science	King Saud University
2	Male	Technology adoption	University of King Abdul-Aziz
3	Male	Technology adoption	Ministry of Transport
4	Male	Technology adoption	Saudi Geological Survey
5	Male	Technology adoption and IS	State Properties General Authority
6	Female	Computer Science	Ministry of Transport
7	Male	Information science	Department of Geography, Umm Al-Qura University
8	Male	Engineering	Saudi Geological Survey
9	Male	Engineering	Saudi Geographical Society
10	Male	Engineering	Ministry of Transport

Experts were shown the aforementioned issues and asked for their opinions due to their potential impact on the integrated GIS system. It was concluded that nine main aspects affect people's intent to use GIS and, by extension, their actual usage. To establish the significance of the factors, this study follows previous research by Hawking and Hawking and Sellitto (2010) and Ahmad and Cuenca (2013) as seen in Table 2.6.

Table 2.6 List of Factors Recommended by Experts

No	Factor	Rank Out of 5
1	System Quality	4.2
2	Pandemic Pressure	4.3
3	Information Quality	4.2
4	Change management	4.3
5	Perceived Ease of Use	4.4
6	Security	4
7	Perceived Usefulness	4.3
8	Service Quality	4.1
9	Competitive Pressure	4
10	Intention to Use	4.1
11	Performance	4.3

This research puts forth a GIS model that incorporates factors that influence the decision to adopt GIS and how effective the adoption is expected for an organization. In addition to variables from De Lone and Mc Lean, such as information quality, system quality, and service quality, and TAM variables, such as perceived ease of use, and perceived usefulness, the study also incorporates additional factors from the literature, including change management, security, competitiveness pressure, and pandemic pressure.

2.6 PRIOR WORKS RELATED TO GIS AND RESEARCH GAP

Differentiating GIS dissemination from other types of technology diffusion described in the literature is the fact that, in this study, technology adoption occurs at the organizational level rather than the personal level. Because of this, it is necessary to investigate the organization's adoption of GIS and how it is disseminated there in order to suit its needs.

Even while countless studies on the spread of GIS technology have been done, only a small number of them focused on underdeveloped countries. In their study, Eria and McMaster (2017) employed a multi-method data-gathering and analytic strategy, and they used the diffusion of innovation (DOI) model to examine GIS uptake in Uganda. The adoption of GIS was decided by its relative advantage over and alignment with existing technologies, given that GIS is defined by a number of communication channels and is impacted by champions and change agents. The adoption rate skewed S-shaped because of government intervention and patronage-based societal norms.

Continuous reforms in the governments of developing nations have encouraged the use of GIS in conjunction with other technologies, such as information and communication ones, for urban area governance. However, as Mukherjee (2018) points out in his study of Surat Municipal Corporation, Spatial knowledge building using GIS has been the subject of little research outside the Western world. Such a corporation is one of the most prominent metropolitan entities in India, and it has been using spatial information and GIS as part of its e-governance initiatives.

Corporations' ability to carve out a place in government's objectives and agendas is only one factor that shapes the spatial knowledge construct in GIS; some influential individuals have been instrumental in bringing about novel developments and rapid shifts in this field, as Mukherjee (2018) demonstrated through an integrated study of GIS.

In a similar work, Abousaeidi et al. (2016) used GIS modelling to find the shortest routes to supply fresh veggies, which lose freshness due to time and temperature. Despite this, transportation difficulties have received little attention in many Kuala Lumpur neighborhoods. Considering the limited shelf life of most perishable foods, this is a big issue because it directly affects the prices that businesses charge their customers. Thus, the correct routes being chosen would reduce overall transportation costs. With the help of a regression model, researchers were able to zero in on the factors that most affect which routes are selected for the quickest delivery of fresh veggies. As a means of resolving complicated network challenges, the authors used ArcGIS software, enhanced with the network analyst extension; the resulting map depicted the most efficient paths for speedy delivery, taking into account all relevant factors.

Also, in Malaysia, Pugi et al. (2016) provided a summarized version of the research method to determine the suitable site to build a new branch for Bank X, specifically in the area of Selangor and Shah Alam. The research method process was divided into three phases: planning, adoption and decision. The planning phase involved data methods and analysis, and the adoption stage involved the creation of a geospatial database and the needed data for making decisions. In the decision phase, the new branch location was examined based on the bank conditions and the location of other banks. The authors concluded that GIS technology is a robust planning and decision-making tool.

Asni et al. (2020), still within the Malaysian context, defined GIS as a technique that facilitates more transparent, accurate, and rapid access to location through real-world spatial data. Their qualitative study conducted a literature review of books, articles, periodicals, fatwa, and circulars on the interaction between Istibdal Waqf and

GIS. Due to the proximity of graveyards to both the Jamek Jelutong Mosque and the Masjid Jamek Sungai Nibong, the writers conducted field research at these two mosques. New land sites depending on system conditions, can be discovered and viewed more clearly and precisely using a GIS approach, as demonstrated by the authors. Based on their research, some mosque administrators and waqf grave heirs were initially less receptive to the Shariah-permitted system notion of the grave than others.

In addition, the risk assessment of dengue hemorrhagic fever (DHF) and its influencing factors was the topic of a study by Chaiphongpachara et al. (2017) that utilized a Geographic Information System (GIS). In order to analyze the DHF patients in the region, eleven (11) different types of data were collected from various organizations. Those include the number of households, population density, altitude, temperature, drainage areas, humidity, areas of residence, rainfall, agricultural areas, and sources of both natural and artificial water resources.

In Ukraine, a study by Lytvynchuk et al. (2020) raised the issue of implementing a brand-new territorial management system based on GIS technology that could help the governance of the developing country's regional public. According to the report, Zhytomyr oblast in Ukraine has been a frontrunner in decentralization efforts across the country. Three fundamental methods were used to compare GIS managing models performance in the world and determine the top practices. These are; the monographic method, the comparative studies and benchmarking. The research results form the basis for a model that improves decentralization and territorial development by providing a platform for developing algorithms that facilitate interaction between public entities and communities.

Additionally, GIS is a robust tool to support disaster risk reduction (DRR). High-income countries and other partners have been called on by international agreements like the Sendai Framework for DRR to support lower-income nations by enhancing their DRR capacities. In addition, Rürup (2017) looked at how different groups have helped build GIS capacity for disaster risk reduction in low- and middle-income countries. The author reviewed the theoretical concepts of DRR, their developmental capacity, and the GIS applications in DRR. The study revealed an array of general initiatives directed towards supporting and enhancing GIS capacities and challenges in the form of culture, politics and power relationships distinctive to the context. Lack of data, high GIS costs, and inadequate decision-making support for GIS are common problems stakeholders face in various settings. Maintaining progress over the long term was also seen as a significant obstacle. The challenges could be overcome and GIS capacity can be made sustainable if the GIS solutions are tailor-made to the specific situation, if low-cost solutions are developed and if GIS is integrated into the organizational structure, and if the GIS advantages for DRR are promoted to the decision-making bodies. This calls for a long-term method and strong participation of stakeholders in the process of capacity development.

In the Mozambique context, Amade et al. (2017) identified the Geographic Information Technologies (GIT) determinants, specifically in light of intention and adoption from the perspective of the institutions in the country. Data were analyzed using PLS, and hypothesized correlations were examined, with the underlying theory including DOI, TOE, and the policy background. Smart PLS 2.0 M3 software was used to estimate the study model, and the results revealed that technological aptitude, security concerns, and the prospect of new competitors significantly influence firms' judgments on whether or not to utilize GIT. While financial factors, government policies, and donor pressure are all important, pressure from donors is the only statistically significant factor in both the desire to adopt and the actual adoption of GIT.

In the context of agriculture, GIS was evidenced to be a technology that drives current methods to precision. Sharma et al. (2018) conducted a systematic literature review (SLR) of 120 relevant works pertaining to Big GIS Analytics (BGA) applications in the agriculture setting using two categories such as level of analytics and GIS applications in agriculture. While designing the BGA framework for the agriculture supply chain, this study considered the many ways in which GIS may be used, such as land suitability analysis, land allocation, resource allocation, site selection, impact assessment, and knowledge-based systems. The framework showed that big data analytics plays a major role in enhancing GIS application quality in agriculture, and it furnishes guidelines for policymakers, researchers and practitioners regarding big GIS data management success in enhancing productivity in agriculture.

In Najran city of Saudi Arabia, Elkhrachy (2015) focused on the GIS role in safeguarding the region from flood by generating a flash flood map for the city with the help of some tools such as GIS and satellite images. Runoff, soil type, surface slope, surface roughness, drainage density, distance to the main channel, and land use are all highlighted in his research as potential contributing factors. The final flood danger map for the city was created using ArcMap and all of the data that was used in the process, while a combination of the flood hazard index map and a layer of zone boundaries, we were able to identify the locations at high risk of flooding.

Aside from the above studies on developing nations, GIS adoption studies (Al Mamun et al. 2021; Huang et al. 2021; Sayed & Fadl 2021) owing to contextual impediments have been few and far between, but examples of GIS adoption through different initiatives, incentives and projects have been mentioned by some studies in the under-examined context. For instance, in Saudi Arabia, Alzighaibi (2017) developed and proposed a GIS adoption model and its outcomes, which he referred to as GISAM. Saudi Arabia's Ministry of Water and Electricity (MOWE) served as a test subject for the model's theories. Several statistical procedures, including regression and correlation analysis, were used for the acquired data. Factors include GIS education, financial rewards, exposure to the technology, management's backing, a sense of purpose, the ability to think creatively, familiarity with geography, the opinions of peers, familiarity with cartography, understanding of cultural values, and social networks were examined. Training, IT expertise, personal innovation, management support, geographical knowledge, cartographic knowledge, social network, peers, and cultural values had a major impact on how people saw GIS. As a result, how people felt about GIS affected how widely it was used. Efficient decision-making, work satisfaction, optimal strategic planning, cost savings, service efficiency, increased customer satisfaction, service quality, reduced risk, and strengthened customer connections were all results and benefits of the system that were examined in the study. Consequently, the study concluded that GIS adoption's significant outcomes included service speed, efficiency, risk management, quality, and customer relationships.

Despite the fact that GIS is becoming increasingly prevalent, very little is known about the factors that truly influence its adoption in the workplace. This is true despite the fact that numerous fields have attested to the benefits of using GIS. Fasteen (2016), examined the factors that mark the common use of GIS in the workplace. The author gave online surveys to property assessment professionals in the U.S. and some other countries, especially those with the ability to access the International Association of Assessing Officers (IAAO) newsletter. This attempt was to find out how easy they thought it was to use, how useful it was, how efficient it was, how they felt about it, how it affected them socially, and if they planned to use GIS technology. Using a structural equation model (SEM) based on the expanded theoretical TAM, the study was shown to explain 86% of the variance within the model, providing support for its excellent fit in predicting assessment professionals' intent to employ GIS technology in their work. Simple GIS apps for visualizing and recording land records management were the most popular among professionals. Their impression of the quality of training they got was a crucial factor in determining their success across all adoption structures.

Added to the above studies, Alqarni (2017) dedicated his empirical study to determine how residential infrastructure agencies can adopt geospatial technology to create strategies that could fully exploit the technologies in the decision-making process. The researcher reviewed government reports and material extensively and used a Delphi study with three consultation rounds. This study concluded that organizational, technological, and human factors prevented the full use of geospatial technology tools in delivering and planning for residential infrastructure delivery. This discovery aided consensus-based approaches to addressing and resolving the challenges encountered and as such, it contributes to practice with the implications for decision-makers in the agencies relevant to the delivery of residential infrastructure to leverage the technologies in order to achieve its best rate of adoption. The findings suggested more studies concerning the development of geospatial technologies usage in the Kingdom.

Finally, Hebert and Root (2019) investigated and explored the use of GIS for infection control in hospital settings. The authors discussed the importance of geographic information systems (GIS) to public health and surveyed previous research on the methodologies' practical uses in this arena. To illustrate the utility of GIS in the hospital setting, we have outlined the potential benefits and drawbacks of using it for infection prevention and evaluated relevant literature. The complexity of the issue under discussion was documented using the adoption, abandonment, scale-up, spread, and sustainability (NASSS) paradigm. The authors went through this approach and discovered the challenges and possibilities, many of which were technological, organizational, and behavioral difficulties. For the most accurate evaluation of GIS's potential impact and usefulness in healthcare settings, further studies incorporating prospective, reproducible clinical trials are needed to overcome these difficulties, and a transdisciplinary strategy was recommended. Table 2.7 compiles research on GIS uptake from several different nations.

Table 2.7 Past Related Work on GIS Adoption

No	Author	Country	GAP
1	(Eria & McMaster 2017)	Uganda	Despite myriad studies having been carried out on the diffusion of geographical information systems (GIS) technology, only a limited number have been done within the context of developing countries
2	(Mukherjee 2018).	India	there have been very few examinations of GIS spatial knowledge construction in a non-Western context
3	Abousaeidi et al. (2016)	Malysia	The need for more investigation for GIS adoption
4	Pugi et al. (2016)	Malysia	The need for more investigation for GIS adoption
5	Asni et al. (2020)	Turki	The need for more investigation for GIS adoption
6	Chaiphongpachara et al. (2017)	Thailand	The need for more investigation for GIS adoption
7	Lytvynchuk et al. (2020)	Ukraine	GIS is usefull and need to be impemented in different fields
8	Rürup (2017)	Sweden	GIS needs more research focus
9	Amade et al. (2017)	Mozambique	GIT adoption is still in its early stage and needs more researchs to be done.
10	Sharma et al. (2018)	India	GIS could be integrated with other tools to help many organizations. The research is still in the early stage.

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11	Elkhrachy (2015)	Saudi Arabia	GIS is useful and could be implemented in different fields
12	Alzighaibi (2017)	Saudi Arabia	There is a need for more investigation, especially at the organizational level
13	Fasteen (2016)	United States of America	The GIS adoption is still in its infancy and needs more attention. New research should be conducted, and new factors to be included.
14	Alqarni (2017)	Saudi Arabia	The GIS adoption is still in its inefficacy and needs more attention. New research should be conducted, and new factors to be included.
15	Hebert and Root (2019)	United States of America	GIS is useful and could be implemented in different fields. More research, specifically prospective, reproducible clinical trials, needs to be done to assess better the potential impact and effectiveness of a Hospital GIS in real-world settings.

Lack of insufficient training skills in GIS, and some other restrictions on its use due to personal data confidentiality and privacy are only a few of the problems that plague GIS technology. This demonstrates that there is variation in how different organizations use GIS technology, even among those engaged in similar tasks.

