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Proposing an M-Government Framework for the Ministry of Housing in Oman:
For Efficient Digital Literacy and Services

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ABSTRACT

In the dynamic world of technology, changes and transformations have emerged rapidly in recent years. Service providers such as government departments transformed their services from e-government to m-government for widespread customer reach. However, several issues existed that were obstructing the implementation of such a system by the Ministry of Housing in Oman, especially in rural areas. This study proposes a novel framework based on the fuzzy delphi and TOPSIS models to provide digital literacy and services. This framework considered the variables extracted from previous studies. Furthermore, a survey was conducted on 20 experts to determine the accepted variables. Thirty-five pre-service engineers evaluated the questionnaires using TOPSIS to determine the skills of pre-service engineers based on delphi criteria outcomes. The conceptual framework developed from the accepted results uses 11 different variables based on the TAM model. The study benefits the stakeholders in the area of m-government development.

KEYWORDS

Fuzzy Delphi, M-Government, Ministry of Housing, Oman, TOPSIS

INTRODUCTION

Over the last decade, the government of Oman has implemented Electronic-Government (e-government) to enhance the efficient provision of public services. The principal aim was to avoid data duplication, to reduce the usage of stationery and to ensure accessibility. Furthermore, it also focused on data management with minimal or zero data loss. Even though such services are required urgently, it is essential to adopt proper procedures and transactions in line with the global trend of data management and the provision of efficient public services delivery (Serra, Carvalho, Ferreira, Vaz, & Freire, 2015). Internationally there is an urgent need for the provision of updated procedures

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and transactions for business organizations and citizens alike. The government are pushed to be up-to-date with the latest trends in the competitive world of technology. The development of information and communication technologies (ICTs) proved to be both positive and beneficial in a fast-evolving world (Vaishnavi & Kuechler, 2015). However, these improvements in the world of technology not only transfigured how businesses are conducted, but they have also changed the delivery mechanisms of the government and their servicing patterns.

The government can embrace the benefits of the internet to engage their citizens, while supplying them with appropriate service delivery in a variety of fields in a relatively shorter time. This system is commonly known as e-government (Baid-Agrawal, Pascual, Moradpour, Somasundaram, & Muche, 2014). The rapid growth and advancement of such practices make it convenient for the authorities to provide critical services to public bodies, corporate groups and other stakeholders, rapidly and efficiently. Moreover, with the recent global improvement and upgrading of mobile devices, consumers' activities shifted from electronic services such as Electronic-Government (e-government), Electronic-Business (e-business) and Electronic-Commerce (e-commerce) to mobile services, which include Mobile-Government (m-government), Mobile-Business (m-business) and Mobile-Commerce (m-commerce). Such developments are primarily due to the high subscription rates in developing countries, whereby mobile devices are part of most people's daily lives (Ariffin, 2016).

The main purpose of using the internet and m-government as the primary channel of communication is to provide better quality government services. The explosive use of different mobile technologies and services has also increased the level to which the government provides mobile access facilities to tablets, phones, laptops and some personal digital assistants (PDAs) (Ebbers, Jansen, & van Deursen, 2016). These digital technologies operate through connecting all the wireless networks, while enabling the government and other relevant parties to transition from e-government to m-government, which is basically done using mobile technology (Fath-Allah, Cheikhi, Al-Qutaish, & Idri, 2014).

Several modern governments in developed and developing countries alike offer a wide range of m-government services (Serra et al., 2015). However, there is an absence of practical guides and adequate theories to monitor the successful implementation of these services. It is worth noting that the adoption rate of e-government services is low in the Arab countries, including Oman, when compared to other developing nations (Li, Yang, Chen, & Yao, 2018). The older generation is usually more reluctant to try out new technologies. Unfortunately, this generation is predominantly working as senior and mid-managers in the government sector. While Oman has taken giant steps towards promoting technological development and the use of mobile devices, there is a lot more to be done.

For m-government to function in its full efficiency, the decision-makers need to convince all the citizens of its values (Li et al., 2018). Oman is one of the countries that have considered the importance of ICTs at all levels of state creation, educational or governmental. Oman has extensively raised the level of using digital devices for the establishment of technological development across the region. It is worth to note that Oman formed an autonomous body called "Information Technology Authority", which was empowered to make policy decisions for implementing ICT solutions in government departments.

Moreover, the revised education policy has empowered the younger generation to appraise the power and benefits of technology. In order to assist its subjects, special service centers are also opened throughout the country, also known as the "Sanad Service Centers". These service centers aimed to assist those in society in need of using the government's digital services. Therefore, one can understand that the government have also been rectifying the need to provide m-government in participating with the citizens in a more definite way. Decision-makers should use the m-government services model in concrete terms as it helps them understand the issues better, which they faced during the implementation of the m-government services, and hence, to be more successful in implementing them.

