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Factors Affecting the Adoption of GIS Systems in the Public Sector in Saudi Arabia and Their Impact on Organizational Performance

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Abstract

This study investigates the adoption of the new phenomenon of Geographic Information Systems (GIS) in an organizational context in an emerging economy, namely Saudi Arabia. It explores the determinants of employees' perceptions of GIS, their actual usage and expected outcomes when they use it. A model was developed for this study based on relevant theories and existing literature. In total 221 responses were collected from the Ministry of Water and Electricity (MOWE) in Saudi Arabia using a structured survey questionnaire. Several statistical techniques were applied to the data collected. Results show that factors having the most significant impact on employees' perceptions of GIS are managerial support, IT expertise and exposure to GIS. However, some factors did not have any significant impact on employees' perceptions, these being GIS training and incentives. It also emerges that attitude to GIS has an impact on and relationship with the actual usage of GIS. In the outcomes of GIS adoption, results indicate that its usage influences enhanced risk management and better customer relationships. However, no significant relationship was found that led to more efficient decision-making and saving of costs. This paper also highlights implications and discusses the limitations and suggestions for future research.

Keywords

GIS Training, Managerial Support, Incentives, GIS Adoption, Saudi Arabia, GIS Usage

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1. Introduction

Geographic Information System (GIS) works by integrating hardware, software, and data to capture geographic data and manage them for analysis, and then displaying the finalized geographic information for users to access. It helps users to easily and quickly understand the data and make a decision [1]. The term "Geographic Information Systems Science" has been used for twenty years internationally. This science has many characteristics and employs various intellectual and technical strategies [2]. Geographic Information System is an important science and it is used in three different contexts or classifications as follows: 1) a Geographic Information System "tool"; 2) a Geographic Information System "application"; and 3) a Geographic Information System "science" [2].

There are six components of GIS, the first and most important being the overarching network. The network is a critical aspect of GIS as data and digital information cannot be shared or communicated except through the network. The second component of GIS is the user's hardware, which consists of devices that execute GIS operations [3]. The third component part of GIS is the software. GIS vendors such as the Environmental Systems Research Institute provide packages that can be purchased by organizations. These packages offered by different GIS vendors have varied applications, level of complexity and data size. The fourth component is the database where all information is saved for a future decision or to solve a problem. The fifth component comprises procedures that manage the GIS and keep it within budget constraints, and as accurate as possible so it can satisfy users. The sixth component concerns people, *i.e.* the users of the GIS and those who provide and update all the digital data on the GIS database so that it is more efficient and effective [3].

There are many benefits of using GIS. These benefits are for all types of organizations and industries whether they are small, medium or large. There are five classifications that these benefits come under, namely saving costs and increasing the organizational efficiency, better decision-making, communication enhancement, more efficient recordkeeping and management of geographical variables [4]. GIS can be merged with any organization's information system framework [1]. Furthermore, GIS is used to store, control and retrieve datasets. It is employed in many applications in many different areas. In GIS a dataset is called a layer, which can refer to roads, seas, buildings, etc. Each layer is stored in a specific location with coordinates in the GIS [5]. Layers that have the same geographical coordinates are linked to each other in the GIS. This relationship, which is referred to as spatial joins between datasets, can help in analyzing the data and making decisions. An example of making decisions can be allocating roads that are close to a certain river. These roads can be allocated by using some queries in the GIS, and help determine roads that may be affected by floods [5].

Another study was conducted in France to reduce the risks of floods/streaming by presenting a framework to manage constraints [6]. Another way that GIS queries can help in decision-making is when infectious diseases can be spread, decisions are vital regarding knowing how long it takes these diseases to reach certain areas and subsequently avoid them [7]. It can also allocate earthquake emergency shelters, which will reduce the amount of damage and injury [8]. An analysis done in South Korea presented a model that can help estimate the amount of forest fire caused by humans. This also can affect the decisions and actions that could be taken to reduce the spread of fire and reduce damage and injuries [9]. GIS was also utilized in Northern Ireland for allocating areas with certain population subgroups according to their religion. The government can employ GIS in helping with development of policies and decisions and manage residential segregation [10]. GIS can also assist in planning for any future climate conditions in rural areas and how to prepare a strategy or strategies in response [11].

There are some general GIS studies that have been conducted in Saudi Arabia. One of these studies is the study by Al-Ramadan (1993) whose main focus was to examine the validity of their hypothesis, which included the highly centralised government in Saudi Arabia may have a much more organized GIS adoption than those governments that are less centralized [12]. Another study by Abdulaal (2009) has provided a general framework for enterprise GIS for Saudi municipalities. This framework includes three main factors, which are business functions, tasks and data requirements [13]. A study by Koshak suggests that during Hajj in Makkah, it is better to use Web-based GIS to manage traffic plan to facilitate easier mobility [14]. In this study, Koshak has developed a Web-based GIS for Hajj traffic plan [14].