Saudi government agencies are exploring how GIS and other forms of cutting-edge IT may be implemented to improve efficiency and productivity. Therefore, most IT application projects focus on serving a single division rather than the institution as a whole, leading to a disjointed set of apps that use different data sets. Of necessity government, agencies need a successful adoption blueprint to follow. Due to their shared business tasks and organizational structures, public sector organizations could benefit from a standard model to speed up their adoption of GIS applications.

This study proposes a model for using GIS by government agencies in Saudi Arabia. The study analyzes the literature to determine the factors that affect GIS adoption in order to develop a model tailored to the Saudi public sector. The GIS adoption model illustrates technology's role in supporting performance and includes the factors necessary for organizations in their desire to embrace the system. The model includes nine exogenous factors: information quality, system quality, change management, service quality, competitiveness pressure, security, perceived usefulness, pandemic pressure, and perceived ease of use. The adoption of GIS was evaluated alongside the consequences of GIS adoption on the overall performance of public organizations. It determines the relative importance of each parameter. Previous GIS studies were conducted out of Saudi Arabia and not similar to the Saudi demographics, that's why this study is conducted.

2.7 RESEARCH GAP

Because of its significant impact on business management, GIS is increasingly recognized as one of the most important tools for improving the efficiency of businesses. The study looks at the main problems associated with the most important factors necessary in adopting GIS for promoting performance among public entities in Saudi Arabia, which is an important step in introducing new technologies. The focus of this research is on the relative significance of the elements that influence the rate at which GIS is adopted; these factors are based on theoretical findings, substantiated by the findings of the examined literature, and advised by industry professionals.

The ideas that this research relied on were TAM and the Success Model developed by De Lone and Mc Lean. A total of 40% of the variation in behavioural intentions can be explained by TAM (Lee et al. 2011). Since TAM has been used in previous studies on IS adoption in large organizations, it is an appropriate model for the present investigation.

Based on the literature, the research concludes that there is less research on how GIS is used in organizations and that no model exists to help with a successful adoption. Literature constraints and gaps on the subject of GIS were outlined in this chapter, highlighting the necessity to create a GIS adoption model to ensure widespread uptake.

2.8 SUMMARY

The chapter explained how GIS may help an organization function better and how its model can increase the effectiveness and efficiency of GIS's adoption. According to the

GIS adoption model and the examined literature, GIS plays a crucial role in businesses and, as an asset, boosts their productivity.

The chapter highlighted the need to further additional research on the function of GIS in productivity and performance to provide a solid foundation upon which to build an efficient GIS adoption model. This work attempts to design a model that can guide the adoption of GIS and address any problems that may arise during such an adoption. According to the related research review, there is a significant association between the successful adoption of GIS and the utilization of an effective model to guide such adoption.

CHAPTER III

METHODOLOGY

3.1 INTRODUCTION

Conducting research involves either of the two major approaches or combined, and they are quantitative and qualitative. According to Creswell (2013), technology adoption had a direct relationship to the study objectives, and in this regard, the quantitative approach in research design would contribute to the strength while minimizing the weaknesses. In quantitative research, the primary objective is to test the theories by testing the relationships among the study variables, and the main objectives of the present study appear to align with the quantitative approach.

3.2 RESEARCH PHASES

In an operational research framework, the entailed procedures and methods are provided to complete the research. Figure 3.1 presents the operational research framework according to the research method laid down by Creswell (2013). On this basis, the research methods focus primarily on determining the answers to the research questions and achieving the research objectives. There are five primary phases to the present study, and they are (refer to Figure 3.1);

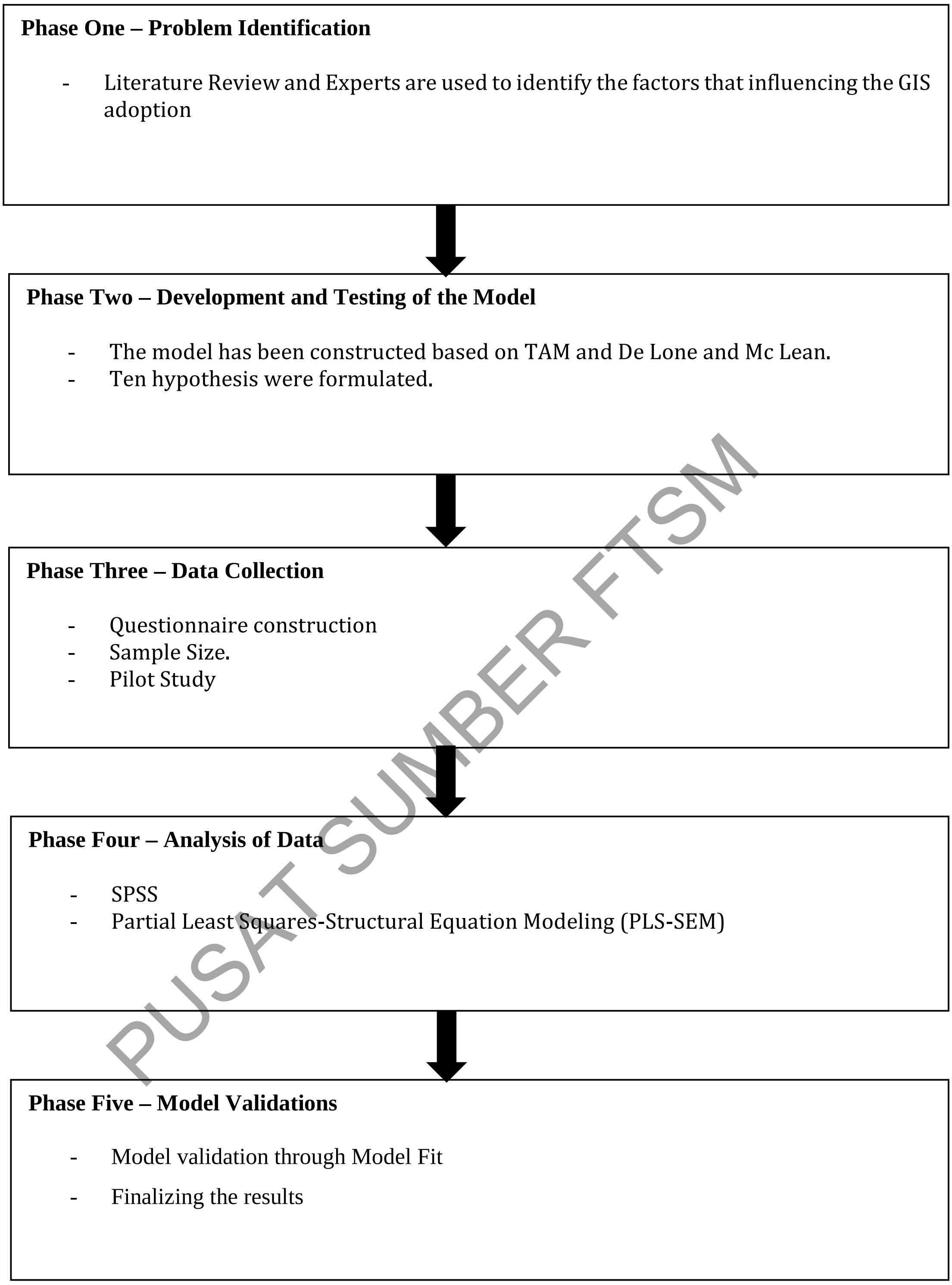

Figure 3.1 Research Operational Framework

The summarized research phases are presented in Table 3.1, involving defining activities, objectives, instruments and outcomes. Figure 3.1 enumerates the phases of research, including preliminary study, literature review, model development and survey to tackle the first and second objectives. The fourth and fifth phases, namely data analysis and case study, relate to the third and fourth objectives, which involve validating and evaluating the proposed GIS adoption model among PSOs.

3.2.1 Phase One – Problem Identification

This stage is characterized by identifying the factors influencing GIS in Saudi Arabia. In effect, the problem statement is defined and the related literature is reviewed, particularly concerning performance caused by using GIS. Specifically, the first phase of the research covers defining the problem, formulating research questions and objectives, and reviewing the literature regarding GIS adoption theories, GIS adoption, behavioural intention and performance. After examining a certain area of study, relevant information sources are determined based on previous work on the subject and its current situation. Often, research may stumble upon specific aspects that need in-depth examination through revising what has already been reported and revealed concerning the topic.

To begin with, the research problem regarding the lack of GIS adoption models are defined in the preliminary study and literature review phase. Through a thorough review of prior studies, the researcher can go through the outcomes left for follow-ups and full exploration. The subject is examined deeply to ascertain what needs to be studied and the reason behind such aim – the problem is then viewed from a more general perspective to pinpoint the issues that should be taken into account. The gap in prior studies is highlighted, after which the questions are formulated to achieve the study objectives. In this phase, the input is the reviewed past studies concerning the topic upon which the study problem was based, and the output is the formulation of research problems, research questions, and research objectives concerning the factors that influence GIS among public sector organizations. This phase is presented in detail with full discussions in the first and second chapters, which fulfilled the first objective.

3.2.2 Phase Two – Development and Testing of the Model

In this phase, the input consisted of the factors influencing GIS adoption among Public Sector Organizations (PSOs) and studies reviewed in the literature. The phase involved the development of the study's conceptual model, which the TAM underpinned. Then, the framework encapsulates the primary elements of internal factors crucial for GIS. The phase outputs include the research model, the identified nine relationships among the constructs in the model, and the formulated ten hypotheses. Finally, the phase is discussed in detail in this chapter (Chapter 3), which fulfilled the second objective.

3.2.3 Phase Three – Data Collection

After reviewing the literature, this phase develops and designs the questionnaire in that the questionnaire items were culled and adopted from prior studies of the same caliber. This third phase involved relating the issues to the selected data collection method used in the thesis. The first step entailed designing the questionnaire based on the research framework and hypotheses formulated in the second phase. Prior literature was also used as a guide to measuring the constructs. The size of the sample is defined and the developed tentative questionnaire is tested through a pilot study prior to the actual study – such a pilot study has a bi-purpose, the first of which is to consult the field experts to enhance content validity and the second is to examine the questionnaire reliability prior to the actual study. Following the instruments' validity and reliability confirmation, the actual survey will be conducted on the PSO in KSA. The pilot study results will be analyzed using descriptive statistics SPSS version 25. In this phase, the output includes the final research instrument and the sample size. The phase is presented and discussed in detail in this chapter.

3.2.4 Phase Four – Analysis of Data

The fourth phase analyzes data through coding and classification based on the developed classification scheme. The coding of responses entailed transcribing data from the questionnaire using a coding sheet, which is then entered manually into the computer. Data were then entered into the SPSS software program to be analyzed using Partial Least Squares-Structural Equation Modeling (PLS-SEM) – the software was also used to examine the research model, determine the relationships among the constructs, and test the formulated hypotheses. In data analysis, testing the hypotheses is the top important step. Specifically, the hypotheses were formulated based on the research framework and tested using appropriate and effective statistical analyses, which in this study is the PLS-SEM, owing to the size of the sample, the complexity of the model and the number of manifest and latent variables, following the suggestions of studies in the literature (e.g., (Hair Jr et al. 2016);(Henseler et al. 2014)). Finally, the third objective accomplished with this phase is detailed in chapter four.

3.2.5 Phase Five – Model Validations

Under the fifth phase, the model validation results are interpreted, and the research implications are enumerated. Recommendations for future work are also provided based on the results. Table 3.1 shows the research phase details.

Table 3.1 Research Phases Details

Phase	Activates	Objective	Instrument	Outcomes	
Preliminary Study and Literature Review	Problem definition	To understand the background of the problem	-	Problem statement	Research Objectives 1 and 2
	Formulating research questions and objectives	Formulating research questions and objectives	-	Research questions and objectives	
	Literature review	To review the literature covering /General adoption, GIS adoption theories.	-	TAM model	
Development Model and Test	Propose the research model	To propose the research model	-	Research model	
	Derived the research hypothesis	To derive the research hypothesis	-	Research hypothesis	
Survey	Questionnaire development	To develop a tentative questionnaire	Questionnaire	An initial research instrument (questionnaire)	
	Define study population and sample size	To define the study population and sample size	-	Sample size	
	Pilot Study	To validate and verify the questionnaire and to revise the questions	SPSS v.25	--	
	Questionnaire refinement	To necessary change and refine the tentative questionnaire based on the pilot test	-	A validated and reliable questionnaire	
Data Analysis	Actual survey-data collection	To survey to estimate the number KSA PSOs which have adopted GIS in their organizations	Questionnaire	Quantitative data	Research Objectives 3
	Data analysis	To analyze the quantitative data by using SPSS and partial least squares (PLS), a variance-based structural equation modelling (SEM) tool in order to test the research model in view of PLS's ability to operationalize a latent construct	SPSS v.25 and SEM- PLS 3.0	A set of revised determinants influencing GIS adoption tested hypothesis; a refined, integrated theoretical framework for adoption of GIS by PSO	
Model Validation by SEM	Model validation	To validate the research model	Smart PLS 3.0	Validation of the research model via F^2, H^2 and GOF criteria	
	Hypothesis testing	To test the research hypothesis	Smart PLS 3.0	Hypothesis results	
	Model Validation	To evaluate the applicability and usability of the proposed model quantitatively.	Smart PLS 3.0	Assessment the completeness and credibility of the proposed model	

3.3 MODEL CONSTRUCTION

The success or failure of GIS projects depends on the managerial and technical aspects found in the organization, as mentioned in prior studies (Hawking & Sellitto 2010; Hawking & Sellitto 2010; Hawking & Sellitto 2017). Managers need to concentrate on the factors for the successful adoption of GIS in organizations.

GIS's success is quite challenging due to unexpected cropping up of issues, which are discussed in this study through the model proposed based on the identification of the taxonomy of dimensions crucial to the system. Appropriate factors are highlighted as the model's operational variables.

3.3.1 Operational Variables and Hypotheses

The first factor in the developed model is system quality. System quality is represented as the IS measurements (DeLone & McLean 1992) and provides output in the information processing system. In addition, it evaluates the system's overall technical soundness and the processing quality of IS, including its data and software components (Gorla et al. 2010).

It is hypothesized that the system quality will substantially impact the information system's efficacy, which can be defined as the extent to which the information system can accomplish the tasks for which it was designed. The quality of a GIS system can be tested by making use of the relevant access reports and services; hence, the study suggests the testing of the following hypotheses;

H1: Perceived system quality has a positive relationship with behavioural intention to adopt GIS.

Regarding the quality of the information, it is defined as the extent to which an information system successfully accomplishes the goals for which it was developed (Mukred & Yusof 2017). Poor quality information can negatively affect the organisation's tactics, strategies and operations (Gorla et al. 2010). When evaluating an information processing system, the characteristics of system quality are quite helpful, while the characteristics of information quality are beneficial when performing evaluations of the system's inputs and outputs (Paggi et al. 2021).

