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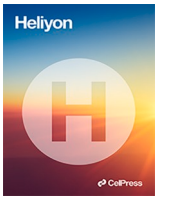

Research article

Geographic information systems adoption model: A partial least square-structural equation modeling analysis approach

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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. However, considering the extensive adoption of Information System (IS) throughout history for government organizations' or citizens' disaster response, the implementation of geographical elements is still minimal. Previous GIS models and framework studies, particularly in developing countries, were affected by pandemic pressure, competitiveness pressure, change management, and security factors. Thus, this study aims to develop a model for the successful adoption of GIS using the Technology Acceptance Model (TAM), and De Lone and Mc Lean Information Success Model and analyze the applicability of the existing factors to enhance the performance of Public Sector Organizations (PSOs). From the study, a new conceptual framework was proposed to examine the effects of factors on GIS adoption that impact performance among PSOs from the perspective of Saudi Arabia. Quantitative methods were used to collect data through a questionnaire distributed to 350 respondents from PSO, and only 272 were found to be valid. Partial Least Square Structural Equation Modeling (PLS-SEM) validated the GIS model. The finding revealed that system quality, service quality, change management, competitiveness pressure, perceived ease of use, perceived usefulness, and security factors significantly and positively affected GIS adoption. The study also showed that GIS adoption substantially affected PSO performance. The proposed model provides insight into how GIS adoption can eventually enhance performance among PSOs. In essence, the study contributes to the running of PSO and the decisions taken by policymakers.

1. Introduction

Adopting Geographic Information System (GIS) technology is defined as selecting technology in professional work surroundings [1,

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2]. In contrast, the actual GIS technology usage refers to the level of use for a specific purpose that literature has kept close documentation of [3–5]. With comprehensive transaction support and reporting capabilities, GIS offers a strong framework to manage types of records [6]. Also, GIS can analyze massive amounts of spatial data [7]. More importantly, the use of GIS technology applications has been evidenced to revolutionize the way of presenting the information obtained from complex data [8,9]. Also, GIS education research is one of the geography sub-fields developed to enhance GIS technology to acquire knowledge in different surroundings [10]. It involves the examination of GIS technology's effectiveness and ability to enhance learning among students and professional development among adults [11]. According to Ref. [12], IT studies require the identification of factors that influence decision-making involving system usage and the necessity of such use.

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 [13]. Researchers widely agree that the actual use of IT in most firms falls short of its potential ([14–16]), 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 adopting technologies have been studied in several works. A study conducted by Ref. [17] came up with some recommendations highlighting the urgent need to identify new factors as its a straightforward technique that might facilitate the adoption. Other past authors, such as [18,19], and [20], 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 Ref. [12], IT studies require the identification of factors that influence decision-making involving existing/new system usage and the necessity of such use. Aside from determining GIS adoption factors, it has been suggested that the top significant factors be examined as past literature has 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 ([21–28]). 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, 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.

Further, it has been suggested that the prominent factors must be identified and examined, as past literature did not focus on such factors and their specific effects on adoption. Therefore, this study aims to examine the factors that influence the adoption of GIS and the effect of such adoption on the performance of organizations. A proposed GIS adoption model has been developed and adjusted based on current technology acceptance theories to fit the Saudi public sector setting. The study incorporates the Technology Acceptance Model (TAM) [4,29] despite recommended in earlier studies [30–32]. Then, the model was validated using Partial Least Square- Structural Equation Modeling (PLS-SEM). Two main phases are involved in validating the model: (1) the measurement model assessment and (2) 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 [33,34].

Prior literature employed existing technology acceptance theory and their modifications, with some of them employing the original versions of the theories [35]. 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 [26,36,37]. 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.

The rest of the paper is organized as follows: Section 2, the related works that involve the adoption of GIS. Section 3, the research method justified the response rate, data preparation and screening, missing data, outliers, and assessment of data normality. Section 4 explained the results of PLS-SEM analysis. Section 5 discussed the hypothesis testing, and the findings were then concluded in Section 6.

2. Related works

Differentiating GIS dissemination from other types of technology diffusion described in the literature is 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 to suit its needs. Even while countless studies have been done on the spread of GIS technology, only a few have focused on underdeveloped countries. Their study [38] 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 several 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 [39] 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 India's most prominent metropolitan entities, and it has been using spatial information and GIS as part of its e-governance initiatives. Corporations' ability to carve out a place in the 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 [39] demonstrated through an integrated study of GIS.

In a similar work [24], used GIS modeling 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, choosing the correct routes 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. To resolve 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 [40], provided a summarized version of the research method to determine the suitable site to build a new branch for Bank X, specifically in 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.

A study [9] explained that within the Malaysian context, GIS is a technique that facilitates more transparent, accurate, and rapid access to location through real-world spatial data, which can produce precise and concise data [41]. 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 the Jamek Jelutong Mosque and the Masjid Jamek Sungai Nibong, the writers conducted field research at these two mosques. Depending on system conditions, new land sites 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 Ref. [42] 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 Ref. [43] 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 nationwide. Three fundamental methods were used to compare GIS managing models' performance worldwide 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 [44], 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, if GIS is integrated into the organizational structure, and if the GIS advantages for DRR are promoted to the decision-making bodies. This GIS necessitates a long-term approach and active involvement from stakeholders in the capacity-building procedure.

In the Mozambique context [45], 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 critical, pressure from donors is the only statistically significant factor in the desire to adopt and the actual adoption of GIT.

In agriculture, GIS was evidenced as a technology that drives current methods to precision. A study [8] conducted a systematic literature review (SLR) of 120 relevant works about Big GIS Analytics (BGA) applications in the agriculture setting using two categories: level of analytics and GIS applications in agriculture. While designing the BGA framework for the agriculture supply chain, this study considered the many ways 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 significant 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, Saudi Arabia [46], 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 used in the process; with a combination of the flood hazard index map and a layer of zone boundaries, we could identify the locations at high risk of flooding.

Aside from the above studies on developing nations, GIS adoption studies [47–49] owing to contextual impediments have been few and far between. However, some studies in the under-examined context have mentioned examples of GIS adoption through different initiatives, incentives, and projects. For instance, in Saudi Arabia [26], 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) was 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 networks, peers, and cultural values significantly impacted 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.

Even though GIS is becoming increasingly prevalent, very little is known about the factors that truly influence its adoption in the workplace. This influence is true, although numerous fields have attested to the benefits of using GIS [50]. examined the factors that mark the everyday 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 who can 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 crucial in determining their success across all adoption structures.

In addition to the above studies [27], dedicated his empirical study to determining how residential infrastructure agencies can adopt geospatial technology to create strategies to fully exploit the technologies in decision-making. The researcher extensively reviewed government reports and material 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. As such, it contributes to practice with implications for decision-makers in the agencies relevant to delivering residential infrastructure to leverage the technologies to achieve their best adoption rate. The [27] findings suggested more studies concerning the development of geospatial technologies usage in the kingdom.

Finally [51], 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 explored this approach and discovered the challenges and possibilities, including 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.