GIS is also used in water resources since engineers, for example, must understand where their pipes, valves, pumps, meters, etc., are located. The Ministry of Water and Electricity (MOWE) in Saudi Arabia is currently using GIS for these same reasons. The location and usage of water and where customers are residing are factors that need to be known. Engineers, managers, etc., also need to know what projects are under construction and

the facilities requiring repair [15]. MOWE in Saudi Arabia has adopted GIS and initially in the Riyadh core area, this process starting in 2003 and then in Dammam core area in 2004 [16]. Following that GIS was integrated in many of the major cities using the Integrated Water Resources Management System [17]. This paper will examine the adoption of GIS in MOWE and evaluate some determinants and test their impact on MOWE's employees' perceptions of GIS and how these affect the actual usage of GIS. Then the outcomes of this adoption will be evaluated.

2. Methods

The method used to collect data from employees was the survey. Our survey was divided into four sections, these consisting of questions about demography, GIS usage, perception of GIS and determinants and benefits of utilizing GIS. The perceptions of GIS and the determinants and benefits questions have one type of question, which is on a 7-point Likert-type scale, serving to measure the level of employees' agreement (1—Strongly disagree, 2—Disagree, 3—Somewhat disagree, 4—Neither agree or disagree, 5—Somewhat agree, 6—Agree, 7—Strongly agree) [18]. The survey was an online survey sent to MOWE's employees. The number of people who participated in this survey was 297 who worked in different branches of MOWE throughout Saudi Arabia.

2.1. Items and Sources

The items used in this research have been utilized in previous studies, which mean they have already been validated. **Table 1** contains all relevant information concerning the items, a brief explanation about each item and the sources of each item.

2.2. Statistical Techniques

In this paper, many statistical analysis techniques were used, which are frequency distribution, reliability and validity analysis, correlation analysis and regression analysis. The frequency distribution analysis explained the participants' demographic information. The frequency distribution for any data can be shown in many different methods and one of these concerns the frequency tables used in this paper to display participants' demographic information [19]. The reliability and validity analysis were conducted to confirm that the survey's constructs are reliable and valid. Correlation analysis indicated the relationships between: firstly, the determinants and perceptions of GIS; secondly, perceptions of GIS and the usage of GIS; and thirdly, the usage of GIS and outcomes of such use. A regression analysis was performed in this paper to examine the effects of independent variables on dependent variables.

Table 1. Items' explanations and sources.

Items	Explanation	Source
GIS training	GIS training was measured by the degree of training provided to MOWE's employees	[31] [33] [34]
Incentives	Incentives are the personal motivations and beliefs about the consequences of using GIS	[34] [40]
Managerial support	Managerial support was measured according to the resources and help provided by the organization's management	[34] [52]
IT expertise	Employees' prior IT experience and skills	[6] [34]
Exposure to GIS technology (Computer self-efficacy)	Extent to which employees are comfortable in dealing with GIS and their previous GIS experience.	[34] [46]
Perception toward GIS	Employees' attitude regarding the use of GIS	[40] [48]
Adoption of GIS	GIS usage	[31] [34] [66]
Efficient decision-making	The efficiency of employees' own decision-making	[48] [50]
Cost savings	GIS adoption's effect on cost savings	[40] [51] [52]
Enhanced risk management	Risk management identifies the risks that may occur in the future and try to find solutions to avoid o reduce them [29]	[34] [50] [52]
Improved customer relationships	Connection and communication between employees and customers	[50] [51] [55] [56]

3. Theoretical Framework

Several models have been used to study the adoption of GIS technology in MOWE. The theories used in this research were Innovation Diffusion Theory (IDT), Technology Acceptance Model (TAM), TAM2, Theory of Reasoned Action (TRA) and the Unified Theory of Acceptance and Use of Technology (UTAUT). Innovation Diffusion Theory (IDT) has been used since the 1950s, but was succeeded by Rogers' introduction of the most well-known and commonly used innovation-decision process in 1962 [20]. This theory describes the process of accepting or rejecting a new innovation. Making a decision about a particular innovation goes through five steps, which are called the IDT stages [20]. The first stage is when the individual gets to know the innovation and how a new technology functions, its purpose and the need for it. The second stage occurs when the individual likes or dislikes this new technology. There are five attributes that encourage an individual to like a new technology and affect their decision: relative advantage, compatibility, complexity, trialability and observability. After that a decision is made to accept or reject the technology, which is the third stage. The fourth stage is the implementation of this new technology while the fifth stage confirms the decision made by the individual [21].

The Theory of Reasoned Action (TRA) was developed by Ajzen and Fishbein in 1975 [22] [23]. This theory can be used in studies referring to people's attitude-behaviour relationships [24]. In this theory, it is believed that personal beliefs influence attitude and social norms will in turn shape the individual's behaviour toward the action [22]. There are two main constructs of intention in the theory of reasoned action, these being attitude toward the behaviour and the behaviour that a person or a decision-maker enacts when social pressure is put on them. This is known as the subjective norm [22].

The Technology Acceptance Model (TAM) grew out of the TRA model and was devised by Davis [25]. TAM is the most accepted of all the technology adoption models [23]. TAM consists of three main parts that influence the behavioural intention and actual usage of a particular technology: perceived usefulness, perceived ease of use and the users' attitudes that affect the behavioural intention [26]. This intention is determined by both users' perceptions and attitudes regarding the technology and its perceived usefulness. Attitude is determined by both perceived usefulness of the technology and its perceived ease of use [25].