The accuracy of the information that is produced by the system is another factor that contributes to how valuable people think the system is (Lin & Lu, 2000) – to put it another way, as per some empirical findings like those presented by Mukred and Yusof (2017), the quality of the information has a considerable link with how often the system is used. IS that generating high-quality information can significantly boost a user's satisfaction with the services being provided; as a result, information quality has a considerable bearing on the rate at which GIS is used. Thus, the study suggests the testing of the following hypotheses;

H2: Perceived information quality has a positive relationship with behavioural intention to adopt GIS.

The third component of the suggested conceptual model is service quality, defined as the difference between the user's normative expectations level of the service and the user's perception of the actual service performance level (Paggi et al. 2021).

In the revised model of Delone and McLean (2003), service quality is considered to be a new dimension in their model. In addition, they summed together all the different ways these effects were measured into one overall effect that they called net benefit. This study assesses the GIS service quality in terms of the timeliness, accuracy, completeness, and proper provision of these elements. This research investigates in detail the following hypothesis concerning this construct;

H3: Perceived service quality has a positive relationship with behavioural intention to adopt GIS.

Another key aspect of the problem at hand is change management, and GIS's use in this context demonstrates the transformations that have taken place within the company. Change management is a technique that is used for making management efficient and effective, and it might require a serious shift to current models instead of traditional ones. This shift is necessary in order to implement change management. Regarding GIS, change management is necessary since personnel need to be ready to adapt to the various changes. The company must have a comprehensive change management plan in place to address issues like employee resistance, redundancies, errors, and ambiguities associated with the new model's implementation (Sánchez‐Prieto et al. 2019). Employees that are more interested in their work will have a better understanding of the benefits, which will make them more capable of utilizing the new model (Huang & Yasuda 2016) and consequently, the following hypothesis is put forward for consideration;

H4: Perceived change management has a positive relationship with behavioral intention to adopt GIS.

The rising degree of competition, both locally and worldwide, is another cause that pushes businesses to look for ways to improve their efficiency and effectiveness by adopting strategies (Azadeh et al. 2012). In other words, governments have been given a cause to take advantage of new ways to prosper due to the dynamic rivalry and technological improvements that have occurred all over the world, as well as the developments that have occurred in digital technology. Because of this, the delivery of government services has shifted away from the use of conventional techniques and toward the use of electronic ways (Cartman & Salazar 2011) and based on the aforementioned review of previous studies, this study proposes the following hypotheses;

H5: Perceived competitiveness pressure has a positive relationship with behavioral intention to adopt GIS.

Pandemic pressure is another factor to play a main part in the adoption of new technology, and the utilization of GIS necessitates disseminating information and instruction to users to address a wide range of problems. Training of users plays a significant part as a determining factor in the effectiveness of overall GIS use (Collins & Mitchell 2019; Al Mamun et al. 2021). Users who are equipped with knowledge of the concepts underlying the new model are better able to develop a favourable attitude toward the use of the new model, are less likely to be firm in their opposition to the use of the new model, and readily accept it. The participation of users is also beneficial for the examination of GIS configurations, the conversion of data, and the testing of models (Chen & Chen 2021).

This study seeks to answer the following hypotheses about the relationship between Pandemic Pressure and the need for immediate training in order to facilitate the widespread adoption of the system and the realization of its benefits, this study tests the following hypotheses;

H6: Pandemic Pressure has a positive relationship with behavioural intention to adopt GIS.

The TAM model describes "perceived ease of use" as the degree to which an individual is confident that employing a certain system will not require significant effort (Davis 1989). Within the context of the current research, the term "perceived ease of use" refers to the manager's and employee's impressions of the lack of effort required to use GIS. The intention to use and the adoption of a product or service are influenced by how easy it is perceived to utilize it (Venkatesh et al. 2012).

In addition, several studies have shown that the perceived simplicity of using a system has a major impact on the individual's intention to use the system (Arpaci 2019; Canillo & Hernandez 2021) and the degree of perceived simplicity of a system's interface has a considerable bearing on whether or not the user intends to adopt the system (Canillo & Hernandez 2021). Therefore, it is suggested that the following hypothesis is to be tested;

H7: Perceived ease of use has a positive relationship with behavioural intention to adopt GIS.

On top of that, a person's level of confidence that employing a given system will boost his productivity at work is what's meant by "perceived usefulness." (Davis 1989).

In a similar study, Vathanophas et al. (2008) used TAM to determine how openly Thai Navy officers used the Internet. What we perceived is that users' expectations of usefulness have a major bearing on their actual behavior. Furthermore, Venkatesh et al. (2012) found that behavioural intention to adopt IS is significantly predicted by performance expectancy (perceived usefulness) and effort expectancy (perceived ease of use).

Perceived usefulness, which has been examined concerning the system's capacity to improve performance, productivity, and effectiveness, is defined in the current study as the perception of managers and employees of the GIS's usefulness. Perceived usefulness affects whether people would use and embrace a system, according to several empirical research published in the literature (Zeng et al. 2021). The following hypothesis is suggested to be tested in light of the discussion above;

H8: Perceived usefulness has a positive relationship with behavioral intention to adopt GIS.

Last but not least, the information system's security is overseen by upper management, although it affects every organizational department. In this regard, the records of manufacturing, sales, financial transactions, customer interactions, and educational activities are all kept on computers in the present day and age, so they can be accessed whenever necessary and from anywhere in the world. Personal and confidential information can be found in the records kept by banks, financial institutions, insurance organisations, hospitals, and laboratories. Additionally, credit card information must be provided to complete online transactions– Because there is no foolproof method for determining whether or not an organization can be trusted to maintain the confidentiality of the information and promote information security, the safety of these records and this information is in jeopardy. According to the current research findings, security may be defined as the characteristics and procedures observed when dealing with organizational assets.

In relation to the aforementioned, several studies found that the perception of security substantially impacts their propensity to accept newly developed technologies

(Adu & Ngulube 2017; Tagliabue et al. 2020). The researcher puts forward the following hypothesis after considering this conversation and its implications;

H9: Security has a positive relationship with behavioural intention to adopt GIS.

After the implementation phase is complete, the company must create a strategy that considers the GIS's goals and provides a road map for the future (Nah et al. 2003; Ngai et al. 2008). Decisions regarding the initiative's implementation should be made in advance using input from management team members, and the initiative itself should be treated as a top priority (Remus 2007).

Relocating to intention to use, this refers to the intention of user's toward the application of new technological developments as well as the likelihood that the user will employ a specific type of system (Seymour et al. 2007). Alok and Mocherla (2016), confirmed the TAM hypothesis that the motivation to act is the determining factor in how people use new technologies. Furthermore, the results corroborated TAM's hypothesized link between intent to use and actual uptake of new systems. It is possible to argue that the purpose to use technology is the primary factor in related to the intention to accept it.

In comparison, the performance of any organization can be defined as fulfilling its obligations to its shareholders and pursuing the greatest possible profit (Yang et al. 2011; Al-Momani et al. 2019). According to previous research, two components—financial performance and market performance—are necessary for a complete understanding of business performance.

It is clear that the goal to change behaviour had a direct impact on the rate of GIS adoption (Henrico et al. 2021) and consequently, the following hypothesis is proposed in this study based on the aforementioned considerations;

H10: Behavioral intention (BI) to adopt GIS has a direct significant and positive effect on the performance of Saudi's private sector GIS.

3.3.2 GIS Conceptual Model and Study Hypotheses

Nine hypotheses were developed for each of the exogenous elements in this study's ten hypotheses, which proposed the influence of factors on the behavioural intention to use GIS. The tenth and final hypothesis (H10) addresses the influence of GIS adoption on organizational performance, whereas the first nine address the effect that GIS factors have on behavioural intention towards adopting GIS. These GIS factors include system quality, information quality, service quality, change management, competitiveness, pandemic pressure, perceived ease of use, perceived usefulness, and security. The components must be brought into alignment with one another to comprehend the adoption of GIS and, consequently, the effect that such adoption has on the organisation's performance. It is impossible to obtain all of the benefits of GIS without first matching the factors. Figure 3.2 illustrates the primary research hypotheses and the study constructs corresponding to those hypotheses. Table 3.2 shows the hypothesis of this study.

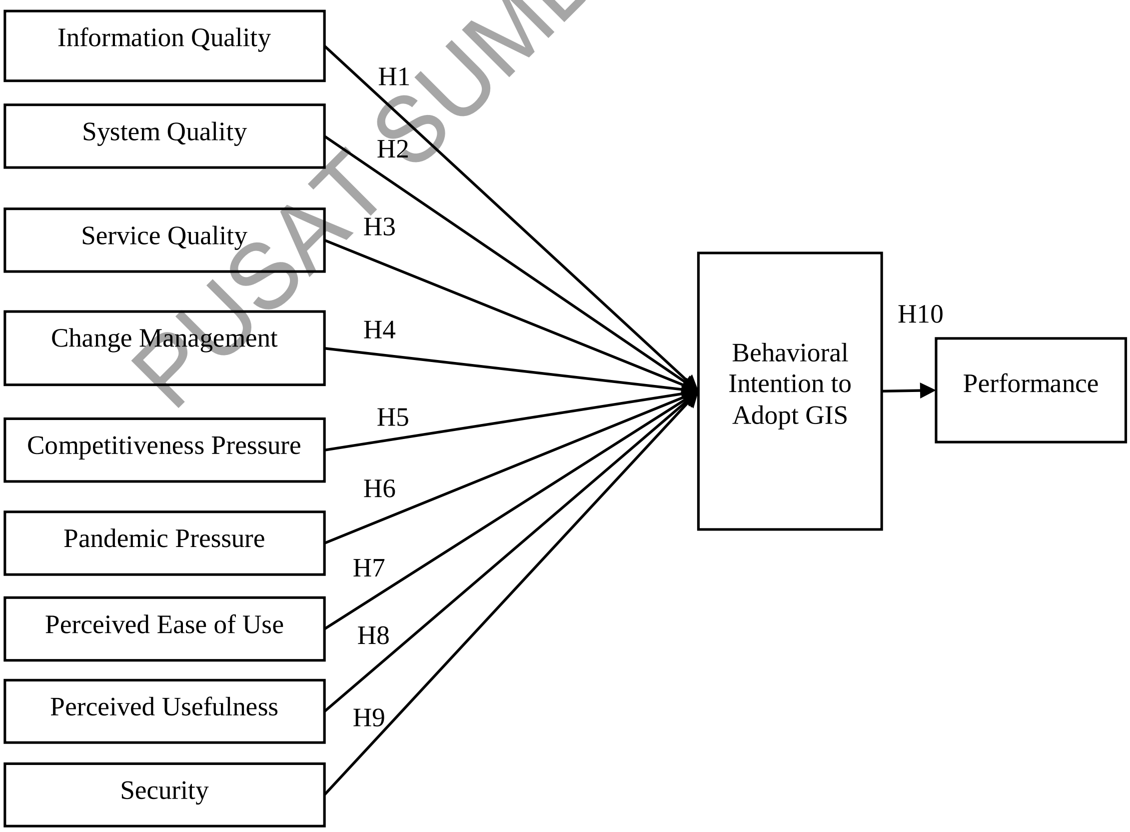

Figure 3.2 GIS Proposed Conceptual Model and Hypothesis

Table 3.2 Research Hypotheses

No	Hypothesis
H1	Information quality has a positive relationship with the intention to adopt GIS
H2	System quality has a positive relationship with the intention to adopt GIS
H3	Service quality has a positive relationship with the intention to adopt GIS
H4	Change management has a positive relationship with the intention to adopt GIS
H5	Competitiveness pressure has a positive relationship with the intention to adopt GIS
H6	Pandemic pressure has a positive relationship with the intention to adopt GIS
H7	Perceived ease of use has a positive relationship with the intention to adopt GIS
H8	Perceived usefulness has a positive relationship with the intention to adopt GIS
H9	Security has a positive relationship with the intention to adopt GIS
H10	intention to Adopt GIS has a positive relationship with use/performance.

3.4 RESEARCH DESIGN

Research design is the structured group of sequential steps to maintain the direction of research (Creswell 2013), and there are two main methods for conducting research, namely quantitative and qualitative methods, or their combination. The method selection is based on the research objectives. The combination of both approaches contributes to the strengths of both methods while minimizing their weaknesses.

To begin with, the quantitative approach tests theories by testing the relationships among the variables, whereas its qualitative counterpart examines and clarifies the meaning of individual attributes, group attributes, or human issues. Researchers in IS often stress using either qualitative or quantitative approaches despite their combined use garnered intense scrutiny (Orozco et al. 2015).

In this regard, quantitative design is thus appropriate in the area of GIS as it is complex, and thus, a single method will do it justice in terms of understanding the phenomenon (Almoawi & Mahmood 2011), and due to this, the present study adopted the quantitative approach.

In quantitative approach design, two major criteria have been mentioned in the literature: priority and implementation. Priority is the selected method to be highlighted in the study, and it is identified through the research objectives (Creswell, 2013). In this study's case, the objectives can be achieved using the quantitative approach and thus it is primarily used for data collection.

In the second criterion, the method of implementing the approaches in data collection through a questionnaire (Creswell 2013) and so in the present one, details will be presented in this chapter.

According to the previous discussion, this study used a quantitative method to obtain the most optimum results and clarify the phenomenon through supported results. Thus, the study involved quantitative data collection and analysis, where data was gathered from the managers/owners for hypotheses testing and research model validation.

3.4.1 Development of the Questionnaire

Churchill and Iacobucci (2010) followed step-by-step instructions on questionnaire development in this study, with every phase entailing the determination of information for pre-testing and revising the contents. Studies like Malhotra and Birks (2007) established guidelines for traditional survey design.

Survey design guidelines were used to develop the study model and to identify the factors contributing to the adoption of GIS, and in turn, such adoption's effect on Saudi PSO. Prior studies validated measures regarding IS adoption were adopted. The study drew up a cover letter within which a brief study explanation and the objectives to be achieved were enumerated to encourage the participation of the respondents and their completion of the questionnaire – this was then attached to the questionnaire (refer to Appendix B for a cover letter). There are different parts to the questionnaire, with each part's contents dedicated to a set of items and instructions for a correct understanding of the items and their complete responses. The respondents were thanked for their cooperation, effort and time in completing the questionnaire.

The questionnaire has four parts, wherein items dedicated to demographic information, factors, GIS adoption factors and performance were listed. The respondents were asked to tick the relevant items based on their best knowledge and information. The items were measured using a 5-point Likert scale with the following agreement levels; 1 (strongly disagree), 2 (disagree), 3 (neutral), 4 (agree) and 5 (strongly agree).