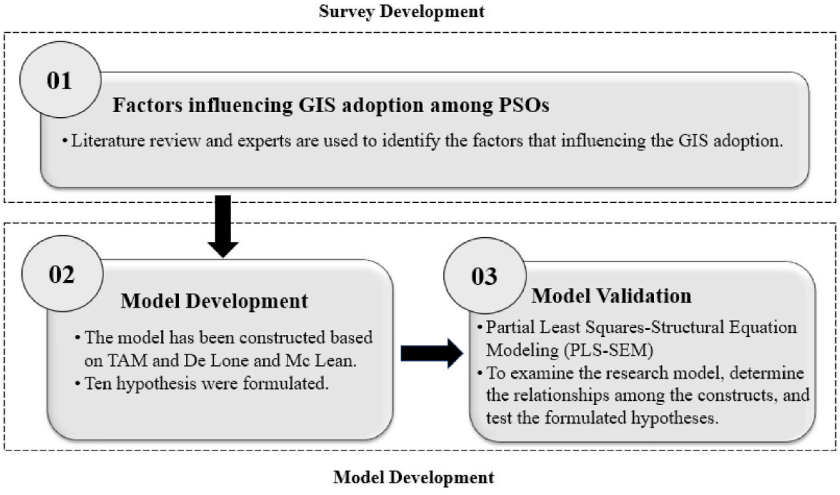

Fig. 1. Phases of development GIS model.

3. Methods

As shown in Fig. 1, three phases are involved in this study. The method is characterized by identifying the factors influencing GIS, whereby Saudi Arabia was considered the study case.

The factors influencing GIS in Saudi Arabia and Malaysia were identified in the first phase through a literature review and expert verification [52]. The preliminary study and literature review phase define the research problem regarding the lack of GIS adoption models. 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 considered. 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.

Table 1
Measurement scale for exogenous factors and their sources.

No	Factor	Questions	Reference
	Perceived System Quality	The GIS should:	[56,57]
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:	[56,58]
1		Information that is free from errors	
2		Correct information	
3		Precise information	
4		Sufficient information	
5		Accurate information	
	Perceived Service Quality	The GIS assists us in providing:	[55,59]
1		Timely services"	
2		Right services	
3		Accurate services	
4		Complete services	
5		Dependable services	
	Change Management	Change management in GIS adoption:	[60]
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		The roles of all employees are clearly communicated.	
	Competitiveness Pressure	With GIS adoption:	[60]
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.	
4		I am expected to use the GIS all the time to meet my work obligations.	
5		GIS is vital to ensure competitiveness.	
	Pandemic Pressure	During the Pandemic of Covid-19	[29,61]
1		We use the system more than before	
2		We depend entirely 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 about integrating all the functions of the system.	
	Perceived Ease of Use	How easy is GIS to use:	
1		GIS is easy to use	
2		GIS can be used without referring to a user manual	
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	
	Perceived Usefulness	How useful is GIS:	[29,61]
1		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	
	Security	What is the security level in GIS:	[61,62]
1		Security features are a factor in choosing whether or not GIS.	
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."	

Phase two involved the development of the study's conceptual model, which the TAM underpinned [53]. Then, the framework encapsulates the primary elements of internal factors crucial for GIS. The first factor in the developed model is system quality. System quality is represented as the IS measurements [54] 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 [55]. The phase outputs include the research model, the nine identified relationships among the constructs in the model, and the ten formulated hypotheses. In the last phase, the questionnaire is developed from prior studies of the same caliber. This third phase involved relating the issues to the selected data collection method used in the paper. 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 sample size 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. The second is to examine the questionnaire's reliability prior to the actual study. After confirming the instruments' validity and reliability, the survey will be conducted on the PSO in KSA. The pilot study results will be analyzed using descriptive statistics SPSS version 25. The output of the last phase includes the final research instrument and the sample size.

The study employs a quantitative research methodology (a questionnaire survey) to gather participant responses. A key aspect of the methodology lies in the rigorous consultations conducted with domain experts prior to data collection. These consultations were pivotal in bolstering the robustness and validity of the findings. By tapping into the insights of seasoned professionals in the field, the study gained deeper insights into the subject matter. Moreover, these interactions empowered the study to fine-tune its data collection and analysis approaches, thereby enhancing the overall quality and reliability of the research outcomes. This iterative process ensures methodological rigor and distinguishes the study by its thoroughness in incorporating expert perspectives to enrich the research framework.

Survey design guidelines were used to develop the study model and to identify the factors contributing to the adoption of GIS and, in turn, the effect of such adoption on Saudi PSO. Prior studies validated measures regarding IS adoption. The questionnaire has four parts: 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. Based on their contribution to adopting 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, as shown in Table 1.

3.1. 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 to 2022. From the distributed copies, 272 were retrieved, indicating a rate of response of 78 %, and from 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 2.

3.2. Demographic background

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. Regarding 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, based on Table 2. 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 %),

Table 2
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 useable	40

indicating that the two main age groups (30–40 years, over 40 years) constituted the majority of the respondents. Those under 20 only comprised 1.3 % of the total respondents, minimizing their influence on the overall survey. The respondents' age distribution in the study has been tabulated.

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 degree (6.0 %), and PhD degree (1.3 %). 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 %). 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 years of experience in the company is included in Table 3.

3.3. 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 hypothesis testing – such analysis methods have their strengths and weaknesses [63]. This study used SEM analysis for data analysis and has its data assumptions, particularly the dataset's distributional characteristics [64,65]. To eliminate the model estimation failure, precautionary steps have been carried out in data preparation and screening involving missing data, outliers, and normality.

3.4. Missing data

This type of data refers to the part of data gathered in the study that has missing information (response to one or more survey items) caused by incomplete answers to the survey [63]. In the real world, complete data cannot always be ensured owing to missing data values in datasets. In the same line of argument [66], warned about how missing data in scientific research can lead to adverse outcomes if not considered in most data analysis procedures, leading to two main outcomes: the reduction of the capability/efficiency of statistical tests in identifying a given data set relationship and the presence of biases relating to parameter estimates.

In the above regard, respondents can be prevented from missing answering any questionnaire item by designing the items without ambiguity and having sufficient space for crosschecking and reviewing missing responses before retrieving questionnaire copies [66]. Several methods can be adopted to counter missing data presence, including considering 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 respondent's misunderstanding of the survey items was clarified through item explanations. This phase also involves data coding and labeling 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 response accuracy. Other factors that affected the results included each question's simplicity and suitability and the number of selected respondents.

3.5. 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 dataset [64]. According to Ref. [67], 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 is an extreme value on two or more variables. Outliers can stem from observational

Table 3
Demography of the respondents.

Demographic		Frequency	Percentage (%)
Gender	Male	138	59.5
	Female	94	40.5
Age	Below 20 years	3	1.3
	Between 20 and 30 years	32	13.8
	Between 30 and 40 years	133	57.3
	Over 40 years	64	27.6
Education Level	Bachelor	124	53.4
	Master	14	6.0
	PhD	3	1.3
	Others	91	39.2
Current position	115	49.6	115
	86	37.1	86
	24	10.3	24
	7	3.0	7
Years of Experience	Less than three years	40	17.2
	3–6 years	90	38.8
	Over than 6 years	102	44.0

errors, wrong responses, errors in data entry, questionnaire errors, unclear instructions, incorrect survey layouts, or sometimes self-reported data [63]. Moreover, outliers can lead to skewed statistical test results [68], affecting the values of mean, standard deviation, and correlation coefficients. Outliers can also influence the fit estimates of the model, the common errors, and parameter estimations; concerning this, parameters that exceed the suitable range or latent variables correlations that exceed one may be caused by outliers in the data set [69].

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 [68]. 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. Each case can calculate the Mahalanobis distance (D2) to determine multivariate outliers. Specifically, Mahalanobis distance (D2), also referred to as squared Mahalanobis distance, is defined as the distance in standard deviations between score sets for one case and the variables sample means (centroid) [64,69]. [67] explained that it focuses on a single observation instead of the set of variables center, while [69] contended that an outlier case is generally determined when the value of (D2) is distinct from the rest of the D2 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 skewness and kurtosis values 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 [67] recommendation. The value of Mahalanobis distance (D2) confirmed the completeness of the answers, with the absence of outliers, so all 232 cases were exposed to the subsequent statistical analysis.