TAM2 was introduced by Venkatesh and Davis [27] in their research paper titled "A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies". This model represented an extension of the original Technology Acceptance Model (TAM) and its main purpose was to add more determinants to the original TAM so that perceived usefulness and the intention to use the technology could be better measured. These determinants include social influences that emerge in the context of subjective norm, voluntariness and image. Other determinants comprise job relevance, output quality and result demonstrability which can all affect perceived usefulness. Another important thing that this extended model wants to understand is how the effects of social influence change with different experience levels that users have. It also looks at how the intention to use the technology varies when the usage is voluntary [28].

The Unified Theory of Acceptance and Use of Technology (UTAUT) was developed by Venkatesh *et al.* (2003) [28]. It is a theory consisting of four main determinants that directly affect the intention to use new technologies: performance expectancy, effort expectancy, social influence and facilitating conditions. This theory also comprises four moderators that can affect the direct four core determinants, *i.e.* gender, age, experience and voluntariness of use [28].

4. Research Model

The research model was constructed based on the existing theories mentioned previously. The research model looks at three parts and tests their impact on each other. The first part of this model consists of five determinants that may affect the perception of GIS. These determinants are GIS training, incentives, managerial support and exposure to GIS. These determinants' impact on people's perceptions of GIS that are going to be tested will be the most significant. The model's second part looks at the impact of perception of GIS on the actual usage of GIS, which will also be tested. The third part tests the actual usage and adoption of GIS. Four outcomes will be tested: efficient decision-making, cost saving, enhanced risk management and improved customer satisfaction. The context being investigated will be the Ministry of Water and Electricity (MOWE) in Saudi Arabia (see **Figure 1**).

5. Literature Review and Hypotheses Development

Geographic Information Systems (GIS) are applied to any science that deals with a location-related phenomenon

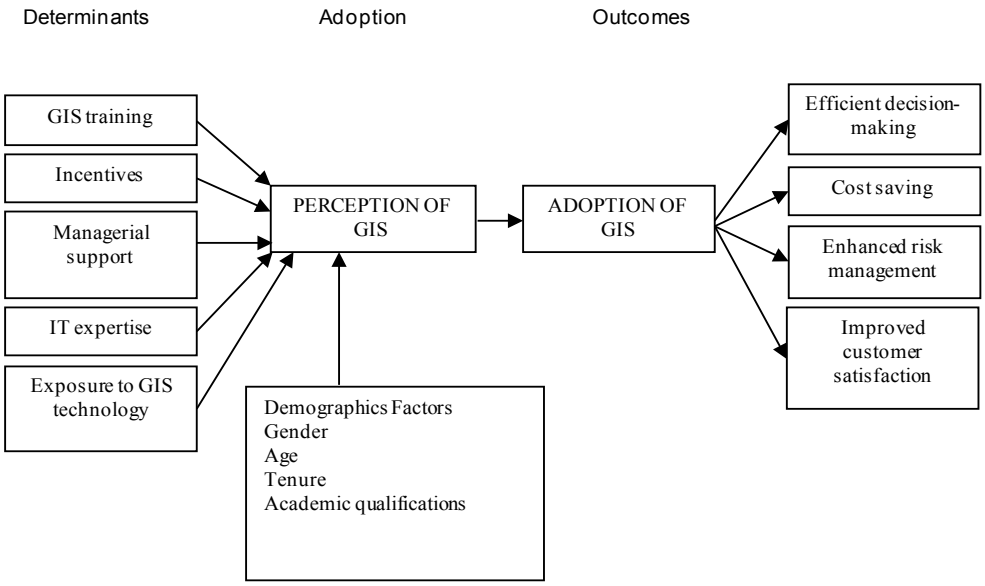

Figure 1. Research model.

on Earth. Some examples of these are the climate in different parts of the planet and how climate change can affect the distribution and spread of diseases. It can also help in detecting the distribution of crimes in various areas, distribution of plants and animals, etc. There are many applications of GIS that can help humans such as Global Positioning System (GPS) in finding locations and managing services and resources [29]. All activities such as building, digging ditches, burying pipelines and cables, finding oil and many other activities, can be documented using GIS [3]. Geographic Information Systems (GIS) keep track of such activities and where they occurred or left their mark. According to Longley *et al.* (2011, p.4), almost everything that happens, happens somewhere. Knowing where something happens can be critically important [3].

We use GIS in our daily lives, for example asking for a direction to get somewhere. We also use GIS to solve problems in many areas such as health care, such as deciding where to build a new hospital in a particular area and why. Delivery companies send things using different routes every day so the decisions they have to make concerning which routes their vehicles should take will solve geographical problems. Some people cannot decide whether their specific problem is geographical or not. There are three variables that can help in deciding if this is the case. The first is that the problem has a question of scale. The second is the purpose of the problem and whether they use geographic data to analyze the issue. The third is the time scale of the problem and whether geographic problems have persisted for a specific period of time [3]. In this way, "GIS does a better job of sharing data and information than knowledge, which is more difficult to detach from the knower" [3].