In the first part of the survey, items were provided to obtain the demographic details of the respondents, and their organizations, which included gender, age, education level, experience in the current position, and organizational information.

In the second part of the survey, items measuring the factors influencing the adoption of GIS are concerned with system quality, information quality, service quality, change management, competitiveness pressure, pandemic pressure, perceived usefulness, and perceived ease of use. Meanwhile, the third part of the survey measured the intention of using GIS. Finally, the fourth part of the survey is dedicated to items measuring the role of GIS technology in light of its contribution to the performance of the PSO.

3.4.2 Survey Instrument Measurement

In this study, the latent variables include information quality, service quality, change management pandemic pressure, competitiveness pressure, perceived usefulness and perceived ease of use. Aside from the above variables are GIS adoption and organizational performance. A summarized view of the factors is presented in the conceptual framework. In the next section, the variables' details are presented and discussed.

a. Measurement Scale of Exogenous Factors

Based on their contribution to the adoption of GIS, the exogenous factors are system quality, information quality, service quality, change management, competitiveness pressure, pandemic pressure, perceived usefulness, and perceived ease of use. Prior studies' measurements of the factors were adopted in this study (refer to Table 3.3).

Table 3.3 Measurement scale for exogenous factors and their sources

No	Factor	Questions	Reference
	Perceived System Quality	The GIS should:	(Mukred & Yusof 2017; Um 2021)
1		work without crash	
2		run smoothly	
3		Be available continuously	
4		Be available for government agencies and administrators	
5		Be available to provide information and services	
	Perceived Information Quality	The information provided by GIS are:	(Mukred & Yusof 2017; Xin et al. 2022)
1		Information that is free from errors	
2		correct information	
3		precise information	
4		sufficient information	
5		accurate information	
	Perceived Service Quality	The GIS assist us in providing:	(Gorla et al. 2010; Qalati et al. 2021)
1		timely services	
2		right services	
3		accurate services	
4		complete services	
5		dependable services	
	Change Management	Change management in GIS adoption:	(Oumran et al. 2021)
1		Ensures that employees understand how their work fits into the system	
2		Receives input from employees about how their jobs will change	
3		Actively works to alleviate employee concerns	
4		Makes available a support group to answer concerns about job changes	
5		Roles of all employees are clearly communicated	
	Competitiveness Pressure	With GIS adoption:	(Oumran et al. 2021)
1		My job frequently requires me to rely on the GIS.	
2		My everyday tasks require me to frequently need the GIS's support.	
3		I frequently have to use the GIS to meet my work obligations.	

to be continued…

… continuation

4		am expected to use the GIS all the time to meet my work obligations	
5		GIS is vital to ensure competitiveness.	
		During the Pandemic of Covid-19	
1	Pandemic Pressure	We use the system more than before	
2		We completely depend on the system	
3		We use the system to comply with regulations by the health	
4		The system is considered vital during the pandemic only	
5		Without this pressure, organizations won’t think to integrate the whole functions of the system.	
		How easy is GIS to use:	
1	Perceived Ease of Use	GIS is easy to use	
2		GIS can be used without referring to a user manual	(Venkatesh & Davis 2000; Tahar et al. 2020)
3		GIS is flexible for interacting with	
4		It is easy to get information using GIS to do what I want to do	
5		It is easy to detect and correct errors in student records using GIS	
		How useful is GIS:	(Venkatesh & Davis 2000; Tahar et al. 2020)
1	Perceived Usefulness	GIS enhances my work effectiveness.	
2		GIS increases my productivity in my work.	
3		GIS enables me to accomplish tasks more quickly.	
4		GIS makes my work easier.	
5		GIS gives me greater control over my work	
		How is the security level in GIS:	
1	Security	Security features are a factor in choosing whether or not GIS.	(Jeong & Shin 2020; Tahar et al. 2020)
2		The organization protects its information assets adequately.	
3		I believe my business unit will survive if a disaster results in the loss of electronic records.	
4		I believe that the GIS I work with is adequately protected.	
5		I feel safe in the environment I work in.	

b. GIS Adoption Measurement Scale

Adoption is the act of accepting a new thing and using it (Saya et al. 2010). Thus, technology adoption is the decision concerning the use of innovation as a top action course Rogers (2003), and within an organization, adoption is the acceptance of new innovation implementation (Deering et al. 2012). This study refers to adoption as the acceptance of GIS usage as an innovation among PSO in Saudi Arabia and four items were adopted from the literature to measure the construct. The items and their sources are tabulated in Table 3.4.

Table 3.4 Measurement scale for behaviour intention on GIS Adoption and their sources

No	Factor	Questions	Reference
	Intention to Adopt GIS	My intention regarding GIS adoption is:	(bin Arshad & bin Mohd Sani 2018; Oumran et al. 2021)
1		Assuming I have the GIS, I intend to adopt it.	
2		Given that I have the GIS, I predict that I will adopt it.	
3		In my work, if I have GIS, I want to use it as much as possible.	
4		I prefer to use the electronic records even though I can do my work with other tools.	
5		GIS is important to my work and I need to adopt it.	

c. Organization Performance Measurement Scale

Measuring performance would enable the effective running of the organization by managers Ketikidis et al. (2006), and the development and enhancement of a thing are impossible without its measurement (Deming & Edwards 1982). Thus, organizational performance enhancement needs performance to be measured in order to highlight the use of resources for the entity's performance (Gadenne & Sharma 2009).

This study adopted subjective measures for performance from Valmohammadi (2011), Brah et al. (2000), and Jaworski and Kohli (1993). Table 3.5 tabulates the items and their sources.

Table 3.5 Measurement scale for organizational performance and their sources

No	Factor	Questions	Reference
		GIS:	
1	Organization's Performance	Our overall competitive position is strong in our business sector.	(Mukred et al. 2019; Khayer et al. 2020)
2		The profitability of our organization is reasonable relative to the overall performance of our business sector.	
3		Compared to the time before the adoption, I judge the quantity of the work to be much better with GIS.	
4		GIS provide efficient management that will enhance overall performance.	
5		The GIS provide effective management to plan the work so that it is done on time.	

3.4.3 Survey Validation and Translation

For the purpose of the questionnaire's validity confirmation, a face validity test was conducted by a team of experts to confirm the instrument's ability to measure what it is intended to measure. According to Han et al. (2010), formal or informal face validity is required prior to the actual distribution of the questionnaire. All the items were adopted from prior studies, which indicates their validity had already been tested in original studies. Nevertheless, owing to the differences in the scope and environment of the present study from the previous ones, a formal face validity test was conducted with the help of ten experts that gave their feedback for adjustment and modification of questionnaire items.

The ten experts were five academicians, with two hailing from, three from UTM and two from Saudi, and two other practical experts in GIS adoption that are familiar with survey questionnaires in IS research. Their inputs were used to delete and restructure some items in the questionnaire.

Moreover, the researcher conducted follow-up discussions with the experts to clarify the ambiguities in the questionnaire items. Modifications were mainly to exclude wrong vocabulary and grammar, typo errors, duplicate meanings, long sentences, and words that are difficult to comprehend.

After that, the original English questionnaire was translated into Arabic following established procedures. The translation requirement stemmed from the fact that the study sample comprises Saudi, whose understanding of Arabic is better than English, on account of the fact that the former is their mother tongue. A Saudi translator was selected as Hendricson et al. (1989) stated that a translator who speaks the same native language is preferred.

A quality translation task is better achieved when two different translators are used, enabling error detection and different interpretations of ambiguous items in the initial version (Guillemin et al. 1993). Therefore, the instrument was translated by an authorized translation office called The Legal Translator Office, after which the Arabic version was back-translated into English and verified by Najed Language Centre. The two translators were unaware of the original instrument, and as such, they were free from biases and expectations – this ensured that any unexpected meanings were highlighted in the final version (Guillemin et al. 1993). Both versions of the questionnaire are attached in Appendix A and B.

3.5 POPULATION AND SAMPLING FRAME

The population is the group of people/objectives/things based on which the sample is taken, and a sample refers to a population segment chosen to be studied (Bell et al. 2018). The literature proposes two main sampling method types: probability and non-probability sampling. Each type has its categories and sub-categories, and the major difference between the two types is that in probability sampling, each entity has the same opportunity to be selected, while in non-probability sampling, the chances of being selected to be in the sample are unknown (Thornhill et al. 2009; Bell et al. 2018).

The present study's population covers one PSO in Saudi Arabia, the ministry of transport and logistics services. There were several criteria considered when choosing the sample from the population: experience with e-service applications or GIS initiatives in business or part of the business. The study respondents were the PSO managers, who are the main overseers of business in most organizations.

The sample includes 232 respondents taking into account the recommendation of Krejcie and Morgan (1970), who suggested this amount when a population reaches of 580 employees. It is also recommended by Rao soft tool (http://www.raosoft.com/samplesize.html).

3.6 DATA COLLECTION

The questionnaire copies are self-administered to the respondents to reap data collection benefits, including cost and time effectiveness. Additionally, the knowledge and experience of the researcher directed him to believe that the majority of organizations in Saudi Arabia tend to steer clear of participating in telephone or postal survey systems because of their erratic nature and lack of development. Thus, a higher response rate is targeted by distributing the questionnaire copies to large sample sizes. A team was organized to distribute and retrieve the copies from September 2021 to November 2021. The coming sub-sections contain the development of instruments for data collection, the pilot study, and the actual study procedures.

3.6.1 Pilot Study

A pilot study is generally carried out prior to the actual study (Creswell 2013), owing to its many benefits, such as minimization of ambiguities, clear interpretation and understanding of the items, and identification of biased or confusing items, among others. A pilot study is described as a procedure that allows the researcher to modify the instrument based on the feedback of a smaller sample, ensuring that the survey items are understood.

Thus, the study carried out a pilot study to validate the instrument before the survey. A suitable sample size for the pilot study ranges from 25 to 100, according to Cooper and Schindler (2003) and as such, this study will use 50 respondents from various managerial levels to complete the questionnaire and provide feedback. Their feedback will be useful in tweaking the questionnaire for effective data collection. The actual study will follow the pilot study.

3.6.2 Final Study

In the actual study, questionnaires will be distributed to CEOs of Saudi PSO through email and personal distribution, with an expected total of 375 copies. The actual study and the details of its procedure and results are supposed to be presented in Chapter Four.

3.7 DATA ANALYSIS

Data collection will be followed by data tabulation, analysis and item-wise categorization to obtain precise conclusions and answers to the research questions (William 2009). Statistical tools for data analysis were used to infer the answers to the research questions enumerated in the first chapter. The research questions will individually be answered through distinct statistical analysis, from which results were obtained to base valid conclusions. Data analysis entailed data analysis, examination and interpretation to determine the answers to the research questions, based on which recommendations and suggestions were provided. Sequential and organized steps were used as guidance for data analysis through inferential and descriptive SPSS statistics, Version 25 and PLS-SEM with Smart-PLS Version 3.

3.7.1 Data Preparation and Screening

Data gathered was manually entered into computer software prior to analysis, taking care not to make errors that could adulterate the results (Pallant & Manual 2007; Kline 2015). Prior to data analysis, the study adopted preventive measures through data screening – with three major screening aspects proposed by Tabachnick and Fidell (2007), which are normality, missing data and outliers.

According to Pallant and Manual (2007), missing data is incomplete information in the data set, and in the context of completing the questionnaire, not the entire respondents generally answer all the items – some would leave items answered, whether intentionally or otherwise, and this is referred to as missing data. Different ways can be adopted to treat missing data, one of which is to exclude cases list-wise and to exclude cases pair-wise and have the mean replace them (Pallant & Manual 2007). Missing data has to be resolved appropriately so that the overall results are not affected – in this regard, Hair Jr et al. (2016) stated that missing data could represent bias issues.

Added to the above, Pallant and Manual (2007) explained that effective planning in data collection might minimize missing data and thus, this study will administer the questionnaire copies to the respondents, after which they were rechecked prior to retrieval. This minimized missing data and ensured that all the items had answers.

Data outliers also need to be screened in addition to missing data – there are two types of outliers, univariate and multivariate (Hair et al. 2010; Byrne 2013). Hair Jr et al. (2016) and Kline (2015) referred to outliers as responses that are dissimilar to the remaining responses. Univariate outliers are high valued outliers in a single variable, while multivariate outlier is one with a high combination of scores on two or more variables (Kline 2015). Data outliers have to be resolved prior to analysis of data and their identification is made using univariate methods like histograms, box-plots and standardized z-score and multivariate ones like Mahalanobis Square of Distance (D^2) (Hair Jr et al. 2016). This study scanned data for the two outlier types prior to analyzing it.

Data screening also covers checking for data normality or lack thereof in the data distribution (Byrne 2013). Screening for normality of data is important in multivariate analysis; in SEM, lack of normal data distribution is a crucial issue that needs resolution and according to prior studies data should possess multivariate normal distribution (Hair Jr et al. 2016). Normality issues may also arise at the univariate level, where the normality of a single variable is confirmed – for the multivariate level, the normality of two or more variables is confirmed (Hair Jr et al. 2016). Normality confirmation at both levels can be done through skewness and kurtosis values (Byrne

2013), with acceptable skewness values falling within the range of ±3, and those of kurtosis falling between ±7. These criteria were kept in mind for the present study.

3.7.2 Descriptive Analysis

Under this analysis presents the strategy of the respondents' demographic information gathered and analyzed through it in light of the means and standard deviation values.

d. Exploratory Factor Analysis (EFA)

Exploratory Factor Analysis (EFA) is used as a standard statistical method to evaluate the measurement model and such evaluation entails using principal components, centroid, principal common factor analysis methods to carry out statistical analyses in factor derivation (Kline 2015).

Costello and Osborne's (2005) study described EFA as an exploratory analysis (in nature and design) when exploring a data set and that it is not appropriate to be employed for hypotheses testing or theories testing as it is vulnerable to errors even with samples of large sizes. They also stated that in the majority of cases, EFA is used when CFA is not opted for. In this study, the author considered EFA rather than CFA to examine the data set for items and accordingly, SPSS Version 25 will be used to conduct EFA based on Pallant and Manual (2007) and Hair Jr et al. (2016) established guidelines.

e. Reliability Analysis

After factor analysis, the reliability analysis of variables was tested – with the acceptable Cronbach's alpha coefficient values ranging from 0 to 1.0 based on Leech et al. (2005). The value of Cronbach's alpha should be found to be 0.7 and was deemed have sufficient internal consistency of variables (Nunnally 1994). CFA details are provided in the coming sub-sections.