3.6. Assessment of the data normality

In multivariate analysis, the final assumption relates to the normality of data distribution, and this is generally assessed by detecting the variables' deviation from normality, which is an SEM assumption - SEM requires data to have a multivariate normal distribution [67]. In other words, normality is a basic multivariate analysis assumption, 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 5 contains the results wherein the values ranged from −0.862 to −0.330, which falls under the range of 3, as stated by Ref. [69]. Moreover, the kurtosis values differed from −0.214 to 1.240, falling within the recommended value (±7) [69]. Data had normal distribution as the skewness and kurtosis values were constant and fell within the acceptable ranges recommended by past studies. The indicators of the items are shown as follows in Table 4.

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

4. Results

This study used exploratory factor analysis (EFA) to reduce or preserve data and their characteristic while deleting items that loaded and cross-loaded at low values [67]. The EFA is also used to examine the factor loading stability of different constructs to ensure the instrument's factor validity. Moreover, Principal Components Analysis was used to extract the 232 responses and 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 [70] recommendation. KMO tests the magnitude of the partial correlations among the examined items – with KMO values required to be higher than 0.60 [71]. 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 $p < 0.05$ for adequate correlations among variables, forming the basis for factor analysis [72].

The eigenvalues were obtained and analyzed in addition to the test mentioned before [63] to confirm that the number of variables

Table 4
Indicators for each item.

Indicator	Item
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

Table 5
Data normality test results.

	Descriptive Statistics				
	N	Skewness		Kurtosis	
	Statistic	**Statistic**	**Std. Error**	**Statistic**	**Std. Error**
SYSQ1	232	−0.690	0.160	0.768	0.318
SYSQ2	232	−0.734	0.160	0.988	0.318
SYSQ3	232	−0.753	0.160	1.099	0.318
SYSQ4	232	−0.626	0.160	0.973	0.318
SYSQ5	232	−0.590	0.160	0.704	0.318
INFQ1	232	−0.697	0.160	0.456	0.318
INFQ2	232	−0.576	0.160	0.320	0.318
INFQ3	232	−0.539	0.160	0.005	0.318
INFQ4	232	−0.502	0.160	0.386	0.318
INFQ5	232	−0.501	0.160	0.396	0.318
SRVQ1	232	−0.537	0.160	−0.002	0.318
SRVQ2	232	−0.638	0.160	0.178	0.318
SRVQ3	232	−0.593	0.160	0.119	0.318
SRVQ4	232	−0.719	0.160	0.823	0.318
SRVQ5	232	−0.714	0.160	0.922	0.318
CMGT1	232	−0.681	0.160	0.355	0.318
CMGT2	232	−0.654	0.160	0.180	0.318
CMGT3	232	−0.636	0.160	0.276	0.318
CMGT4	232	−0.623	0.160	0.163	0.318
CMGT5	232	−0.608	0.160	0.261	0.318
CMPT1	232	−0.693	0.160	0.468	0.318
CMPT2	232	−0.640	0.160	0.309	0.318
CMPT3	232	−0.626	0.160	0.481	0.318
CMPT4	232	−0.619	0.160	0.407	0.318
CMPT5	232	−0.790	0.160	1.133	0.318
PNPR1	232	−0.631	0.160	0.099	0.318
PNPR2	232	−0.525	0.160	−0.241	0.318
PNPR3	232	−0.431	0.160	−0.165	0.318
PNPR4	232	−0.379	0.160	0.094	0.318
PNPR5	232	−0.572	0.160	0.149	0.318
PEUS1	232	−0.637	0.160	0.220	0.318
PEUS2	232	−0.691	0.160	0.387	0.318
PEUS3	232	−0.588	0.160	0.047	0.318
PEUS4	232	−0.645	0.160	0.489	0.318
PEUS5	232	−0.655	0.160	0.499	0.318
PUSE1	232	−0.570	0.160	0.384	0.318
PUSE2	232	−0.479	0.160	0.218	0.318
PUSE3	232	−0.683	0.160	0.955	0.318
PUSE4	232	−0.697	0.160	0.736	0.318
PUSE5	232	−0.657	0.160	0.811	0.318
SECU1	232	−0.797	0.160	0.797	0.318
SECU2	232	−0.857	0.160	1.240	0.318
SECU3	232	−0.862	0.160	0.917	0.318
SECU4	232	−0.589	0.160	0.569	0.318
SECU5	232	−0.684	0.160	0.876	0.318
BHVI1	232	−0.789	0.160	0.753	0.318
BHVI2	232	−0.688	0.160	0.648	0.318
BHVI3	232	−0.853	0.160	0.512	0.318
BHVI4	232	−0.794	0.160	0.387	0.318
BHVI5	232	−0.774	0.160	0.367	0.318
PERF1	232	−0.789	0.160	0.753	0.318
PERF2	232	−0.688	0.160	0.648	0.318
PERF3	232	−0.379	0.160	0.094	0.318
PERF4	232	−0.797	0.160	0.797	0.318

is predominantly responsible for the variation in data. Accordingly, 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 indication is sufficient for a factor resolve, particularly in social science [67], although other studies such as [73] deemed 50 % of the described total variance as the entry.

4.1. Exogenous constructs

The rotated component matrix through Varimax rotation was conducted to validate the perceived distinction of the nine exogenous constructs, 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 commonalities ranged from 0.519 to 0.788, which means the indicator variables have worked well for the study model, and Eigenvalue exceeded 1.0 (cut-off for extraction). To reach 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 45 items of the nine distinct factors related to the exogenous constructs. Evidently, the nine-factor solution is the most appropriate, producing 67 % of the total variance. A particular pattern was produced.

Nine distinct factor structures 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) to extract items with 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.

4.2. Endogenous and dependent constructs

This study examined the endogenous and dependent factors using factor analysis with Varimax Rotation (Table 5), specifically GIS and perceived overall performance, to validate the perceived distinction of the constructs given to the respondents. The two-factor solution showed the following results: Eigenvalues exceeded 1.0, with variance explained as 64.253 % of the total variance of the two factors. 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 a 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 loading ranges from 0.685 to 0.833. Ten (10) items represented the two constructs, as shown in Table 6.

The study ran exploratory factor analysis using Varimax Rotation for scale validation coupled with other validity tests in the later stages. Some studies in the literature applied EFA with Varimax Rotation to establish convergent validity [74] 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 convergent and discriminant validity are present. Thus [75], contended that EFA cannot validate the convergent and discriminant validity of the indicators of latent variables. Hence, additional validity testing, known as construct validity, is needed. The study conducted this additional testing with details presented in the next sub-section.

4.3. Scales reliability testing

Two more validation phases were carried out, the first being factor structure and reliabilities of the revised scales for scale refinement. Accordingly, EFA was used in SPSS 25.0. The second phase involved validating 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 has at least three items.

Furthermore, reliability refers to the level to which a set of measurement items of a construct matches each other [67]. According to Ref. [76], testing the presence of reliability can be done through Cronbach's alpha–internal consistency scale measurement, which has been extensively used in the literature [77,78]. Accordingly, Cronbach's alpha coefficient was calculated for every scale. The acceptable values for Cronbach's alpha begin from 0.70, although preferable values begin from 0.80 and above. Table 7 presents the results of 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. Descriptive analysis

This section presents the descriptive characteristics and profile of the examined variables. The final descriptive statistics results for the study variables are presented in Table 8. Sample characteristics along with their mean, standardized error of the mean, median,

Table 6
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.