There are three relationships in the research model that need to be tested and looked at in detail. The first relationship is between determinants and perception of GIS. Determinants consist of five factors that can affect MOWE's employees' opinions concerning GIS. These five determinants' impacts will be tested in the form of hypotheses as described in more detail below.

5.1. GIS Training

Training programs are important for employees because they can help staff increase their knowledge of newly introduced technologies. These programs will result in employees having a positive perception about using new technologies [30]. It is important that organizations have training programs in their culture because it is significant when new technologies are adopted [30]. Training in this context refers to the training provided to staff at MOWE, and it will provide employees with knowledge and practical skills in using a new technology [31]. Employees will develop their self-confidence and level of skills when applying new technologies [32]. GIS training was measured by the amount of training given to MOWE employees. Participants in this survey were asked about the level of training provided to them and how internal training courses would improve their GIS usage abilities. Five questions were devised to obtain employees' opinions on GIS training provided to them. These

five questions were constructed according to Al-Gahtani and King (1999), Talukder (2014) and Gosh and Glott (2005) [31] [33] [34]. The hypothesis that will be tested is:

H1: GIS training impacts on employees' perceptions of GIS.

5.2. Incentives

Incentive can be defined as what a person thinks and perceives the benefits to be of introducing a new technology into the firm [35]-[37]. A person's perception of an innovation is very important as it might change people's behaviour regarding whether they accept this innovation [38]. Adoption of new technologies is expected to enable institutions meet their goals and benefits more efficiently. In order to reinforce employees' perception of the advantage of adopting new technologies, management should give them individual behavioural motivators that encourage them to adopt new technologies [39]. In this research incentives are employees' motivations and beliefs about the consequences of using GIS in MOWE. Participants were asked to rate their level of agreement or disagreement concerning four items developed by Kurnia *et al.* (2006) and Talukder (2014) [34] [40]. The second hypothesis that will be tested is:

H2: Incentives impact on employees' perceptions of GIS.

5.3. Managerial Support

Managerial support is a very important variable that can affect employees' perceptions of adopt new innovation in the workplace [25]. Previous studies discovered that managerial support is associated with the adoption of new technology. It was also found by other studies that managerial support has a positive impact on employees' adoption of new technologies [41]. The more that an organization offers managerial support to employees the more likely they are to accept and utilize new technologies. However, the lack of managerial support is considered to be a problem to such an adoption [42]. This determinant will be tested as follows:

H3: Managerial support impacts on employees' perceptions of GIS.

5.4. IT Expertise

People's prior experience refers to their skills and what they know about an innovation beforehand [43] [44]. In this case employees' IT expertise means their level of skills and experience about Information Technology (IT). IT expertise was measured according to workers' prior experience and skills and from where they were acquired. Participants were asked to rate their level of agreement or disagreement on four items that were constructed according to Talukder (2014) and Al-Gahtani and King (1999) [31] [34]. The hypothesis to be tested is as follows:

H4: IT expertise impacts on employees' perceptions of GIS.

5.5. Exposure to GIS Technology (Computer Self-Efficacy)

Employees' exposure to a particular technology refers to their previous experience [43] [44]. Each employee has their own beliefs about what they are capable of when using GIS and solving related problems [45]. This means in effect how comfortable are employees when using GIS? This determinant tests employees' abilities to deal with GIS in MOWE according to their exposure to this technology. The determinant was constructed according to Sanchez and Hueros (2010) and Talukder (2014) [34] [46]. Five questions were asked to obtain information on this determinants' impact on employees' perceptions of GIS. The hypothesis that will be tested is:

H5: Exposure to GIS technology impacts on employees' perceptions of GIS.

5.6. Perception of GIS

The second relationship in the research model is that between perception of GIS and the adoption (usage) of GIS. Perception is the same as attitude when using this technology, and in particular employees' positive or negative feelings about it [47]. Consequently, MOWE employees' attitude to the use of GIS is measured. Five questions were constructed based on Cakar (2011) and Kurnia *et al.* (2006) to test MOWE's employees' perceptions of and feelings about GIS [40] [48]. The impact of perception on GIS adoption and its usage will be tested as a hypothesis in the following way:

H6: Perceptions of GIS affect the actual usage of GIS.

The third relationship is between the adoption of GIS (usage) and the benefits of adopting such technology in

an organization, in this case the Ministry of Water and Electricity (MOWE) in Saudi Arabia. The hypotheses in this relationship are explained in more detail below.

5.7. Efficient Decision-Making

Decision-making is the process of choosing an option out of many that are available [49]. Decision-making plays a big role in organizations as it can sometimes lead to good or bad outcomes [49]. In this paper the impact of actual usage on enhancing employees' decision- making will be tested [48]. The items measuring the level of decision-making were constructed based on the work by Abu-Al-Aish and Love (2013) and Cakar (2011) [48] [50]. Items were edited to suit this variable. The hypothesis that will be tested is:

H7: Usage of GIS leads to efficient decision-making.