3.7.3 Partial Least Square-Structural Equation Modeling (PLS-SEM)

The study will use PLS-SEM for data analysis, particularly for testing the research model, assessing The measurement and structural models will be assessed under this phase.

In this regard, Garson (2012) described PLS as a statistical method supporting the modelling of causal paths among the latent variables (Garson 2012), where paths are measured by the indicators indirectly. PLS comprises iterative algorithms set based on least squares, involving the use of extensive exploratory and explanatory multivariate methods, including but not limited to path modelling, principal component, regression and multi-block data analysis (Esposito Vinzi & Russolillo 2013) for simultaneous assessment of data and theory (Staples & Webster 2008).

Therefore, following Hair Jr et al. (2016) suggestion, Smart PLS 3.0 will be used to assess the model and to gain results. Specifically, Smart PLS 3.0 is described as a statistical software application used for the graphical path modelling of latent variables and for their analysis. It is also useful for evaluating psychometric properties of the measurement model and to obtain the structural model's estimates (Hair Jr et al. 2016).

3.7.4 Justification of Using PLS-SEM

The research model in this study will be analyzed using PLS-SEM in consideration of the complexity of the model, the number of latent variables, the sample size and the number of manifest variables. The following are reasons that justify the use of PLS-SEM;

1. PLS dedicated literature emphasized its appropriate use in exploratory studies (e.g. Henseler et al. (2009); Ringle et al. (2012)), whereas other studies (Hair Jr et al. 2016) claimed it is suitable for use in developing extant theory. Hence, this study extends Western theories and explores their use in the Middle East context, and because of its exploratory nature, the researcher deemed it suitable for analysis.

2. Contrastingly, CB-SEM needs 10 cases and over for every indicator (Wang & Wang 2019), while PLS is suitable for varying sample sizes so long as they are 10 times the maximum number of paths directed at a latent variable (Hair Jr et al. 2016). In the present study, the highest number of paths directed towards GIS adoption is expected to be 10, with 100 required numbers of observations, making PLS appropriate for analysis.

3. CB-SEM is difficult to utilise on large independent and dependent variables within a model (Chin 1998), and this holds true when investigating new theoretical relationships, making PLS more suitable for garnering accurate outcomes.

4. PLS may also be used in the presence of relationships or lack thereof (Chin 1998), and in the case of this study, the relationship between the model and latent variables is focused on, which makes PLS the right choice.

5. PLS can confirm the relationships between latent and manifest variables, posing a critical issue in validating models, particularly in exploratory studies (Julien & Ramangalahy 2003; Mahmood et al. 2004), which again makes PLS the right choice for this study.

6. In studies where several measured variables constitute the data, PLS can work efficiently for analysis (Esposito Vinzi & Russolillo 2013) – this is true in this study, where several manifest variables measure the majority of the latent variables.

7. Lastly, with PLS, residual variance in predicting relationships through optimized condition use can be minimized – the variance can be minimized iteratively until the parameter estimates are stabilized (Fornell & Cha 1994).

The rules of thumb established by Henseler et al. (2014) and Hair Jr et al. (2016) are tabulated in Table 3.6, and based on the table, PLS-SEM is opted for instead of CB-SEM.

Table 3.6 Rules of thumb for PLS-SEM and CB-SEM

	Criterion	**PLS-SEM**	**CB-SEM**
Research Objective	1. Predicting key target constructs.	√	
	2. Theory testing, theory confirmation or comparison of alternative theories.		√
	3. Exploratory research or extension of an existing structural theory.	√	
Measurement model	1. Formative measures are part of the model.		√
	2. Reflective and formative measures are part of the model.	√	
Structural model	1. Structural model is complex.	√	
	2. Structural model is non-recursive.		√
Data characteristics and algorithm	1. Data meet distributional assumptions.		√
	2. Data did not meet distributional assumptions.	√	
	3. Small sample size consideration.	√	
	4. Large sample size consideration.	√	√
	5. Non-normal distribution.	√	
	6. Normal distribution.	√	√
Model evaluation	1. Use latent variable scores in subsequent analyses.	√	
	2. Need to test for measurement model invariance.		√

Source: (Henseler et al. 2009; Hair et al. 2012)

3.7.5 Process of Model Assessment in PLS-SEM

In assessing the model using PLS-SEM, two main phases are involved, the first being the assessment of the measurement model and the second is the structural model evaluation. In the measurement model assessment, the relationships between latent and manifest variables are measured to assess the validity and reliability of items (Henseler et al. 2014; Hair Jr et al. 2016). Contrast, in the structural model's assessment, the latent variables links are evaluated using the coefficient of determination, path coefficient and effect size (Hair Jr et al. 2016).

a. Measurement Model Assessment

The measurement model is assessed keeping four conditions in mind; evaluation of internal consistency reliability, discriminant validity, indicator reliability and convergent validity on the construct and indicator level (Henseler et al. 2014; Hair Jr et al. 2016). Every manifest variable's factor loadings are scrutinized for indicator reliability, and the value should be higher than 0.70, according to Hair Jr et al. (2016). As for internal consistency reliability through composite reliability and Cronbach's alpha, the acceptable value is 0.7 (Hair Jr et al. 2016), whereas convergent validity is confirmed using AVE variables, whose values have to be more than 0.50 based on Hair Jr et al. (2016) studies.

Lastly, Fornell and Larcker (1981) criterion will be used for measuring discriminant validity of the constructs. In this regard, each construct's squared AVE should exceed its correlation with other constructs (Hair Jr et al. 2016) – in that correlations between constructs should be lower than their squared AVE. Discriminant validity of the indicator is established when every indicator loads most on the construct it is supposed to measure (Henseler et al. 2014; Hair Jr et al. 2016). Table 3.7 tabulates the criteria of the measurement model assessment established by Urbach and Ahlemann (2010).

Table 3.7 Assessment of measurement model criteria

Assessment	Criterion	Description
Indicator reliability	Factor Loading	Measures how much of the indicators' variance is explained by the corresponding latent variable. The recommended threshold should be 0.7 and above.
Internal consistency reliability	Cronbach's Alpha	Measures the degree to which the indicators load simultaneously when the latent variable increases. The recommended value should be 0.7 and above.
	Composite Reliability	Measures the sum of latent variable factor loadings relative to the sum of the factor loadings plus error variance. The recommended value should be 0.7 and above.
Convergent validity	Average Variance Extracted	Measures the amount of variance a latent variable component captures from its indicators relative to the amount due to measurement error. Each construct should have an AVE value of more than 0.5.

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Discriminant validity	Fornell-Larker Criterion (at construct level)	Requires the latent variable to share variance with its indicators more than any other latent variable. The AVE of the latent variable should be greater than its highest squared correlation with any other latent variable.
	Cross-Loadings (at indicator level)	Requires the loading of each indicator to be higher for its designated construct than for any of the other constructs, and each of the constructs loads to be highest with its items. It can be inferred that the models' constructs differ sufficiently from one another when the items are not cross-loaded.

Source: (Urbach & Ahlemann 2010)

b. Structural Model Assessment

The structural model will be evaluated based on three indices; coefficient of determination, effect size and path coefficient. The coefficient of determination (R^2) is the latent variable's level of explained variance and the values of explanatory strength values are labeled as follows; 0.25 is large, 0.09 is medium, and 0.01 is small (Mitchell & Jolley, 2012). With regards to the path coefficient, it is the correlation strength between latent variables and it gauges the hypotheses, with the following strengths labelled based on values; 0.35 is large, 0.15 is medium, while 0.02 is small strength of relationships (Cohen 1988; Cohen 2013). Lastly, effect size (f^2) reflects the effect of specific exogenous latent variables towards the endogenous latent variables through the changes in the latter (R^2). The f^2 values are labeled with the following sizes based on their values; 0.35 is large, 0.15 is medium, while 0.02 is a small effect (Henseler et al. 2014). Table 3.9 contains the summarized version of the conditions of structural model assessment by (Urbach & Ahlemann 2010).

Table 3.8 Assessment of structural model criteria

Assessment	Criterion	Description
Model Validity	Coefficient of Determination (R2)	Measures the explained variance of a latent variable relative to its total variance. Values from 0.01, 0.09, and 0.25, indicate small, medium, and large
Model Validity	Path Coefficient (β)	Path coefficients between latent variables should be analyzed in terms of their algebraic sign, magnitude, and significance. Values of 0.02, 0.15, and 0.35 indicate small, medium, and large relationships.

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Model Validity	Effect Size (f2)	Measures whether an independent variable has a substantial impact on a dependent variable. Values of 0.02, 0.15, and 0.35 indicate the predictor variable's low, medium, and large effect in the structural model.

Source: (Urbach & Ahlemann 2010)

3.8 SUMMARY

In this chapter, the adopted research method with detailed processes and procedures was presented and the chapter covered research design, target population, sample, sample determination, instruments measurement, and data collection methods. The chapter also presented quantitative data collection and its administration location. Quantitative data analysis will be conducted using descriptive analysis, EFA, CFA and SEM. In the next chapter, it’s expected to have the results of the descriptive analysis of data gathered from the sample respondents and the obtained empirical findings from exploratory analysis and confirmatory factor analysis to be presented with discussions. The chapter also expected to present the structural model and the process of analyzing data gathered from the questionnaire.

CHAPTER IV

RESULTS AND DISCUSSION

4.1 INTRODUCTION

This study's main objective is to examine the effect of factors on the adoption of GIS and the effect of such adoption on the performance of organizations. The data analysis results are presented in this chapter according to the analysis methods discussed in the third chapter. The chapter first provides details on the response rate, after which the demographic profile of the respondents is discussed in relation to the examined topic. The chapter then proceeds to provide details on the preparation and screening of data for analysis. This includes missing data treatment, outliers' detection and establishment of normality. The EFA findings are presented, followed by the questionnaire item reliability results to gauge survey scale and data quality. The results are analyzed and discussed, beginning with the measurement model assessment results, followed by the structural model results and the formulated hypotheses test results. Towards the end, the chapter describes the model validation results using model fit indices and the hypotheses results, ending with the conclusion of the chapter.

4.2 DESCRIPTIVE ANALYSIS; PROFILE OF RESPONDENTS

Descriptive analysis was used in this study on the characteristics of the participants, and such statistical analysis is commonly conducted at the beginning of data analysis. The respondents' characteristics are important in providing insight into the examined population.

4.2.1 Response Rate

The author distributed 350 questionnaire copies to the public sector organizations in Saudi Arabia, particularly those with accurate postal addresses and operational from 2021-2022. From the distributed copies, 272 were retrieved, indicating a rate of response of 78% and of the total retrieved number of copies, 232 were deemed suitable to be analyzed, making the final response rate 66%. The rate of response of the distributed questionnaire copies is presented in Table 4.1.

Table 4.1 Response rates of the final study

Description	**Number/Frequency**
Quantity of questionnaires sent out	350
The total number of completed surveys	272
The percentage of people who respond	78%
The number of questions that can be used	232
Response rate that has been adjusted	66%
The number of questionnaires that are not usable	40

4.2.2 Demographic Profile of the Respondents

Background information of the respondents was solicited through the questionnaire, including their gender, age, level of education, experience years, years of experience using the Internet, and the size of the firm.

a. Gender

With regards to the respondents' gender, female respondents make up 40.5% of the total respondents, while male respondents make up 59.5%, making the respondents primarily from the latter category (refer to Table 4.2).

Table 4.2 Respondents' gender

Gender	Frequency	Percentage
Male	138	59.5
Female	94	40.5

b. Age

The respondents' ages were gauged based on four age range categories (below 20 years, between 20 and 30 years, between 30 and 40 years, and more than 40). The analysis result showed that the majority of the respondents fell in the 30-40 years category (57%), followed by those over 40 years old (27.6%), and lastly, those from 20 to 30 years old (13.8%), indicating that the two main age groups (30-40 years, over 40 years) constituted the majority of the respondents. Those under 20 years of age only comprised 1.3% of the total respondents, minimizing their influence on the overall survey. The respondents' age distribution in the study is tabulated in Table 4.3.

Table 4.3 Respondents' age

Age	Frequency	Percentage
Below 20 years	3	1.3
Between 20-30 years	32	13.8
Between 30 - 40 years	133	57.3
Over 40 years	64	27.6

c. Education Level

The education level of the respondents was also measured, and the analysis results showed that the majority of them (53.4%), had at least bachelor's degrees, followed by other degrees (39.2%), master's degree (6.0%), and PhD degree (1.3%) (see Table 4.4).

Table 4.4 Respondents' education level

Educational level	Frequency	Percentage
Bachelor	124	53.4
Master	14	6.0
PhD	3	1.3
Others	91	39.2

d. Current Position in the Company

The majority of the respondents had a permanent position in the company (49.6%), followed by part-timers (37.1%), those who were transfers (10.3%), and others (3.0%).

Table 4.5 Current position

Current position	Frequency	Percentage
Permanent	115	49.6
Part-time	86	37.1
Loaned	24	10.3
Other	7	3.0

e. Years of Experience

The experience of the respondents is measured in years. Most of them (44%) have been in their positions for over six years, followed by those between three and six years (38.8%), and under three years (17.2%). The distribution of respondents based on their experience years in the company is tabulated in the following table (Table 4.6).

Table 4.6 Respondents' years of experience

Years of Experience	Frequency	Percentage
Less than three years	40	17.2
3-6 years	90	38.8
Over than 6 years	102	44.0

4.3 DATA PREPARATION AND SCREENING

In the data analysis stage, data preparation and screening come second, and this involves the use of multivariate analysis methods like multiple regression, factor analysis and SEM for hypotheses testing – such analysis methods have their strengths and weaknesses (Tabachnick & Fidell 2007). This study used SEM analysis for data analysis and has its data assumptions, particularly the data set's distributional characteristics (Kline 2011). Researchers are generally cautioned on the issues that pertain to data that may arise, as this may lead to model estimation failure (Kline 2011). Hence, the next sections present the three data preparation and screening aspects, including missing data, outliers and normality.

4.3.1 Missing Data

This type of data refers to the part of data gathered in the study that has missing information about the respondents (response to one or more survey items) caused by the incomplete answering of the survey (Tabachnick & Fidell 2007). Data missing is problematic during data analysis, so researchers generally use complete data sets with no missing values (Tabachnick & Fidell 2007). In the real world, complete data cannot always be ensured owing to missing data values in data sets, even with the researcher's best efforts for its prevention (Kline 2011). In the same line of argument, Schafer and Graham (2002) warned researchers about how missing data in scientific research can lead to adverse outcomes if not considered in most data analysis procedures. Basically, missing data can lead to two main issues: the reduction of the capability/efficiency of statistical test in identifying a given data set relationship and the presence of biases relating to parameter estimates (Hair et al. 2010).