Table 7
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

mode, standard deviation, variation, skewness, and kurtosis values of the constructs and sub-constructs were obtained using SPSS 25.0. Past studies on PLS-SEM [79,80] indicated that the minimum sample size requirements should be 30–100 cases. PLS application requires a sample size with 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 constructs in the inner path model [81]. The sample size of this study is 232, indicating sufficient sample size for reliability and accurate analysis using PLS as it can simultaneously estimate the measurement and structural models [82].

The practical assessment of the measured variables' multivariate normality is difficult; thus, skewness and kurtosis are employed to justify applying variance-based SEM methods (i.e., PLS-SEM) (West et al., 1995). In light of skewness and kurtosis [82], 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 [82]. The skewness and kurtosis values of the measured variables were obtained using SPSS 25.0 and are tabulated in Table 7. Based on the table, skewness values ranged between -0.162 and 0.275, and kurtosis values ranged between -0.512 and 2.946. Overall, the sample's data characteristics match the suitable use of PLS; therefore, robust outcomes are expected from PLS analysis.

In PLS, the assumption is that data distribution is not normal and is employed in cases with limited knowledge concerning the latent variables distribution and the ones needing more data-related estimation [83]. In other words, it may be logically assumed that the variables have a normal distribution. The sample's data characteristics made sure that the PLS use was suitable.

4.5. Assessment of measurement model

The measurement model houses indicators and their connections to the latent variables requiring measurement (Fig. 2). Measurement model assessment provides the specifications concerning the relationships between indicators and latent variables [84]. Such assessment evaluates validity, reliability, and the inner path model estimates [84]. Therefore, this study conducted the tests to confirm indicator reliability, internal consistency reliability, convergent validity, and discriminant validity.

4.6. 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 was 0.70 or higher, following the suggestion of [67]. Concerning this [85], stated that the factor loadings ranging from 0.70 to 0.90 indicate a 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 [67]. revealed that if the factor loadings range from 0.40 to 0.50, the indicators need to be dropped in a way that contributes to increasing the composite reliability above the cut-off value. The model indicators' factor loadings are tabulated in Table 9. The results showed that all 55 model indicators possessed high indicator reliability levels.

4.7. 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 Ref. [84], stated that CR should be employed over Cronbach's alpha in testing the internal consistency of the model, but [86] 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. Regarding the cut-off value [87], suggested that the measurement model will have satisfactory internal consistency reliability of Cronbach's alpha, and the CR value of each construct is higher than 0.70. They suggested higher values of above 0.80 or 0.90 for the internal consistency reliability of the research to reach satisfactory levels [84]. As a result, as indicated in Table 10, this study employed the PLS algorithm test to determine the CR and Cronbach's alpha values of each sub-construct.

Table 8
Descriptive analysis for all measurement items.

	N	Min	Max	Mean	Std.	Skewness		Kurtosis	
	Statistic	**Statistic**	**Statistic**		**Deviation**	**Statistic**	**Std. Error**	**Statistic**	**Std. Error**
SYSQ1	232	2	5	4.14	0.654	−0.332	0.128	0.027	0.256
SYSQ2	232	2	5	4.06	0.660	−0.293	0.128	0.095	0.256
SYSQ3	232	2	5	4.09	0.625	−0.275	0.128	0.327	0.256
SYSQ4	232	2	5	4.11	0.710	−0.303	0.128	−0.518	0.256
SYSQ5	232	2	5	4.03	0.737	−0.680	0.128	0.684	0.256
INFQ1	232	2	5	3.76	0.862	−0.436	0.128	−0.363	0.256
INFQ2	232	2	5	4.05	0.801	−0.677	0.128	0.192	0.256
INFQ3	232	2	5	3.91	0.832	−0.473	0.128	−0.256	0.256
INFQ4	232	2	5	4.17	0.723	−0.573	0.128	0.102	0.256
INFQ5	232	2	5	3.66	0.844	−0.360	0.128	−0.400	0.256
SRVQ1	232	2	5	4.31	0.718	−0.863	0.128	0.540	0.256
SRVQ2	232	2	5	4.27	0.732	−0.851	0.128	0.613	0.256
SRVQ3	232	2	5	3.90	0.786	−0.547	0.128	0.133	0.256
SRVQ4	232	2	5	3.94	0.792	−0.436	0.128	−0.179	0.256
SRVQ5	232	2	5	4.01	0.751	−0.577	0.128	0.314	0.256
CMGT1	232	2	5	3.95	0.675	−0.488	0.128	0.677	0.256
CMGT2	232	2	5	3.98	0.691	−0.530	0.128	0.669	0.256
CMGT3	232	2	5	3.92	0.772	−0.443	0.128	−0.029	0.256
CMGT4	232	2	5	4.09	0.709	−0.457	0.128	0.099	0.256
CMGT5	232	2	5	4.24	0.660	−0.530	0.128	0.289	0.256
CMPT1	232	1	5	4.09	0.751	−0.869	0.128	1.503	0.256
CMPT2	232	1	5	3.99	0.778	−0.702	0.128	0.852	0.256
CMPT3	232	1	5	3.96	0.757	−0.480	0.128	0.293	0.256
CMPT4	232	1	5	3.96	0.743	−0.515	0.128	0.491	0.256
CMPT5	232	1	5	4.17	0.715	−0.576	0.128	0.448	0.256
PNPR1	232	2	5	4.30	0.679	−0.832	0.128	0.981	0.256
PNPR2	232	2	5	4.40	0.639	−0.859	0.128	0.871	0.256
PNPR3	232	2	5	4.43	0.624	−0.753	0.128	0.262	0.256
PNPR4	232	2	5	4.47	0.615	−0.946	0.128	0.947	0.256
PNPR5	232	2	5	4.11	0.882	−0.720	0.128	−0.262	0.256
PEUS1	232	2	5	4.43	0.764	−1.346	0.128	1.490	0.256
PEUS2	232	2	5	4.58	0.596	−1.415	0.128	2.508	0.256
PEUS3	232	2	5	4.55	0.604	−1.313	0.128	2.156	0.256
PEUS4	232	2	5	4.28	0.735	−0.789	0.128	0.248	0.256
PEUS5	232	2	5	4.43	0.671	−1.142	0.128	1.616	0.256
PUSE1	232	2	5	4.58	0.642	−1.620	0.128	2.946	0.256
PUSE2	232	2	5	4.53	0.601	−1.217	0.128	1.986	0.256
PUSE3	232	3	5	4.64	0.526	−1.028	0.128	−0.045	0.256
PUSE4	232	1	5	4.53	0.587	−1.162	0.128	2.640	0.256
PUSE5	232	2	5	4.57	0.584	−1.139	0.128	1.194	0.256
SECU1	232	1	5	4.23	0.746	−0.850	0.128	0.870	0.256
SECU2	232	1	5	4.27	0.740	−0.894	0.128	0.920	0.256
SECU3	232	1	5	3.97	0.872	−0.593	0.128	0.209	0.256
SECU4	232	1	5	4.21	0.790	−1.180	0.128	2.263	0.256
SECU5	232	1	5	4.15	0.828	−0.823	0.128	0.503	0.256
BHVI1	232	2	5	4.45	0.622	−0.972	0.128	1.235	0.256
BHVI2	232	2	5	4.26	0.674	−0.640	0.128	0.436	0.256
BHVI3	232	2	5	4.23	0.620	−0.342	0.128	0.090	0.256
BHVI4	232	2	5	4.19	0.730	−0.571	0.128	−0.088	0.256
BHVI5	232	1	5	4.12	0.800	−0.583	0.128	−0.111	0.256
PERF1	232	1	5	3.73	0.921	−0.529	0.128	−0.112	0.256
PERF2	232	2	5	3.99	0.771	−0.566	0.128	0.187	0.256
PERF3	232	2	5	4.04	0.740	−0.442	0.128	−0.062	0.256
PERF4	232	2	5	4.04	0.690	−0.313	0.128	−0.075	0.256
PERF5	232	1	5	3.84	0.839	−0.365	0.128	0.007	0.256
Valid N	232								