5.8. Cost Savings

This variable was constructed to measures if costs are reasonable and if the GIS are cost-effective. The items below were developed with reference to Kurnia *et al.* (2006), Kim and Ammeter (2014) and Oliveira *et al.* (2014) [40] [51] [52]. This will test if the actual usage of GIS will lead to costs being saved. A study by Kurnia 2006, found that perceived cost does not have an impact on either attitude to using an innovation or usage intentions [40]. The hypothesis that will be tested is:

H8: Usage of GIS leads to cost savings.

5.9. Enhanced Risk Management

Risk management is defined as identifying the risks that may occur in the future and try to find solutions to them so dangers will be averted [53]. The items that measure the level of risk management were constructed according to Abu-Al-Aish and Love (2013), Talukder (2014) and Oliveira *et al.* (2014) [34] [50] [52]. The test will measure the impact of actual GIS usage on enhancing risk management in MOWE. Subsequently the hypothesis to be tested is:

H9: Usage of GIS leads to enhanced risk management.

5.10. Improved Customer Relationships

Improved customer relationships refer to better communication between employees and customers [54]. Items that measure such improvements were constructed based on the work by Phichitchaisopa and Naenna (2013), Kim and Ammeter (2014), Alharbi and Drew (2014) and Abu-Al-Aish and Love (2013) [50] [51] [55] [56]. They have been edited to suit this variable. The test will be on the impact of actual GIS usage on improved customer relationships in MOWE.

H10: Usage of GIS leads to improved customer relationships.

6. Results

6.1. Participants' Demographic Information

Demographic factors refer to factors that identify participants and their characteristics in terms of gender, age, tenure, academic qualification and their usage and perception of Geographic Information Systems (GIS). In the survey, all participants were male employees because in the Ministry of Water and Electricity (MOWE), Water Sector, only men worked there so the percentage was 100% male. The participants' age categories were diverse in that 42% were in the 18 - 30 age category, while most participants were in the 31 - 40 age group (51% of all age groups). Furthermore 5% fell under the 41 - 45 age groups and the smallest age group (2%) consisted of participants who were 46 to 65 years of age. No-one in the group was 65 or older. Most participants (91%) are full-time employees and only a few (9%) work on a part-time basis. Most employees (86%) are permanent and only 14% work at MOWE on a temporary or contract basis. Participants' academic qualifications vary in that 8% have their secondary certificate, 19% have a diploma, while the majority (56%) have a Bachelor degree. In terms of postgraduate qualifications, 17% hold a Master's degree. **Table 2** summarizes participants' demographic information.

Table 2. Demographic information of participants.

Characteristics	Frequency	Percentage
Gender		
Male	221	100
Age		
18 - 30	94	42.5
31 - 40	112	50.7
41 - 45	11	5.0
46 - 65	4	1.8
Employed as		
Full time	201	91.0
Part time	20	9.0
Tenure		
Permanent	191	86.4
Temporary	30	13.6
Education		
Secondary	18	8.1
College	43	19.5
Bachelor	123	55.7
Master	37	16.7
Total	221	100

6.2. Reliability and Validity of Constructs

A reliability and validity test was done to confirm the survey's constructs are reliable and valid. **Table 3** represents the reliability in terms of Cronbach's alpha for all dependent and independent variables. Reliability values between 0.70 and 0.80 are considered to be "respectable" while those between 0.80 and 0.90 are deemed "very good" [57]. The Cronbach's alpha coefficient shows that the results are highly reliable as the Cronbach's alpha coefficient ranges from 0.692 to 0.962; this means that the data has a high internal consistency [58]. A lower limit for Cronbach's alpha was agreed upon, whereby 0.70 and the lower limit can decrease if the research was an exploratory research [59]. **Table 3** also shows the Average Variance Extracted (AVE) and the factor loadings of the items that measure the validity of the constructs. It is considered to be proof of an acceptable validity level if the AVE is greater than 0.50 [60], which means that "at least 50% of the measurement variance is to be captured by the constructs" [34] [60]. The results of the collected data reveal that the AVE ranges from 0.733 to 0.932, which is considered highly acceptable. Based on both Cronbach's alpha and AVE results, it can be concluded that the constructs are reliable and valid enough to measure the drivers of using GIS, perceptions of using GIS and the actual usage of GIS.

6.3. Correlations

The Pearson correlations were calculated for all variables included in this paper. These calculations show the relationships between the determinants in relation to perceptions of GIS and the relationship between them and the usage of GIS (see **Table 4**). These calculations also indicate the relationship between the usage of GIS and outcome variables (see **Table 5**). The results show there is no relationship between perception of GIS and training. Results reveal that the level of perception is significant and positively related to incentives ($r = 0.164$, $p < 0.05$) and negatively related to managerial support ($r = -0.336$, $p < 0.01$). These results reveal that perceptions of GIS are significant and positively related to IT experience ($r = 0.256$, $p < 0.01$) and exposure to GIS ($r = 0.391$, $p < 0.01$). There is also a positive relationship between perception of GIS and level of usage ($r = 0.470$, $p < 0.01$).

Table 3. Reliability and convergent validity results.