In the above regard, respondents can be prevented from missing answering any questionnaire item by designing the items in a clear, without ambiguity and having sufficient space for crosschecking and reviewing missing responses before retrieving questionnaire copies (Kline 2011). Several methods can be adopted to counter missing data presence, including the consideration of proper planning in data collection during the instrument's administration.

In this study, the researcher considered and applied the above recommendations. The questionnaire copies were self-administered; thus, the respondents misunderstanding of the survey items was clarified through explanations of such items.

This phase also involves data coding and labelling based on the questionnaire's various parts and item numbers following data collection. The SPSS software was employed to check for missing data and illegal entries in the descriptive analysis, ensuring the respondents' full cooperation and high level of response accuracy. Other factors that affected the results included each question’s simplicity and suitability and the number of selected respondents.

4.3.2 Outliers

Outliers are described as data points having the most extreme values in the data set on the independent/dependent variables or both variable types. They stand out from the remaining data points within a distinct data set (Kline 2011). According to Hair et al. (2010), outliers are examples that are distinct from the data set. Such values are of two types: univariate outliers and multivariate outliers. The former type is an extreme value on a single variable, while the latter type is an extreme value on two or more variables. The presence of outliers can stem from observational errors, wrong responses, errors in data entry, questionnaire errors, unclear instructions or wrong survey layout, or sometimes because of self-reported data (Tabachnick & Fidell 2007).

Moreover, outliers can lead to skewed statistical test results (Schumacker & Lomax 2004), affecting the values of mean, standard deviation and correlation coefficients. Outliers can also influence the fit estimates of the model, the standard errors and parameter estimations, and in relation to this, parameters that exceed the suitable range or latent variables correlations that exceed one may be caused by outliers in the data set (Byrne 2013).

Outliers that arise in data collection can influence the statistical analysis results, as a result of which the identification of such outliers in data collection is a must for their appropriate accommodation, elimination or explanation (Schumacker & Lomax

2004). Therefore, it is pertinent for researchers to determine the presence of outliers by using skewness and kurtosis (for univariate data) and ensure that skewness values remain under 3, or otherwise outliers may be present in the data set.

For multivariate outliers, each case can calculate the Mahalanobis distance (D^2) for determination. Specifically, Mahalanobis distance (D^2) is described also referred to as squared Mahalanobis distance, is described as the distance in standard deviations between score sets for one case and the variables sample means (centroid) (Kline 2011; Byrne 2013). Hair et al. (2010) explained that it focuses on a single observation as opposed to the set of variables center while Byrne (2013) contended that an outlier case is generally determined when the value of (D^2) is distinct from the rest of the D^2 values in a data set.

This study, as mentioned, employed the SPSS 25 to determine the presence of outliers (univariate and multivariate), and based on the results, the values of skewness and kurtosis did not exceed the threshold levels, which showed the absence of univariate outliers. Notably, for the multivariate outliers, the Mahalanobis distance in the SPSS program is useful in their determination. Mahalanobis distance was conducted to determine the critical value of each construct, having degrees of freedom equal to the number of independent variables, within the p=0.001 probability following Hair et al. (2010) recommendation. The value of Mahalanobis distance (D^2) confirmed the completeness of the answers, with the absence of outliers, so all 232 cases were exposed to the next statistical analysis.

4.3.3 Assessment of the Data Normality

In multivariate analysis, the final assumption relates to normality of data distribution and this is generally assessed by detecting the variables' deviation from normality, which is a SEM assumption - SEM requires data to have multivariate normal distribution (Hair et al. 2010). In other words, normality is a basic multivariate analysis assumption and it is referred to as the data distribution shape for one metric variable and its relationship to the normal distribution, serving as the statistical procedure standard.

Therefore, this study obtained the skewness and kurtosis values to assess data distribution normality. Table 4.7 contains the results wherein the values ranged from -0.862 to -0.330, which fall under the range of 3 as stated by Byrne (2013). Moreover, the values of kurtosis differed from -.214 to 1.240, also falling within the recommended value (±7) by Byrne (2013). Data had normal distribution as the skewness and kurtosis values were constant and they fell within the acceptable ranges recommended by past studies.

Table 4.7 Data normality results

Descriptive Statistics					
	N	**Skewness**		**Kurtosis**	
	Statistic	**Statistic**	**Std. Error**	**Statistic**	**Std. Error**
SYSQ1	232	-.690	.160	.768	.318
SYSQ2	232	-.734	.160	.988	.318
SYSQ3	232	-.753	.160	1.099	.318
SYSQ4	232	-.626	.160	.973	.318
SYSQ5	232	-.590	.160	.704	.318
INFQ1	232	-.697	.160	.456	.318
INFQ2	232	-.576	.160	.320	.318
INFQ3	232	-.539	.160	.005	.318
INFQ4	232	-.502	.160	.386	.318
INFQ5	232	-.501	.160	.396	.318
SRVQ1	232	-.537	.160	-.002	.318
SRVQ2	232	-.638	.160	.178	.318
SRVQ3	232	-.593	.160	.119	.318
SRVQ4	232	-.719	.160	.823	.318
SRVQ5	232	-.714	.160	.922	.318
CMGT1	232	-.681	.160	.355	.318
CMGT2	232	-.654	.160	.180	.318
CMGT3	232	-.636	.160	.276	.318
CMGT4	232	-.623	.160	.163	.318
CMGT5	232	-.608	.160	.261	.318
CMPT1	232	-.693	.160	.468	.318
CMPT2	232	-.640	.160	.309	.318
CMPT3	232	-.626	.160	.481	.318
CMPT4	232	-.619	.160	.407	.318
CMPT5	232	-.790	.160	1.133	.318

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PNPR1	232	-.631	.160	.099	.318
PNPR2	232	-.525	.160	-.241	.318
PNPR3	232	-.431	.160	-.165	.318
PNPR4	232	-.379	.160	.094	.318
PNPR5	232	-.572	.160	.149	.318
PEUS1	232	-.637	.160	.220	.318
PEUS2	232	-.691	.160	.387	.318
PEUS3	232	-.588	.160	.047	.318
PEUS4	232	-.645	.160	.489	.318
PEUS5	232	-.655	.160	.499	.318
PUSE1	232	-.570	.160	.384	.318
PUSE2	232	-.479	.160	.218	.318
PUSE3	232	-.683	.160	.955	.318
PUSE4	232	-.697	.160	.736	.318
PUSE5	232	-.657	.160	.811	.318
SECU1	232	-.797	.160	.797	.318
SECU2	232	-.857	.160	1.240	.318
SECU3	232	-.862	.160	.917	.318
SECU4	232	-.589	.160	.569	.318
SECU5	232	-.684	.160	.876	.318
BHVI1	232	-.789	.160	.753	.318
BHVI2	232	-.688	.160	.648	.318
BHVI3	232	-.853	.160	.512	.318
BHVI4	232	-.794	.160	.387	.318
BHVI5	232	-.774	.160	.367	.318
PERF1	232	-.789	.160	.753	.318
PERF2	232	-.688	.160	.648	.318
PERF3	232	-.379	.160	.094	.318
PERF4	232	-.797	.160	.797	.318
PERF5	232	-.589	.160	.569	.318

SYSQ: Service Quality, INFQ: Information Quality, SRVQ: Service Quality, CMGT: Change Management, CMPT: Competitiveness Pressure, PNPR: Pandemic Pressure, PEUS: Perceived Ease of Use, PUSE: Perceived Usefulness, SECU: Security, BHVI: Behavioral intention to adopt, PERF: perceived performance

After data was screened, cleaned and treated for missing observations, outliers and normality, they were exposed to exploratory factor analysis, internal consistency analysis and confirmatory factor analysis.

4.4 EXPLORATORY FACTOR ANALYSIS (EFA)

In this study, EFA was used to reduce data or preserve them and their characteristic, while deleting items that loaded and cross-loaded at low values (Hair et al. 2010). The EFA is also used to examine the factor loadings stability of different constructs for ensuring the instruments factor validity.

Moreover, Principal-Components analysis was used to extract the 232 responses along with the orthogonal rotation method, Varimax. Data-EFA suitability was established using Bartlett's test of sphericity (BTS) and Kaiser-Mayer-Olkin (KMO) measure of sampling adequacy following Kaiser's (1974) recommendation. KMO tests the magnitude of the partial correlations among the examined items – with KMO values required to be higher than 0.60 (Blaikie 2003). BTS tests if the correlation matrix is an identity matrix because if it is, then this shows the unsuitability of the factor model. The test significance is at $p<0.05$ for adequate correlations among variables, forming the basis for factor analysis (Williams et al. 2012).

Added to the above test, the eigen values were obtained and examined for the purpose of ensuring that the number of factors is primarily liable for the variation in data (Tabachnick & Fidell 2007). Accordingly, the Kaiser's criterion value in determining the measure for deciding the number of factors is 1.00 and the variance was considered with a 60% objective level and/or more of the whole variance. This has been evidenced to be sufficient for a factor resolve particularly in the field of social science (Hair et al. 2010) although other studies like Diekhoff (1992) deemed 50% of the described total variance as the entry.

4.4.1 Exogenous Constructs

The rotated component matrix through Varimax rotation was conducted to validate the perceived distinction of the nine exogenous constructs (refer to Table 4.8) and the KMO measure of sampling adequacy was found to be 0.921, indicating enough inter-correlation levels, with significant BTS value (Chi-square=9694.394, $p<0.001$). Based on the result, the communalities ranged from 0.519 to 0.788, which means the indicator variables have worked well for the study model, and moreover, Eigen value exceeded 1.0 (cut-off for extraction).

To come to a final scale, the study repeated the cycles of iterative factor analysis sequence and item deletion after which, no deletion was made in the EFA, resulting in the retention of all the 45 items of the nine distinct factors related with the exogenous constructs. Evidently, the nine-factor solution is the most appropriate, producing 67% of the total variance. A particularly pattern was produced by the factor analysis as that against the post-content validation model.

Table 3.8 Component of Exogenous Variables: Factor Loading of the Final Items

Exogenous Variables	**Components**								
	SYSQ	**INFQ**	**SRVQ**	**CMGT**	**CMPT**	**PNPR**	**PEUS**	**PUSE**	**SECU**
SYSQ1	0.780								
SYSQ2	0.797								
SYSQ3	0.791								
SYSQ4	0.813								
SYSQ5	0.795								
INFQ1		0.748							
INFQ2		0.831							
INFQ3		0.747							
INFQ4		0.756							
INFQ5		0.775							
SRVQ1			0.808						
SRVQ2			0.869						
SRVQ3			0.811						
SRVQ4			0.819						
SRVQ5			0.797						
CMGT1				0.774					
CMGT2				0.766					
CMGT3				0.827					
CMGT4				0.851					
CMGT5				0.834					
CMPT1					0.774				
CMPT2					0.766				
CMPT3					0.827				
CMPT4					0.851				
CMPT5					0.834				

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PNPR1						0.739			
PNPR2						0.800			
PNPR3						0.827			
PNPR4						0.836			
PNPR5						0.739			
PEUS1							0.773		
PEUS2							0.858		
PEUS3							0.836		
PEUS4							0.772		
PEUS5							0.799		
PUSE1								0.722	
PUSE2								0.798	
PUSE3								0.842	
PUSE4								0.870	
PUSE5								0.875	
SECU1									0.806
SECU2									0.779
SECU3									0.845
SECU4									0.801
SECU5									0.770
Eigenvalues	16.890	3.883	2.759	2.137	1.982	1.700	1.496	1.222	1.197
% of Variance (67.04)	30.709	8.628	6.132	4.749	4.404	3.777	3.323	2.716	2.661

SYSQ: Service Quality, INFQ: Information Quality, SRVQ: Service Quality, CMGT: Change Management, CMPT: Competitiveness Pressure, PNPR: Pandemic Pressure, PEUS: Perceived Ease of Use, PUSE: Perceived Usefulness, SECU: Security.

Nine distinct factors structure are present within the scale with no significant cross-loadings of items (cross-loadings did not exceed 0.4). The study used EFA with Principal Component Analysis (PCA) for extracting items that had low loadings. Double loading items were detected using Varimax rotation in the EFA. The results confirmed the unidimensionality of each construct and the uniqueness of the construct, with items used to measure specific construct loading on a single factor, indicating the absence of the need for deletion.

4.4.2 Endogenous and Dependent Constructs

This study examined the endogenous and dependent factors using factor analysis with Varimax Rotation (see Table 5.3), specifically GIS and perceived overall performance, for the validation the perceived distinction of the constructs in view of the respondents. The two-factor solution showed the following results; Eigen values exceeded 1.0, with variance explained is 64.253% of the two factors total variance. In addition, the KM measure of sampling adequacy exceeded the cut-off value of 70% at 88.2%, indicating adequate items inter-correlations for each factor. Also, Bartlett's Test of Sphericity was significant with Chi square of 1767.318, $p<0.001$, every item loaded at 0.50 or higher on a single factor and there was no double loading. Each item loadings are presented in Table 4.9, ranging from 0.685 to 0.833. Ten (10) items represented the two constructs (refer to Table 4.9).

Table 4.9 Component of Endogenous and dependent Variables: Factor Loading of the Final Items

Exogenous Variables	**Component**	
	BHVI	**PERF**
BHVI1	0.728	
BHVI2	0.831	
BHVI3	0.798	
BHVI4	0.855	
BHVI5	0.829	
PERF1		0.685
PERF2		0.800
PERF3		0.838
PERF4		0.837
PERF5		0.741
Eigenvalues	5.060	1.365
% of Variance (64.253)	50.600	13.653

BHVI: Behavioral intention to adopt, PERF: perceived performance

The study ran exploratory factor analysis using Varimax Rotation for scales validation coupled with other validity tests in the later stages. Some studies in literature applied EFA with Varimax Rotation to establish convergent validity (Treiblmaier & Filzmoser 2010), in a procedure whose results confirm convergent and discriminant validity of the scale items. It was evidenced that exploratory factor models have no explicit test statistics to determine if both convergent and discriminant validity are present and thus, Karimi et al. (2004) contended that EFA lacks the capability to validate the convergent and discriminant validity of the indicators of latent variables. This is the reason why additional validity testing known as constructs validity is needed. This was conducted by the study with details presented in the next sub-section.

4.4.3 Scales Reliability Testing

Two more phases of validation were carried out, with the first being factor structure and reliabilities of the revised scales for scales refinement. Accordingly, EFA was used in SPSS 25.0. The second phase involved the validation of the measurement model through confirmatory factor analysis in Smart PLS.