4.8. Convergent validity

A study [84] described convergent validity as representing a set of indicators of the same construct, which can be illustrated via uni-dimensionality. This type of validity depends on the response correlations obtained through various measuring methods on a single construct [88]. In this regard, AVE is an extensive and common method to establish convergent validity [89]. Convergent validity values are sufficient if they are 0.5 or higher (J. F. Hair et al., 2013), indicating that the indicators share half of their variance with the examined construct [84], and in this study, the AVE values of the sub-constructs were obtained using the PLS algorithm test. The AVE values of the constructs ranged, as shown in Table 11, from 0.632 to 0.687 (all exceeding 0.50), which means the convergence validity

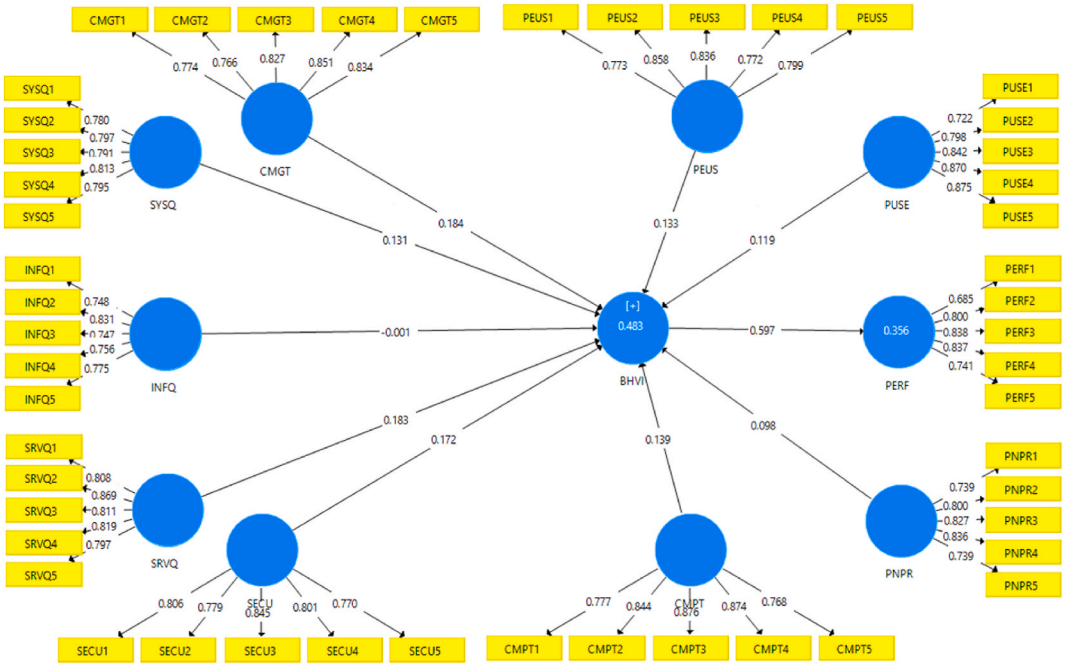

Fig. 2. Measurement model for GIS adoption.

of the constructs met the required values.

4.9. Discriminant validity

The level to which the items discriminate among the constructs or to which the items measure the distinct concepts is known as discriminant validity. The measures of discriminant validity were tested through the correlations of the measures of the possible overlapping constructs. In past studies, the stress was laid on robust item 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 [84]. The discriminant validity of the measurement model can be evaluated in two ways, namely at the construct level and the indicator level. Details of both are provided in the next paragraphs. Accordingly, the construct level discriminant validity was tested using the [89] criterion, where the squared AVE is 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 11, with the bold diagonal values representing squared AVE values. On the other hand, inter-correlations are denoted by the non-bolded values located off-diagonally. Table 12 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.

4.10. Assessment of the structural model

The structural model formation comprises the constructs/latent variables along with their connected paths to each other (Fig. 3). Structural model assessment is directed towards specifying the latent variables' relationships [84] and evaluating the validity of the research model and the path estimates, involving the testing of the formulated hypotheses [86]. The process of assessing the structural model involves using a coefficient of determination (R2), path coefficient (β), and model fit analyses.

4.11. 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 [90,91]. In other words, the coefficient of determination (R2) assesses the goodness of fit of the regression function against the empirical manifest variables, and the higher the coefficient of determination (R2) value, the higher the percentage of variance explained. According to Ref. [91], such a value ranges from 0 to 1. The values of the PLS path models should have sufficiently high values to achieve the least explanatory power level [92]. established that R^2 values ranging from 0.02 to 0.12 are considered small, those from 0.12 to 0.25 are moderate, and those from 0.25 to 1 are considered substantial. On the other hand [93], indicated that such values are small when they range from 0.01 to 0.09, moderate from 0.09 to 0.25, and substantial if they are from 0.25 to 1.

Table 9
Factor loading – Indicator Reliability.

Factor	Items	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)
System Quality	SYSQ5 <- SYSQ	0.795	0.797	0.026	30.991
	SYSQ4 <- SYSQ	0.813	0.815	0.021	38.410
	SYSQ3 <- SYSQ	0.791	0.787	0.028	28.240
	SYSQ2 <- SYSQ	0.797	0.797	0.026	30.560
	SYSQ1 <- SYSQ	0.780	0.777	0.029	27.339
Service Quality	SRVQ5 <- SRVQ	0.797	0.797	0.022	36.364
	SRVQ4 <- SRVQ	0.819	0.818	0.022	37.255
	SRVQ3 <- SRVQ	0.811	0.811	0.022	37.593
	SRVQ2 <- SRVQ	0.869	0.869	0.017	49.725
	SRVQ1 <- SRVQ	0.808	0.808	0.023	35.847
Security	SECU5 <- SECU	0.770	0.769	0.034	22.680
	SECU4 <- SECU	0.801	0.800	0.026	30.362
	SECU3 <- SECU	0.845	0.843	0.020	42.162
	SECU2 <- SECU	0.779	0.775	0.030	26.353
	SECU1 <- SECU	0.806	0.804	0.026	31.440
Perceived Usefulness	PUSE5 <- PUSE	0.875	0.876	0.016	54.375
	PUSE4 <- PUSE	0.870	0.871	0.019	45.240
	PUSE3 <- PUSE	0.842	0.840	0.020	42.131
	PUSE2 <- PUSE	0.798	0.797	0.037	21.568
	PUSE1 <- PUSE	0.722	0.719	0.042	17.127
Pandemic Pressure	PNPR5 <- PNPR	0.739	0.741	0.029	25.472
	PNPR4 <- PNPR	0.836	0.837	0.018	47.436
	PNPR3 <- PNPR	0.827	0.826	0.021	38.951
	PNPR2 <- PNPR	0.800	0.799	0.025	32.568
	PNPR1 <- PNPR	0.739	0.739	0.035	21.355
Perceived Ease of Use	PERF5 <- PERF	0.741	0.741	0.028	26.259
	PERF4 <- PERF	0.837	0.839	0.017	48.125
	PERF3 <- PERF	0.838	0.838	0.020	42.724
	PERF2 <- PERF	0.800	0.801	0.031	25.571
	PERF1 <- PERF	0.685	0.685	0.034	20.201
Performance	INFQ5 <- INFQ	0.775	0.776	0.029	26.662
	INFQ4 <- INFQ	0.756	0.757	0.034	21.999
	INFQ3 <- INFQ	0.747	0.745	0.032	23.004
	INFQ2 <- INFQ	0.831	0.831	0.020	41.686
	INFQ1 <- INFQ	0.748	0.746	0.035	21.258
Information Quality	CMPT5 <- CMPT	0.768	0.767	0.030	25.839
	CMPT4 <- CMPT	0.874	0.873	0.016	53.142
	CMPT3 <- CMPT	0.876	0.876	0.015	58.352
	CMPT2 <- CMPT	0.844	0.847	0.026	32.577
	CMPT1 <- CMPT	0.777	0.780	0.028	28.227
Competitiveness Pressure	CMGT5 <- CMGT	0.834	0.835	0.017	49.679
	CMGT4 <- CMGT	0.851	0.851	0.018	47.719
	CMGT3 <- CMGT	0.827	0.828	0.017	48.888
	CMGT2 <- CMGT	0.766	0.764	0.030	25.376
	CMGT1 <- CMGT	0.774	0.772	0.024	32.317
Change Management	BHVI5 <- BHVI	0.829	0.829	0.020	42.017
	BHVI4 <- BHVI	0.855	0.855	0.017	51.361
	BHVI3 <- BHVI	0.798	0.798	0.027	29.299
	BHVI2 <- BHVI	0.831	0.832	0.020	42.558
	BHVI1 <- BHVI	0.728	0.726	0.031	23.635