Factor	Factor Loading	Cronbach's Alpha	AVE
Usage		0.937	0.905
USE1	0.910		
USE2	0.953		
USE3	0.918		
USE4	0.873		
USE5	0.867		
Training		0.895	0.844
TRA1	0.868		
TRA2	0.906		
TRA3	0.871		
TRA4	0.775		
TRA5	0.795		
Incentives		0.838	0.834
INC1	0.806		
INC2	0.874		
INC3	0.872		
INC4	0.611		
INC5	0.784		
Managerial Support		0.866	0.808
MSP1	0.731		
MSP2	0.848		
MSP3	0.909		
MSP4	0.814		
MSP5	0.724		
IT Expertise		0.906	0.885
ITE1	0.901		
ITE2	0.921		
ITE3	0.884		
ITE4	0.830		
Exposure to GIS		0.962	0.932
EXG1	0.925		
EXG2	0.934		
EXG3	0.921		
EXG4	0.929		
EXG5	0.952		
Perceptions of GIS		0.836	0.786
POG1	0.896		
POG2	0.900		
POG3	0.900		
POG4	0.717		
POG5	0.396		
Efficient Decision-Making		0.778	0.733
EDM1	0.732		
EDM2	0.851		
EDM3	0.776		
EDM4	0.766		
EDM5	0.486		
Cost Savings		0.740	0.891
COS2	0.891		
COS5	0.891		
Enhanced Risk Management		0.820	0.807
ERM1	0.819		
ERM2	0.754		
ERM3	0.815		
ERM4	0.838		
Improved Customer Relationships			
ICR3	0.875	0.692	0.875
ICR4	0.875		

Table 4. Inter-correlations among variables.

	1	2	3	4	5	6	7
1. TRA	1.000	0.041	0.361[a]	0.350[a]	0.386[a]	0.112	0.080
2. INC	0.041	1.000	0.132[c]	0.439[a]	0.276[a]	0.452[a]	0.164[c]
3. MSP	0.361[a]	0.132[c]	1.000	0.216[a]	0.105	−0.035	−0.336[a]
4. ITE	0.350[a]	0.439[a]	0.216[a]	1.000	0.280[a]	0.382[a]	0.256[a]
5. EXG	0.386[a]	0.276[a]	0.105	0.280[a]	1.000	0.426[a]	0.391[a]
6. USE	0.112	0.452[a]	−0.035	0.382[a]	0.426[a]	1.000	0.470[a]
7. POG	0.080	0.164[c]	−0.336[a]	0.256[a]	0.391[a]	0.470[a]	1.000

[a]Correlation is significant at the 0.01 level (2-tailed). [c]Correlation is significant at the 0.05 level (2-tailed). TRA = Training, INC = Incentives, MSP = Managerial support, ITE = IT experience, EXG = Exposure to GIS, POG = Perception of GIS.

Table 5. Inter-correlations among variables.

	1	2	3	4	5
1. USE	1.000	0.055	0.092	0.141[c]	0.477[a]
2. EDM	0.055	1.000	0.910[a]	−0.031	0.165[c]
3. COS	0.092	0.910[a]	1.000	−0.076	0.115
4. ERM	0.141[c]	−0.031	−0.076	1.000	0.225[a]
5. ICR	0.477[a]	0.165[c]	0.115	0.225[a]	1.000

[a]Correlation is significant at the 0.01 level (2-tailed). [c]Correlation is significant at the 0.05 level (2-tailed). USE = Usage, EDM = Efficient decision-making, COS = Cost savings, ERM = Enhanced risk management, ICR = Improved customer relationships.

The results also show that at the other end of the research model there is no significance at all between usage and efficient decision-making or cost savings. However, there is a significantly positive relationship between usage and enhanced risk management ($r = 0.141$, $p < 0.05$) and improved customer relationships ($r = 0.477$, $p < 0.01$) in the outcomes.

6.4. Regression Analysis

The regression analysis collected data on how independent variables impact on dependent variables. In this paper regression analysis was undertaken to assess how determinants influenced the perception of using GIS, the impact of this perception on usage and impact of usage on outcomes. The results from the multiple regression analysis regarding perception of GIS as a dependent variable support the model fit at the 1% level of significance with an r^2 of 35.0%. Based on the independent variables, managerial support, IT expertise and exposure to GIS were found to be significant at the level of Sig < 0.001. Training and incentives show no significance with perception of GIS (see **Table 6**). **Table 7** presents the results of multiple regression analysis with usage as a dependent variable and perception of GIS as an independent variable. In **Table 7**, results indicate with usage as a dependent variable that there is significance at Sig < 0.001, which supports the model, fit at the 1% level of significance with an r^2 of 22.1%. **Table 8** summarizes the results of the multiple regression analysis with usage as an independent variable and each of the outcomes as dependent variables. Results show that usage has no significance for efficient decision-making and cost savings. However, it emerged that improved customer relationships is significant with Sig < 0.000, and enhanced risk management is significant at Sig < 0.05.

7. Discussion of Results

In this discussion of results, the hypotheses will be discussed in detail regarding their significance and the test results for each one. **Table 9** highlights the results of hypotheses testing and briefly summarizes the findings.

Table 6. Results of multiple regression analysis with perception of GIS as a dependent variable.