There was no pre-specification of the number of required items in each scale and thus, an over-identified scale in SEM was needed to improve the scale's psychometric value, considering that each scale at least has three items.

Furthermore, reliability refers to the level to which a set of measurement item of a construct matches each other (Hair et al. 2010). According to Sekaran (2003), testing the presence of reliability can be done through Cronbach's alpha – internal consistency scale measurement that has been extensive used in literature as Santos (1999) and Durfee et al. (2006).

Table 4.10 Summary of Cronbach's alpha of each Scale

Constructs	**Number of items**	**Cronbach's Alpha**	**Items deleted**
SYSQ	5	0.856	No
INFQ	5	0.831	No
SRVQ	5	0.879	No
CMGT	5	0.870	No
CMPT	5	0.885	No
PNPR	5	0.848	No
PEUS	5	0.867	No
PUSE	5	0.880	No
SECU	5	0.860	No
BHVI	5	0.867	No
PERF	5	0.842	No

SYSQ: Service Quality, INFQ: Information Quality, SRVQ: Service Quality, CMGT: Change Management, CMPT: Competitiveness Pressure, PNPR: Pandemic Pressure, PEUS: Perceived Ease of Use, PUSE: Perceived Usefulness, SECU: Security, BHVI: Behavioral intention to adopt, PERF: perceived performance

Accordingly, every scale's Cronbach's alpha coefficient was calculated. The acceptable values for Cronbach's alpha begin from 0.70, although preferable values begin from 0.80 and above, Table 4.10 presents the results for Cronbach's alpha testing and the values showed that the constructs all had reliability as they varied from 0.830 to 0.878, satisfying the least value requirement (0.70).

4.4.4 Descriptive Analysis

Under this section, the descriptive characteristics and profile of the examined variables are presented. The final descriptive statistics results for the study variables are presented in Table 4.11. Sample characteristics along with their mean, standardized error of mean, median, mode, standard deviation, variation, skewness and kurtosis values of the constructs and sub-constructs were obtained through the use of SPSS 25.0.

Past studies on PLS-SEM (Chin & Newsted 1999; Gefen et al. 2000) indicated that the least sample size requirements should be from 30-100 cases. PLS application require a sample size that has the following criteria; 1) 10 times the number of items, consisting of the formative constructs and 2) 10 times the largest number of structural paths, focused on specific construct in the inner path model (Barclay et al. 1995). In this study, the size of the sample is 232, indicating sufficient sample size for reliability and accurate analysis using PLS as it is capable of estimating the measurement model and the structural model in a simultaneous manner (Ringle et al. 2005).

The practical assessment of the measured variables multivariate normality is difficult and thus, using skewness and kurtosis are employed for the justification of the application of variance-based SEM methods (i.e., PLS-SEM) (West et al. 1995). In light of skewness and kurtosis, West et al.'s (1995) rule of thumb indicated that skewness values have to be <2, while kurtosis values have to be <7, and owing to the lack of normality of the underlying distributions of measured variables, results from PLS are expected to be robust (West et al. 1995). The skewness and kurtosis values of the measured variables were obtained using SPSS 25.0 and are tabulated in Table 4.11. Based on the table, skewness values ranged between -0.162 and 0.275 and kurtosis values ranged between -0.512 and 2.946. On the whole, the sample's data characteristics matches the suitable use of PLS and therefore, robust outcomes are expected from PLS analysis.

In PLS, the assumption is such that the distribution of data is not normal and it is employed in cases where limited knowledge is known concerning the latent variables distribution and the ones that need the estimates to be more data-related (Fornell & Cha 1994). In other words, it may be logically assumed that the variables have normal distribution. The sample's data characteristics made sure that the PLS use was suitable.

Table 4.11 Descriptive analysis for all measurement items

	N	Min	Max	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic			Statistic	Std. Error	Statistic	Std. Error
SYSQ1	232	2	5	4.14	.654	-.332	.128	.027	.256
SYSQ2	232	2	5	4.06	.660	-.293	.128	.095	.256
SYSQ3	232	2	5	4.09	.625	-.275	.128	.327	.256
SYSQ4	232	2	5	4.11	.710	-.303	.128	-.518	.256
SYSQ5	232	2	5	4.03	.737	-.680	.128	.684	.256
INFQ1	232	2	5	3.76	.862	-.436	.128	-.363	.256
INFQ2	232	2	5	4.05	.801	-.677	.128	.192	.256
INFQ3	232	2	5	3.91	.832	-.473	.128	-.256	.256
INFQ4	232	2	5	4.17	.723	-.573	.128	.102	.256
INFQ5	232	2	5	3.66	.844	-.360	.128	-.400	.256
SRVQ1	232	2	5	4.31	.718	-.863	.128	.540	.256
SRVQ2	232	2	5	4.27	.732	-.851	.128	.613	.256
SRVQ3	232	2	5	3.90	.786	-.547	.128	.133	.256
SRVQ4	232	2	5	3.94	.792	-.436	.128	-.179	.256
SRVQ5	232	2	5	4.01	.751	-.577	.128	.314	.256
CMGT1	232	2	5	3.95	.675	-.488	.128	.677	.256
CMGT2	232	2	5	3.98	.691	-.530	.128	.669	.256
CMGT3	232	2	5	3.92	.772	-.443	.128	-.029	.256
CMGT4	232	2	5	4.09	.709	-.457	.128	.099	.256
CMGT5	232	2	5	4.24	.660	-.530	.128	.289	.256
CMPT1	232	1	5	4.09	.751	-.869	.128	1.503	.256
CMPT2	232	1	5	3.99	.778	-.702	.128	.852	.256
CMPT3	232	1	5	3.96	.757	-.480	.128	.293	.256
CMPT4	232	1	5	3.96	.743	-.515	.128	.491	.256
CMPT5	232	1	5	4.17	.715	-.576	.128	.448	.256

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PNPR1	232	2	5	4.30	.679	-.832	.128	.981	.256
PNPR2	232	2	5	4.40	.639	-.859	.128	.871	.256
PNPR3	232	2	5	4.43	.624	-.753	.128	.262	.256
PNPR4	232	2	5	4.47	.615	-.946	.128	.947	.256
PNPR5	232	2	5	4.11	.882	-.720	.128	-.262	.256
PEUS1	232	2	5	4.43	.764	-1.346	.128	1.490	.256
PEUS2	232	2	5	4.58	.596	-1.415	.128	2.508	.256
PEUS3	232	2	5	4.55	.604	-1.313	.128	2.156	.256
PEUS4	232	2	5	4.28	.735	-.789	.128	.248	.256
PEUS5	232	2	5	4.43	.671	-1.142	.128	1.616	.256
PUSE1	232	2	5	4.58	.642	-1.620	.128	2.946	.256
PUSE2	232	2	5	4.53	.601	-1.217	.128	1.986	.256
PUSE3	232	3	5	4.64	.526	-1.028	.128	-.045	.256
PUSE4	232	1	5	4.53	.587	-1.162	.128	2.640	.256
PUSE5	232	2	5	4.57	.584	-1.139	.128	1.194	.256
SECU1	232	1	5	4.23	.746	-.850	.128	.870	.256
SECU2	232	1	5	4.27	.740	-.894	.128	.920	.256
SECU3	232	1	5	3.97	.872	-.593	.128	.209	.256
SECU4	232	1	5	4.21	.790	-1.180	.128	2.263	.256
SECU5	232	1	5	4.15	.828	-.823	.128	.503	.256
BHVI1	232	2	5	4.45	.622	-.972	.128	1.235	.256
BHVI2	232	2	5	4.26	.674	-.640	.128	.436	.256
BHVI3	232	2	5	4.23	.620	-.342	.128	.090	.256
BHVI4	232	2	5	4.19	.730	-.571	.128	-.088	.256
BHVI5	232	1	5	4.12	.800	-.583	.128	-.111	.256
PERF1	232	1	5	3.73	.921	-.529	.128	-.112	.256
PERF2	232	2	5	3.99	.771	-.566	.128	.187	.256
PERF3	232	2	5	4.04	.740	-.442	.128	-.062	.256
PERF4	232	2	5	4.04	.690	-.313	.128	-.075	.256
PERF5	232	1	5	3.84	.839	-.365	.128	.007	.256
Valid N	232								

SYSQ: Service Quality, INFQ: Information Quality, SRVQ: Service Quality, CMGT: Change Management, CMPT: Competitiveness Pressure, PNPR: Pandemic Pressure, PEUS: Perceived Ease of Use, PUSE: Perceived Usefulness, SECU: Security,BHVI: Behavioral intention to adopt, PERF: perceived performance

4.5 ASSESSMENT OF MEASUREMENT MODEL

The measurement model houses indicators and their connections to the latent variables that require measurement (see Figure 4.1). Measurement model assessment provides the specifications concerning the indicators-latent variables relationships (Henseler et al. 2009). Such assessment is directed towards the evaluation of validity, reliability and the inner path model estimates (Henseler et al. 2009). Therefore, this study conducted the tests to confirm the following accordingly; indicator reliability, internal consistency reliability, convergent validity and discriminant validity.

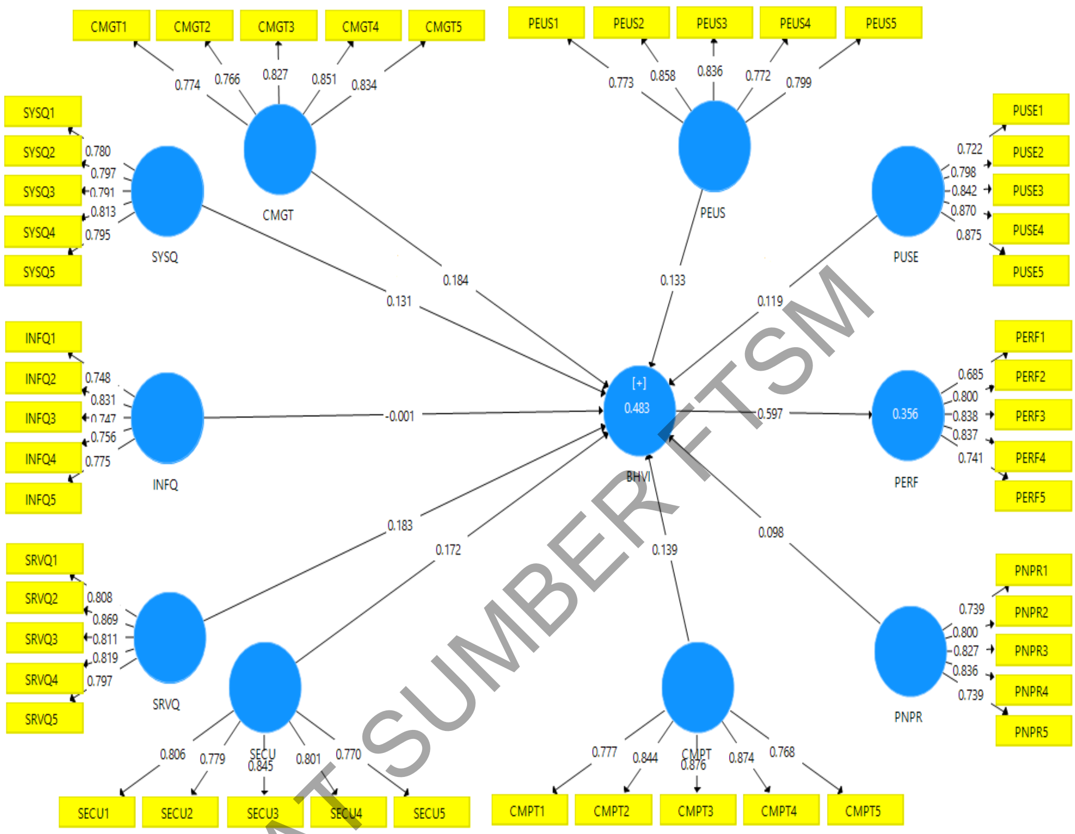

Figure 4.1 Measurements Model for GIS adoption

4.5.1 Indicator Reliability

The measurement model's indicator reliability was tested through the indicators' factor loadings. The measurement model's indicator reliability was established by ensuring that each factor loading is 0.70 or higher following Hair et al. (2010) suggestion. In relation to this, Chin (2010) stated that the factor loadings ranging from 0.70 to 0.90 is indicative of higher confidence level that the items of the measurement model converge in their corresponding constructs.

Thus, 55 reflective indicators were used to test the measurement model and all the items were retained. Hair et al. (2010) revealed that if the factor loadings range from

0.40 to 0.50, the indicators need to be dropped in a way that it contributes to increasing the composite reliability above the cut-off value. The model indicators' factor loadings are tabulated in Table 4.12.