Table 10
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

Table 11
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

Table 12
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**

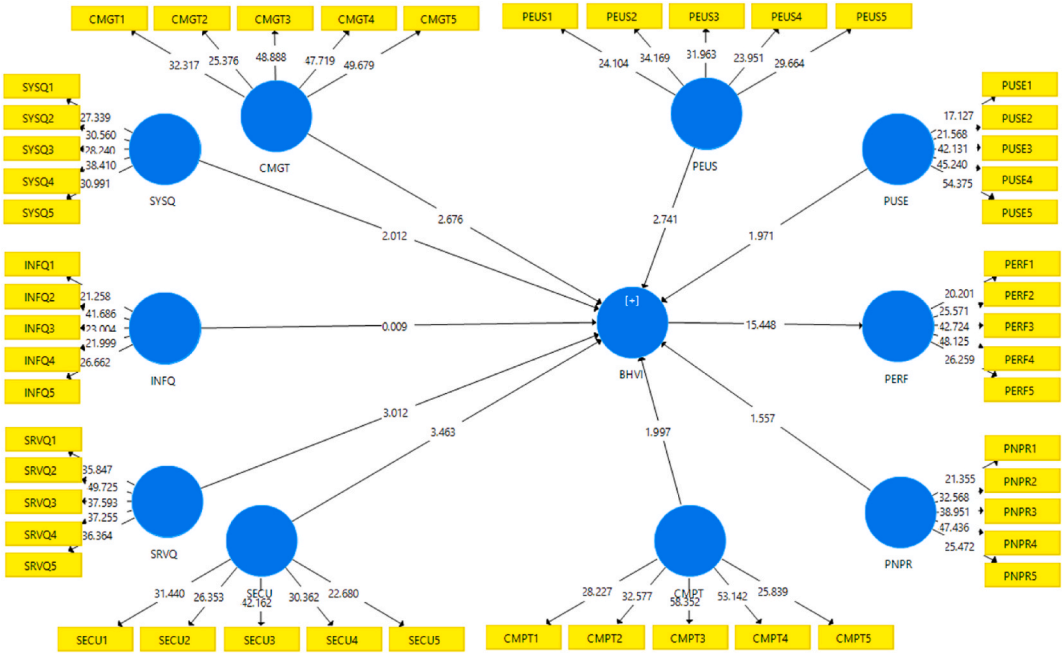

Fig. 3. Structural model of GIS adoption.

The dependent variables coefficient of determination (R^2) values in this study were calculated using the PLS algorithm test and tabulated in Table 13. 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 value indicates that

both R^2 values are high.

4.12. Model fit

Prior studies dedicated to model fit, such as [94,95], 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 [96] 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 [85]. GoF was referred to by Ref. [97] 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 [98], the method is missing a global GoF measure, which confines its use to testing and confirming theories, while [99] proceeded to propose a GoF for PLS-SEM, and [95] brought forward the standardized root mean square residual (SRMR) for measuring the squared discrepancy between the correlations of the model and the implied ones for model validation. A good model fit is represented by values not exceeding 0.08. In addition, the model fit can be evaluated using PLS fit values, and as such, this study used SRMR to obtain GoF, which turned out to be 0.06 (less than 0.08), confirming the fit of data to the model.

5. Discussion

Under this section, the study hypotheses are tested based on the structure of the model. After presenting the tested hypotheses' quantitative findings, the exogenous factors to adopt the GIS relationship were tested through nine hypotheses. The section is also dedicated to presenting the relationships between exogenous-dependent variables.

The path coefficient assessment results from the structural model were used to test the formulated hypotheses, including the path estimates and t-statistics with p-values. Path coefficient values (β) were obtained through the use of the PLS algorithm test, t-statistics values were obtained through the bootstrapping method, and p-values were obtained using an online free calculator (http://easycalculation.com/statistics/p-value-t-test.php). According to Ref. [95], the significant t-values for the two-tailed test should exceed 1.96, with a p-value of 0.05 or lower.

Moreover, path coefficients ranging from 0 to 1 indicate a perfectly positive correlation – in other words, the independent variable variation leads to equal variation in the corresponding dependent variable [100]. On the other hand, if the path coefficient values range from −1 to 0, a perfectly negative correlation indicates that an increase in the independent variable results will lead to an equal decrease in the corresponding dependent variable. The research hypotheses test results through path coefficients, t-statistics, and significance levels are tabulated in Table 14.

The research proposed ten direct hypotheses (Table 15), from which eight were supported (H1, H2, H3, H4, H6, H7, H8 and H10) and two were rejected (H5 and H9). Details on the results are discussed in the following sub-sections. The first research hypothesis (H1) proposed that information quality has a positive relationship with the intention to adopt GIS in Saudi PSO, and based on the results in Table 13, the hypothesis is rejected. The statistical outcome showed that the significant relationship between information quality and behavioral intention towards GIS adoption is not at the level of 0.05, which shows that information obtained from GIS is of no value as it is fixed and unprocessed data. Past findings in the context of mobile commerce by Ref. [101], in e-Government services by Ref. [102], and mobile banking adoption by Ref. [103] underlined the need for GIS to be useful and variable importance in successful technology adoption. The present did not validate prior findings on this hypothesis. Nevertheless, some other past findings align with the result, such as the study by Refs. [104,105], who revealed no significant relationship with information quality/adoption.

The second study hypothesis (H2) proposed that system quality has a positive relationship with the intention to adopt GIS in Saudi Arabia, and the result supported the hypothesis. In the Saudi PSO, system quality influences GIS adoption, which past studies have also evidenced [93]. System quality brings about GIS adoption success through the smooth working of the system without technical glitches or unexpected breaches. Studies that support this hypothesis include [106,107], and [106].