Dependent Variable	Perception of GIS					
Independent Variables	Unstand. Coef. B	Standard Coef.$^{\beta}$	T	*R* Square	*F*	Sig.
				0.350	23.193	0.000
Training	0.013	0.013	0.191			0.849
Incentives	0.017	0.017	0.265			0.791
Managerial support	−0.432	−0.432	−7.235			0.000
IT expertise	0.237	0.237	3.590			0.000
Exposure to GIS	0.360	0.360	5.776			0.000

Table 7. Results of multiple regression analysis with usage as a dependent variable and perception of GIS as an independent variable.

Dependent Variable	Usage					
Independent Variables	Unstand. Coef. B	Standard Coef.$^{\beta}$	T	*R* Square	*F*	Sig.
				0.221	62.103	0.000
Perception of GIS	0.470	0.470	7.881			0.000

Table 8. Results of multiple regression analysis with usage as an independent variable.

Independent Variable	Usage					
Dependent Variables	Unstand. Coef. B	Standard Coef.$^{\beta}$	T	*R* Square	*F*	Sig.
						0.000
Decision-making	0.055	0.055	0.814	0.003	0.663	0.416
Cost savings	0.092	0.092	1.371	0.009	1.879	0.172
Risk Management	0.141	0.141	2.105	0.020	4.429	0.036
Customer Relationships	0.477	0.477	8.033	0.228	64.523	0.000

Table 9. Results of hypotheses.

Hypotheses	Results	Summary of findings
H1: GIS training impacts on employees' perceptions of GIS	No significant impact found	GIS training has no impact on employees' perceptions of GIS
H2: Incentives impact on employees' perceptions of GIS	No significant impact found	Incentives have no impact on employees' perceptions of GIS. However, there is a relationship between the two variables
H3: Managerial support impacts on employees' perceptions of GIS	Significant	Managerial support has an impact on and relationship with employees' perceptions of GIS
H4: IT expertise impacts on employees' perceptions of GIS	Significant	IT expertise has an impact on and relationship with employees' perceptions of GIS
H5: Exposure to GIS technology impacts on employees' perceptions of GIS	Significant	Exposure to GIS technology has an impact on and relationship with employees' perceptions of GIS
H6: Perception of GIS affects the actual usage of GIS	Significant	Perception of GIS has an impact on and relationship with the actual usage of GIS
H7: Usage of GIS leads to efficient decision-making	No significant impact found	Usage of GIS has no impact on efficient decision-making
H8: Usage of GIS leads to cost savings	No significant impact found	Usage of GIS has no impact on cost savings
H9: Usage of GIS leads to enhanced risk management	Significant	Usage of GIS has an impact on and relationship with enhanced risk management
H10: Usage of GIS leads to improved customer relationships	Significant	Usage of GIS has an impact on and relationship with improved customer relationships

7.1. Hypotheses 1, 2, 3, 4 and 5

Hypotheses 1 to 5 are the determinants that were tested to evaluate whether they impact on employees' perceptions of GIS or not. Hypotheses 1 and 2 were tested and it was found that GIS training and incentives have no impact on perception. The reason for this may be that the participants' sample who filled the survey and used for this paper may have previous GIS experience, which is why training results showed that it did not impact employees' perception toward GIS. Incentives also did not have an impact on perception of GIS because employees believe GIS helps in their actual work duties, not in self-organization. Hypotheses 3, 4 and 5 are significant and also have a relationship with perception of GIS. This means that managerial support, IT expertise and exposure to GIS impact on people's perceptions of GIS.

7.2. Hypothesis 6

Hypothesis 6 was designed to test if perception of GIS has an impact on the usage of GIS. Regression analysis shows that the results are consistent with previous studies regarding the relationship and impact between the two variables perception of GIS and its usage [46] [47] [61]-[64]. Findings for the impact of perception of GIS on its usage were significant and a link was detected between the two variables.

7.3. Hypotheses 7, 8, 9 and 10

Hypotheses 7 to 10 are concerned with the impact of usage on the outcomes. The regression analysis for these hypotheses showed that there was no significant impact found between usage and decision-making, which was unexpected as most GIS studies assert that GIS helps to make good decisions [5] [6] [8] [9]. This was the case in MOWE. It may suggest that MOWE's employees did not receive GIS training, and explains why they are not using it properly and not noticing the big difference GIS made in making good decisions. Usage also did not have any significant impact on cost savings, as many of MOWE's projects have still not been completed. This may be the reason or it could be that many participants only operated GIS to execute tasks and did not concentrate on its cost aspects. There are some finance experts who are responsible for projects' costs and these participants constitute a minority in this study as there are only a few of them in each branch. Hypotheses 9 to10 which stated the usage impact on enhanced risk management and improved customer satisfaction were significant. This means that usage of GIS has an impact on and relationship with enhanced risk management and improved customer relationships.

8. Conclusion and Implications

It can be concluded from the results of this research paper that some determinants impact on MOWE's employees' perceptions of GIS. It is also found that this perception influences actual usage. Some outcomes were tested and some were found to be affected by the actual usage of GIS. Managerial support, IT expertise and exposure to GIS technology have an impact on and relationship with employees' perceptions of GIS. Training and incentives emerged as insignificant determinants that do not impact on employees' perceptions of using GIS; there is, however, a relationship between incentives and perception of GIS. Furthermore there is a strong impact on and relationship between employees' perceptions of GIS and their actual usage of it. When using GIS, there are many benefits that emerge such as efficiency of service, speed of service, quality of service, enhanced risk management and improved customer satisfaction. These are the factors found to be significant and impacted on by GIS usage.