Table 4.12 Factor loading – Indicator Reliability

Factor	**Items**	**Original Sample (O)**	**Sample Mean (M)**	**Standard Deviation (STDEV)**	**T Statistics (|O/STDEV|)**	**P Values**
System Quality	SYSQ5 <- SYSQ	0.795	0.797	0.026	30.991	0.000
	SYSQ4 <- SYSQ	0.813	0.815	0.021	38.410	0.000
	SYSQ3 <- SYSQ	0.791	0.787	0.028	28.240	0.000
	SYSQ2 <- SYSQ	0.797	0.797	0.026	30.560	0.000
	SYSQ1 <- SYSQ	0.780	0.777	0.029	27.339	0.000
Service Quality	SRVQ5 <- SRVQ	0.797	0.797	0.022	36.364	0.000
	SRVQ4 <- SRVQ	0.819	0.818	0.022	37.255	0.000
	SRVQ3 <- SRVQ	0.811	0.811	0.022	37.593	0.000
	SRVQ2 <- SRVQ	0.869	0.869	0.017	49.725	0.000
	SRVQ1 <- SRVQ	0.808	0.808	0.023	35.847	0.000
Security	SECU5 <- SECU	0.770	0.769	0.034	22.680	0.000
	SECU4 <- SECU	0.801	0.800	0.026	30.362	0.000
	SECU3 <- SECU	0.845	0.843	0.020	42.162	0.000
	SECU2 <- SECU	0.779	0.775	0.030	26.353	0.000
	SECU1 <- SECU	0.806	0.804	0.026	31.440	0.000
Perceived Usefulness	PUSE5 <- PUSE	0.875	0.876	0.016	54.375	0.000
	PUSE4 <- PUSE	0.870	0.871	0.019	45.240	0.000
	PUSE3 <- PUSE	0.842	0.840	0.020	42.131	0.000
	PUSE2 <- PUSE	0.798	0.797	0.037	21.568	0.000
	PUSE1 <- PUSE	0.722	0.719	0.042	17.127	0.000
Pandemic Pressure	PNPR5 <- PNPR	0.739	0.741	0.029	25.472	0.000
	PNPR4 <- PNPR	0.836	0.837	0.018	47.436	0.000
	PNPR3 <- PNPR	0.827	0.826	0.021	38.951	0.000
	PNPR2 <- PNPR	0.800	0.799	0.025	32.568	0.000
	PNPR1 <- PNPR	0.739	0.739	0.035	21.355	0.000
Perceived Ease of Use	PEUS5 <- PEUS	0.799	0.798	0.027	29.664	0.000
	PEUS4 <- PEUS	0.772	0.770	0.032	23.951	0.000
	PEUS3 <- PEUS	0.836	0.835	0.026	31.963	0.000
	PEUS2 <- PEUS	0.858	0.857	0.025	34.169	0.000
	PEUS1 <- PEUS	0.773	0.772	0.032	24.104	0.000

to be continued…

… continuation

Performance	PERF5 <- PERF	0.741	0.741	0.028	26.259	0.000
	PERF4 <- PERF	0.837	0.839	0.017	48.125	0.000
	PERF3 <- PERF	0.838	0.838	0.020	42.724	0.000
	PERF2 <- PERF	0.800	0.801	0.031	25.571	0.000
	PERF1 <- PERF	0.685	0.685	0.034	20.201	0.000
Information Quality	INFQ5 <- INFQ	0.775	0.776	0.029	26.662	0.000
	INFQ4 <- INFQ	0.756	0.757	0.034	21.999	0.000
	INFQ3 <- INFQ	0.747	0.745	0.032	23.004	0.000
	INFQ2 <- INFQ	0.831	0.831	0.020	41.686	0.000
	INFQ1 <- INFQ	0.748	0.746	0.035	21.258	0.000
Competitiveness Pressure	CMPT5 <- CMPT	0.768	0.767	0.030	25.839	0.000
	CMPT4 <- CMPT	0.874	0.873	0.016	53.142	0.000
	CMPT3 <- CMPT	0.876	0.876	0.015	58.352	0.000
	CMPT2 <- CMPT	0.844	0.847	0.026	32.577	0.000
	CMPT1 <- CMPT	0.777	0.780	0.028	28.227	0.000
Change Management	CMGT5 <- CMGT	0.834	0.835	0.017	49.679	0.000
	CMGT4 <- CMGT	0.851	0.851	0.018	47.719	0.000
	CMGT3 <- CMGT	0.827	0.828	0.017	48.888	0.000
	CMGT2 <- CMGT	0.766	0.764	0.030	25.376	0.000
	CMGT1 <- CMGT	0.774	0.772	0.024	32.317	0.000
Behavioral Intention to Adopt	BHVI5 <- BHVI	0.829	0.829	0.020	42.017	0.000
	BHVI4 <- BHVI	0.855	0.855	0.017	51.361	0.000
	BHVI3 <- BHVI	0.798	0.798	0.027	29.299	0.000
	BHVI2 <- BHVI	0.831	0.832	0.020	42.558	0.000
	BHVI1 <- BHVI	0.728	0.726	0.031	23.635	0.000

SYSQ: Service Quality, INFQ: Information Quality, SRVQ: Service Quality, CMGT: Change Management, CMPT: Competitiveness Pressure, PNPR: Pandemic Pressure, PEUS: Perceived Ease of Use, PUSE: Perceived Usefulness, SECU: Security, BHVI: Behavioral intention to adopt, PERF: perceived performance

The results showed that all 55 model indicators possessed high indicator reliability levels.

4.5.2 Internal Consistency Reliability

The measurement model's internal consistency reliability was tested using Cronbach's alpha and composite reliability (CR). Authors have differing views about the appropriate tests to be utilized; for instance, Henseler et al. (2009) stated that CR should be employed over Cronbach's alpha in testing the internal consistency of the model but Hair et al. (2013) stressed that both Cronbach's alpha and CR should be used in a way that the lower bound of true reliability is measured by the former, while the lower one by the latter. With regards to the cut-off value, Nunnally (1994) suggested that the measurement model will have satisfactory internal consistency reliability if the Cronbach's alpha and CR value of each construct is higher than 0.70. Henseler et al. (2009) suggested higher values of above 0.80 or 0.90 for the internal consistency reliability of the research to reach satisfactory levels. Thus, PLS algorithm test was used in this study to obtain the CR and Cronbach's alpha values of each sub-construct.

Table 4.13 Values of CR and Cronbach's alpha for the sub constructs

Construct	**Composite Reliability**	**Cronbach's Alpha**
SYSQ	0.896	0.856
INFQ	0.881	0.831
SRVQ	0.912	0.879
CMGT	0.906	0.870
CMPT	0.916	0.885
PNPR	0.892	0.848
PEUS	0.904	0.867
PUSE	0.913	0.880
SECU	0.899	0.860
BHIV	0.904	0.867
PERF	0.887	0.842

SYSQ: Service Quality, INFQ: Information Quality, SRVQ: Service Quality, CMGT: Change Management, CMPT: Competitiveness Pressure, PNPR: Pandemic Pressure, PEUS: Perceived Ease of Use, PUSE: Perceived Usefulness, SECU: Security, BHVI: Behavioral intention to adopt, PERF: perceived performance

The CR values differed from 0.896 to 0.916, whereas those of Cronbach's alpha differed from 0.856 to 0.885 (all exceeding the 0.70 cut-off). When both sets of values are compared (Cronbach's alpha and CR), CR appears to be a more robust measurement criterion for internal consistency reliability. Both tests were used to ensure that the model had high internal consistency reliability level.

4.5.3 Convergent Validity

Henseler et al. (2009) described convergent validity as representing a set of indicators of one and the same construct, and this can be illustrated via uni-dimensionality. This type of validity depends on the responses correlations that are obtained through the use of various measuring methods on a single construct (Götz et al. 2010). In this regard, AVE is an extensive and common method used to establish convergent validity (Fornell & Larcker 1981).

Convergent validity values are sufficient if they are 0.5 or higher (Hair et al., 2013), indicating that the indicators share half of their variance with the examined construct (Henseler et al. 2009) and in this study, the AVE values of the sub-constructs were obtained using PLS algorithm test.

Table 4.14 The AVE values for the sub constructs of the study

Sub Construct	**AVE**
SYSQ	0.632
INFQ	0.596
SRVQ	0.675
CMGT	0.658
CMPT	0.687
PNPR	0.623
PEUS	0.653
PUSE	0.678
SECU	0.641
BHIV	0.655
PERF	0.612

SYSQ: Service Quality, INFQ: Information Quality, SRVQ: Service Quality, CMGT: Change Management, CMPT: Competitiveness Pressure, PNPR: Pandemic Pressure, PEUS: Perceived Ease of Use, PUSE: Perceived Usefulness, SECU: Security, BHVI: Behavioral intention to adopt, PERF: perceived performance

The AVE values of the constructs ranged from 0.632 to 0.687 (all exceeding 0.50), which means convergence validity of the constructs met the required values.

4.5.4 Discriminant Validity

The level to which the items differentiate/discriminate among the constructs or to which the items measure the distinct concepts is known as discriminant validity. The measures discriminant validity was tested through the correlations of the measures of the possible overlapping constructs. In past studies, the stress was laid on robust items loadings on corresponding constructs with the necessity of the average variance shared between each construct and its measures to exceed the variance shared between the construct and other model constructs (Henseler et al. 2009).

Discriminant validity of the measurement model can be evaluated in two ways, namely at the construct level and at the indicator level. Details of both are provided in the next paragraphs. Accordingly, the construct level discriminant validity was tested using Fornell and Larcker (1981) criterion, where the squared AVE is observed to be higher than the specific constructs and other constructs correlations. PLS algorithm was employed to obtain the AVE of each construct after which the squared AVE was manually calculated. Discriminant validity values are tabulated in Table 4.15, with the bold diagonal values representing squared AVE values. The constructs inter-correlations are, on the other hand, denoted by the non-bolded values located off-diagonally.

Table 4.15 shows that the squared AVEs were all higher than the inter-correlation values in the column, confirming discriminant validity at the construct level as a result of which, squared AVE values and inter-correlation values evidence discriminant validity using the measurement model’s first assessment.

Table 4.15 Inter-correlation matrix

	BHVI	CMGT	CMPT	INFQ	PERF	PEUS	PNPR	PUSE	SECU	SRVQ	SYSQ
BHVI	**0.809**										
CMGT	0.554	**0.811**									
CMPT	0.527	0.615	**0.829**								
INFQ	0.420	0.505	0.449	**0.772**							
PERF	0.597	0.443	0.492	0.401	**0.783**						
PEUS	0.391	0.250	0.264	0.265	0.373	**0.808**					
PNPR	0.509	0.502	0.518	0.489	0.480	0.379	**0.789**				
PUSE	0.374	0.317	0.281	0.197	0.312	0.515	0.495	**0.823**			
SECU	0.417	0.363	0.349	0.277	0.398	0.240	0.258	0.188	**0.800**		
SRVQ	0.560	0.588	0.550	0.601	0.525	0.353	0.620	0.384	0.291	**0.821**	
SYSQ	0.401	0.486	0.424	0.452	0.394	0.217	0.440	0.253	0.296	0.460	**0.795**

SYSQ: Service Quality, INFQ: Information Quality, SRVQ: Service Quality, CMGT: Change Management, CMPT: Competitiveness Pressure, PNPR: Pandemic Pressure, PEUS: Perceived Ease of Use, PUSE: Perceived Usefulness, SECU: Security, BHVI: Behavioral intention to adopt, PERF: perceived performance

4.6 ASSESSMENT OF THE STRUCTURAL MODEL

The structural model formation comprises of the constructs/latent variables along with their connected paths to each other (refer to Figure 4.2). Structural model assessment is directed towards specifying the latent variables relationships (Henseler et al. 2009) and at evaluating the validity of the research model and the path estimates, involving the testing of the formulated hypotheses (Hair Jr et al. 2013). The process of assessing the structural model involves the use of coefficient of determination (R^2), path coefficient (β) and model fit analyses.

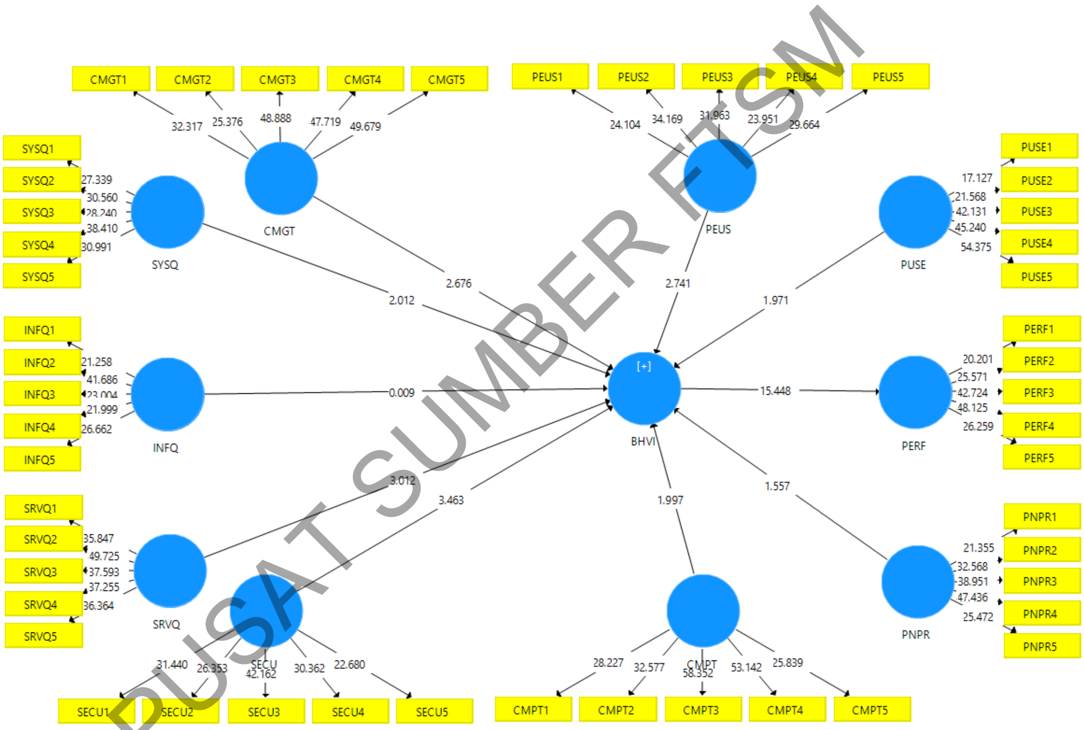

Figure 4.2 Structural Model of GIS Adoption

4.6.1 Coefficient of Determination

The amount of variance in the dependent variable is measured through the coefficient of determination and often, it is predicted by the independent variables (Hair et al. 2012). In other words, the coefficient of determination (R^2) assesses the goodness of fit of the regression function against the empirical manifest variables and the higher the coefficient of determination (R^2) value, the higher will be the percentage of variance explained. According to Hair et al. (2012), such a value ranges from 0 to 1.

The values of the PLS path models should have sufficiently high value to achieve the least explanatory power level. Cohen (1988) established that R^2 values ranging from 0.02 to 0.12 are considered small, those from 0.12 to 0.25 are moderate, while those from 0.25 to 1 are considered substantial. On the other hand, Mitchell and Jolley (2013) indicated that such values are small when they range from 0.01 to 0.09, they are moderate from 0.09 to 0.25, and they are substantial if they are from 0.25 to 1. The dependent variables coefficient of determination (R^2) values in this study were calculated using PLS algorithm test and they are tabulated in Table 4.16.

The R^2 values displayed in the above table indicate that performance obtained an R^2 value of 35.6% in predicting behavioral intention and behavioral intention obtained an R^2 value of 48.3% as predicted by factors. This indicates that both R^2 values are high.

Table 4.16 The R square values

Construct	**R^2**	**Power**
Behavior Intention (BHVI)	0.483	High
Performance (PERF)	0.356	High

4.6.2 4.7Model Fit

Prior studies dedicated to model fit such as Vinzi et al. (2010) and Henseler and Sarstedt (2013) brought forward a goodness of fit (GoF) criterion to be used to measure the PLS model's overall fit. GoF is an index used in PLS path modeling (Sarstedt & Ringle 2010) and is acknowledged as an operational approach to verify and confirm the PLS model's performance (both measurement and structural models), and is directed towards the overall model performance (Chin 2010; Esposito Vinzi et al. 2010). GoF was referred to by Tenenhaus et al. (2005) as the index that validates the global fit of the PLS model.

The use of GoF in PLS-SEM has been debatable in literature; to begin with, Hair et al. (2017) claimed that the method is missing a global GoF measure, which confines