In the third hypothesis (H3), the study proposed the positive influence of service quality on GIS adoption in PSO for Saudi Arabia. The hypothesis is supported by the result presented in Table 14 at the significance level of 0.05, indicating that service quality and the present values and information infrastructure contribute to the success of GIS adoption. Based on this finding, the service quality of GIS in PSO is significant in that timely and quality services are a must for adoption. Past studies, including [107,108] reported a similar finding. The context of this study is Saudi Arabia, a developing nation, and for the fourth hypothesis (H4), it was proposed that change management has a positive relationship with the intention to adopt GIS. Based on the results presented in Table 14, the factor was found to have the highest effect on behavioral intention to adopt GIS. Evidently, change management is crucial to promoting GIS adoption in PSO Saudi Arabia, and it is worth considering during the adoption of technology. System adoption equally calls for change management to prevent unexpected outcomes or potential drawbacks. Several past studies support this finding, such as [109,110]; thus, administrators are advised to be cautious when adopting technology.

This study hypothesized in the fifth hypothesis (H5) that competitive pressure has a positive significant relationship with GIS

Table 13
The R square values.

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

Table 14
Direct hypotheses testing results.

No.	Hypothesis	Path Coefficients)	T-statistics	P-value	Result
H1	INFQ→BHVI	−0.001	0.009	0.993	*Not supported*
H2	SYSQ→ BHVI	0.131	2.012	0.045	Supported
H3	SRVQ→BHVI	0.183	3.012	0.002	Supported
H4	CMGT→ BHVI	0.184	2.676	0.008	Supported
H5	CMPT→ BHVI	0.139	1.997	0.046	Supported
H6	PNPR→BHVI	0.098	1.557	0.120	*Not supported*
H7	PEUS→ BHVI	0.133	2.741	0.006	Supported
H8	PUSE→BHVI	0.119	1.971	0.049	Supported
H9	SECU→BHVI	0.172	3.463	0.000	Supported
H10	BHVI→PERF	0.597	15.448	0.000	Supported

Table 15
Summary of the hypothesis results.

No	Hypothesis	Result
H1	Information quality has a positive relationship with the intention to adopt GIS.	Not Supported
H2	System quality has a positive relationship with the intention to adopt GIS.	Supported
H3	Service quality has a positive relationship with the intention to adopt GIS.	Supported
H4	Change management has a positive relationship with the intention of adopting GIS.	Supported
H5	Competitiveness pressure has a positive relationship with the intention to adopt GIS.	Supported
H6	Pandemic pressure has a positive relationship with the intention to adopt GIS.	Not supported
H7	Perceived ease of use has a positive relationship with the intention to adopt GIS.	Supported
H8	Perceived usefulness has a positive relationship with the intention to adopt GIS.	Supported
H9	Security has a positive relationship with the intention to adopt GIS.	Supported
H10	Intention to adopt GIS has a positive relationship with use/performance.	Supported

adoption, and the finding showed that to remain competitive and ensure a far lead, PSO needs pressure from rivals' competitiveness. The respondents agreed that "GIS is vital to ensure competitiveness". The result is consistent with studies by Refs. [108,111,112]. The sixth proposed hypothesis was not supported by the results indicating that pandemic pressure does not contribute to the successful adoption of GIS. Based on the findings, PSO requires GIS adoption and is inclined towards such adoption even prior to the pandemic. Saudi respondents agreed with the consensus of system dependence even without the pandemic. Furthermore [113], reported similar findings.

The results supported the significant positive effect of perceived ease of use on intention towards adopting GIS. This result is consistent with past studies [114]. Evidently, the respondents in PSO agree that perceived ease of use is a component that boosts their adoption of GIS. This finding was also reported by Refs. [115,116]. PSOs need to consider perceived ease of use regarding GIS and its adoption. This study hypothesized a positive relationship between perceived usefulness and intention toward GIS adoption. Further into the study, evidence shows that GIS adoption is crucial for work effectiveness, productivity, timely task completion, perceived ease at work, and higher control over it. In relation to this, the regression weight of the technology dimension in its prediction of perceived usefulness is significantly different from zero at the 0.001 level (two-tailed). The findings from the hypothesis testing showed that the significant values are below 0.05. Therefore, the hypothesis is significant and supported. It can be concluded that a positive and significant relationship exists between perceived usefulness and perceived intention to adopt GIS.

Thus, for PSOs, GIS adoption effectiveness depends on the system's usefulness, as evidenced in past literature [115,116]. GIS adoption calls for the usefulness of the system to ensure timely work completion and enhanced work effectiveness. Hypothesis 9 proposed that security positively influences behavioral intention toward GIS adoption. Findings showed a significant relationship at a p-value of 0.000, with a standardized estimate (β) for the path from security to the adoption of GIS at 0.172 and t-value at 3.463. In contrast to the past findings that indicated a significant relationship between the two [117–120], this study's results showed that security does not contribute to behavioral intention towards adopting GIS. A study [121] prior finding was not aligned with this in that security improved information quality in the Wellington-based medium and large firms' workers, but it is aligned with the reported ones [122,123]. Findings appear to support the importance of security during GIS adoption, and the respondents agreed on the critical contribution of security features in selecting GIS.

Hypothesis 10: Behavioral intention to adopt GIS adoption positively influences performance. The results supported a positive relationship between behavioral intention towards GIS adoption and performance at the 0.02 level, with a standardized estimate (β) for the behavioral intention path to GIS adoption at 0.597 and 15.448 as t-values. As such, GIS adoption positively influenced performance, with the former bringing about an enhanced form of the latter and ensuring overall competitiveness in the business market. Respondents asserted that GIS enhances the organization's profitability, particularly when performance is compared to pre-adoption, with one of the gauging statements being, "I judge the quantity of the work to be much better with GIS". Based on the findings, GIS adoption has a significant relationship with management efficiency and the overall performance of the firms. Due to the lack of extensive explication, conceptualization, and empirical testing of the GIS discipline stemming from the stakeholders' complexity, this relationship calls for more studies. Prior studies also supported this result [124–126].

The attempt to propose a GIS model in this research is based on the Technology Acceptance Model (TAM) theory and De Lone and Mc Lean's theory. Empirical evidence has been obtained in this study in light of the factors influencing behavioral intention toward GIS adoption in Saudi PSOs. The original TAM has several components: PU, PEOU, AT, BI and actual use. Based on these five components, ten relationships have been investigated: 1) perceived ease of use-perceived usefulness, 2) perceived usefulness and attitude, 3) perceived ease of use and attitude, 4) perceived usefulness and behavioral intention, 5) perceived ease of use and behavioral intention, 6) attitude and behavioral intention, 7) attitude and use, 8) behavioral intention and use, 9) perceived ease of use and use, and 10) perceived usefulness and use [127]. refer to the information system (IS) success model, which has several dimensions and interdependencies between success categories. IS success has been defined to match the current IS success definitions and measures. It can be classified into six major categories: information quality, user satisfaction, organizational impact, system quality, user and individual impact.

The proposed model contained factors statistically identified to be significant to behavioral intention and performance compared to the previous studies by Refs. [26,48–50], and [128]. The study findings pave the way towards strategies development in the promotion of GIS usage in PSOs. The current literature on information systems in this study, particularly GIS adoption was reviewed and discussed in terms of the relevant theories and models in IT adoption. The strengths and the weaknesses of the models were also investigated in light of their relevance to the examined PSOs to provide an in-depth insight into the factors influence on the GIS adoption among such organizations in the Saudi context. This investigation attempts to minimize theoretical gaps through the provision of information on the factors motivating management/owners to adopt GIS services in a developing nation's PSOs [26]. Regardless of its significance on the global level, studies concerning GIS adoption factors impacting such acceptance have under-examined the topic and this prevents the leveraging of their potential advantages [35]. The results of the study are crucial for developing methods to facilitate GIS adoption in PSOs of Saudi Arabia. This indicates that good GIS investment can be brought about by the information provided by the study.