The outcome factors that were found to be insignificant were efficient decision-making and cost savings. Some determinants require more attention from MOWE in order for employees to be more willing to adopt GIS. It is also important to help employees to know the benefits and outcomes from adopting GIS. Staff needs to be trained to obtain the maximum benefits of technology. The impact of actual usage on decision-making and cost savings could become significant if MOWE worked hard on some determinants that can affect employees' behavior when using GIS. This research will benefit the Saudi Arabian government since MOWE is a government department. The government can use the results of this research to implement GIS in other ministries. This research can also help organizationally because: firstly, the government can use results from this research to improve GIS in MOWE; and secondly, make it easier for other departments to adopt GIS according to the results of this research. This analysis can assist managers to understand their employees' behaviors and provide them with the means to change how they perceive GIS. This will enable MOWE to use GIS productively.

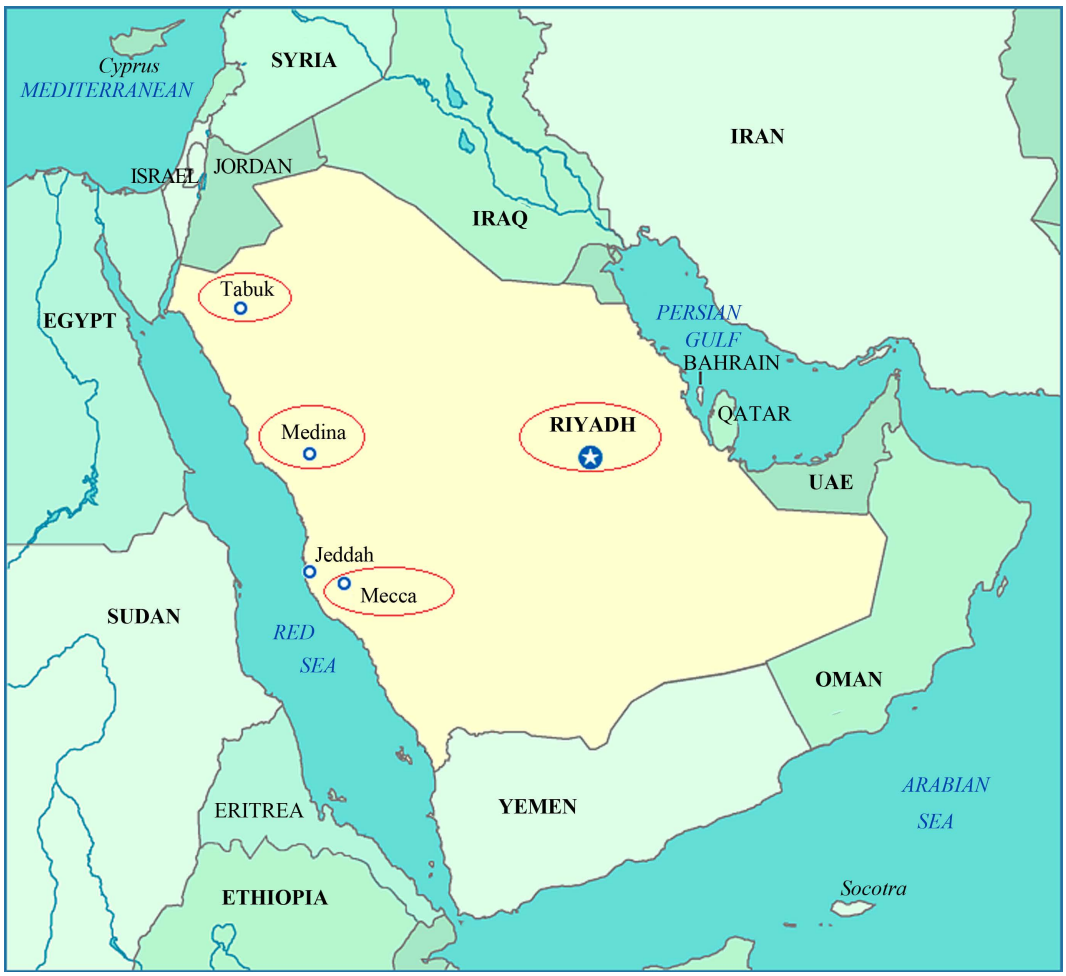

Figure 2. A location map of the study area [65].

9. Limitations and Future Research

The main limitation of the research is that data were collected from only four major cities in Saudi Arabia-Madinah, Makkah, Tabuk and Riyadh (see **Figure 2**). This limited sample may affect the generalizability of the findings across the whole country, which needs to be taken into account when interpreting the results. Future research should look into all departments or ministries having more participants and develop more representative and nation-wide samples that reflect Saudi Arabian workers' adoption behavior of GIS. Finally, future research should use the structural modelling approaches such as SEM or PLS to test the model with a more broad-based sample so that the GIS system adoption is more rigorously researched.

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