6. Implication and future works

Regardless of the increased promotion of GIS adoption within PSOs, it is crucial to develop such adoption at the national level as the PSOs level of system adoption is still lacking and at its infancy phase, as a result of which studies concerning it are still few. The study focuses on the factors effects in a way that is distinct and makes the study one of the few investigations addressing adoption of GIS in Saudi PSOs. Added to the mentioned theoretical contributions of the study, the formulated model may also practically enable such entities to understand their role in GIS adoption success. The study proposes adoption process facilitators, indicating what to do to promote and increase its adoption and use among administrators through their increased presence within the work premises.

The understanding of the examined phenomenon and the related issues required highlighting the factors that drive managers/owners towards GIS adoption or non-adoption. As a result of the adoption, performance of the entity is boosted and this may be attributed to the technological abilities and the level to which manages/owners adopt and make use of GIS. The study results may be leveraged by the Saudi policy makers in PSOs when it comes to GIS implementation success. Based on the results, PSOs managers/owners are receptive towards adopting GIS and thus, they are inclined towards adoption and deployment of GIS to enhance their performance.

Moreover, the study results also have implications towards decision makers in PSOs as it provides information on the GIS adoption objectives, the use of open source applications and the pre-test. In the same line of contribution, staff engagement in the discussions relating to GIS may improve its adoption as this increases their trust and through training initiatives, there will be increase in usage. Additionally, periodic meetings may also be carried out to share reports concerning the performance of the organization, with awards presented to success stories pertaining to increased GIS level of adoption within the entities.

Managers and owners of the PSOs can benefit from the study to increase the adoption level of GIS and promotes is application among GIS employees. The proposed GIS model promotes the consideration of influencing factors so that GIS use is increased through the enhanced behavioral intention towards such use. The study is beneficial to the PSO sector in Saudi Arabia, and other countries with similar entities. Managers may take note of the factors leading to the extensive GIS use among Saudi PSOs for present and future implementations. In-depth understanding of the factors can boost GIS acceptance among PSOs, and in turn, improving PSOs performance. Failure to take heed of such factors may prevent the system's successful adoption.

Understanding the examined phenomenon and related issues required highlighting the factors that drive managers/owners towards GIS adoption or non-adoption. As a result of the adoption, the entity performance is boosted. This performance may be attributed to the technological abilities and the level to which managers/owners adopt and use GIS. For example, in Malaysia, GIS projects have been conducted by [129–131] for prediction in drug and crime activities. The study results may be leveraged by the Saudi policymakers in PSOs regarding GIS implementation success. Based on the results, PSOs managers/owners are receptive to adopting GIS and thus are inclined towards adopting and deploying GIS to enhance their performance. Moreover, the study results also have implications for decision-makers in PSOs as they provide information on the GIS adoption objectives, open-source applications, and the pre-test. In the same line of contribution, staff engagement in the discussions relating to GIS may improve its adoption as this increases their trust, and through training initiatives, there will be an increase in usage. Additionally, periodic meetings may also be carried out to share reports concerning the performance of the organization, with awards presented to success stories pertaining to increased GIS level of adoption within the entities.

7. Limitations

There are several limitations present in this study. The first limitation is the study's relatively small sample size, requiring cautious

interpretation of the findings. The study also covered PSOs listed in only specific cities, which makes the outcomes inapplicable to other parts of the country or other sectors. Future studies may extend the examination by covering specific areas and higher sample numbers from the PSO population. The second limitation pertains to the developed research model, which is tailor-made for PSOs, particularly those in Saudi Arabia. This downscoping decreases the relevance of the model to other nations despite the provision of guidance through the model. This study should be reproduced by future studies in other developing countries, after which comparisons can be made to aid future studies in making accurate estimations of the GIS adoption and their drivers – this is especially true when it comes to cultural differences.

Another limitation relates to the limited factors examined, to which future studies may add other external factors when exploring this area in developing nations like Saudi Arabia and other similar countries. The fourth limitation may be resolved by forming an application to assess the GIS adoption level for organizations based on the studied factors. Each factor's strengths and weaknesses must be identified to enhance GIS adoption in Saudi PSOs. Finally, the study sample was comprised of managers and owners of PSOs, a trend followed by most past studies considering that such individuals are the primary decision-makers in PSOs. This limitation may be resolved in future studies by focusing on other respondents, like policymakers who are in a position to ensure adoption prediction and business trend interpretations, particularly regarding GIS adoption in the context of developing countries such as Malaysia.

8. Conclusion

The descriptive analysis results covered the sample's demographic characteristics, showing that most respondents were men. Regarding their ages, most of them fell in the age category of 30–40 years old. As for their education level, they are mostly Bachelor's degree holders. The results also showed that most respondents were from small enterprises and were primarily managers and owners, which may be the reason for the high response rate. After analyzing the demographic profile characteristics, data was screened for the potential presence of outliers, missing data, and normality, which is required for SEM. The questionnaire attributes were also tested in light of every item's mean, standard deviation, skewness, and kurtosis values. The next step involved the application of EFA to identify the most appropriate item from a set of items of a specific factor, and the results showed nine factors with their corresponding items.

The construct variance exceeded the cut-off (50 %) established by Ref. [73], indicating factors reliability. With EFA, the study also ran reliability statistics of the questionnaire, where Cronbach's alpha was higher than 0.70, indicating the high reliability of the instrument. Partial Least Square–Structural Equation Modeling was employed to determine the answers to the research questions, and this involved analyzing the measurement and the structural model to identify the influence of the factors on behavioral intention and the influence of the latter on performance (research hypotheses testing). The results from the measurement model analysis supported its reliability and validity, with the factors loadings higher than 0.70. Composite reliability and Cronbach's alpha of the constructs were all higher than 0.70, showing sufficient internal consistency reliability. Moving on to the AVE of the constructs, all were higher than 0.50, confirming the presence of an acceptable convergent validity level. Moreover, the squared AVE values exceeded the constructs' correlations. The indicators' loadings on their respective constructs were also high; thus, discriminant validity was confirmed.

Furthermore, structural model analysis results illustrated acceptable model validity, with high R2 values of behavioral intention to adopt and performance. These high values support a robust explanatory power. Also, path coefficient levels of significance were higher than 1.96, and based on the assessment, from 10 hypotheses, eight (8) were supported. Lastly, the effect size values remained within the recommended values and showed the independent variables' small-medium effect size. Further validation of the model came in using model fit indices that supported sufficient model validity, with acceptable model quality measurement at the average communality index of 0.06 (acceptable model quality). The results also showed a large GoF, which means the model had excellent global validity.

Ethics

The study received ethical approval from UKM Ethical Board (reference number: UKM PPI/111/8/JEP-2020-174 (2)).

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Data and materials availability

The data and materials presented in this study are available on request from the corresponding author.

Data availability statement

The data that has been used is confidential.

CRediT authorship contribution statement

Nouf Abdulaziz Alzahrani: Writing – review & editing, Writing – original draft, Software, Methodology, Data curation, Conceptualization. **Siti Norul Huda Sheikh Abdullah:** Writing – review & editing, Supervision, Resources, Funding acquisition. **Noridayu Adnan:** Writing – review & editing. **Khairul Akram Zainol Ariffin:** Writing – review & editing, Data curation. **Muaadh Mukred:** Writing – review & editing. **Ibrahim Mohamed:** Data curation. **Suzaily Wahab:** Writing – review & editing.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Siti Norul Huda Sheikh Abdullah reports financial support was provided by Malaysia Ministry of Higher Education. Siti Norul Huda Sheikh Abdullah reports a relationship with Malaysia Ministry of Higher Education that includes: funding grants. Siti Norul Huda Sheikh Abdullah has patent pending to MyIPO. No conflict of interest. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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