This study has some limitations. Firstly, the study extracted the research variables using only secondary data from previous studies in m-government. Secondly, it conducted a systematic review to extract the study variables using only three academic databases: Web of Science (WoS), ScienceDirect

and Scopus. Thirdly, only IT experts were engaged for the assessment in this study due to the limited number of experts in the m-government field.

This article begins with the introduction that describes the background to the m-government framework. Next, it elaborates on the literature that supports the variables for m-government and thirdly, proposes the methodology. Thereafter, the results are discussed and the article concludes with the next directions to be taken.

LITERATURE REVIEW

M-government is crucial as a digital platform for the citizen's usage and services, and he proliferation of IT has raised the need for efficient government services (Almarashdeh & Alsmadi, 2017). Li et al. (2018) suggested a paradigm based on the satisfaction principle for m-government microblogging services. The findings stated that the perceived convergence of the service integration of online-offline had a strong and positive effect on gratification, though it also revealed that perceived internet censorship affected the mobile usage continuity (Li et al., 2018). A study on the evaluation of the usability of the Saudis' m-business and m-government applications using Nielsen's heuristics method for the mobile environment context stated that the performance of m-business application was higher than m-government, and therefore, the m-government applications need to be strengthened (Alotaibi, 2016). Additionally, the mobile applications need to satisfy the local users' requirements (Ariffin & Dyson, 2015).

Even though there are limitations to the use of phones, they have drastically changed the life factor in developing countries. Using mobile phones to deliver essential government services becomes important, even where the internet penetration rate is low. There are several constraints, such as no access to electricity or services like telecommunications, post offices and even banking. However, continued cooperation between the government sectors and local communities would eventually result in better service provision through m-government (Watson, Suwamaru, Mow, & Logan, 2017).

The m-government modified a method called the application data management (ADM), which was provided by The Open Group Architecture Framework (TOGAF) (Isagah & Wimmer, 2018). Saxen (2017) suggested that the basis for implementing the m-government in India was based on the study of Theory of Planned Behavior (TPB), Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT). He tested many concepts and found valuable impressions of the utility, trust, ease-of-use and efficiency of m-government acceptance (Saxena, 2017). Bilkova (2018) proposed an adoption of m-government, model-based TAM model, which was enlarged by factors that affected the behavior of customers (Bilkova & Kralova, 2017). The following year they collected data from a structured questionnaire to propose a framework for structural equation modeling using the Theory of Reasoned Action (TRA), Technology Acceptance Model (TAM), Theory of Planned Behavior (TPB) and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Hameed, Shukur, Al-khafaji, & Al-Farhan, 2014). Meanwhile, Wirtz (2018) suggested a model for Jordan's citizens on smart Diffusion of Innovation-based (DOI-based) government services, integrated external trust, perceived risk and efficiency. The results of this analysis showed that most of the proposed variables affected the user's intention to use and accept intelligent government services in Jordan (Wirtz & Birkmeyer, 2018).

The desires of users to embrace and use the Jordan's smart DOI-based government facilities were influenced by most of the factors suggested in this study. Another research proposed a model to analyze the role of "perceived threats" in the Indian m-government services based on UTAUT, TAM and TPB (Saxena, 2018). Aiming to examine and understand m-services adoption in Saudi Arabia, they proposed a framework based on UTAUT2 and expanded it by considering trust and knowledge as variables in the proposed model (Baabdullah, Alalwan, & Al Qadi, 2018).

A study in Malaysia had developed a framework for the success of m-government services (M-GSEF) from the citizens' perspective using the Fuzzy Delphi method to test the factors of system

quality, information quality, service quality, citizen's usefulness, citizen's satisfaction, citizen's trust, perceived m-government service quality and perceived effectiveness of m-government services (Azeez & Lakulu, 2018). A study in Tanzania was conducted with the aim of capturing the critical success factors (CSFs) for m-government adoption and proposed a framework using seven factors, which were privacy trust, accessibility, usability, security, cost, infrastructure, and personal initiatives and characteristics. The result of their study accepted all the tested factors, except privacy trust (Ishengoma, Mselle, & Mongi, 2019). This highlights the importance of further research in accessibility design and evaluation of mobile applications, in order to provide more inclusive access to essential applications used by all citizens, such as e-government services (Serra et al., 2015).

METHODOLOGY

This study attempted to construct a new success evaluation framework for the Ministry of Housing in Oman focusing on the experts' perspectives. In order to obtain an ideal framework, dimensions and factors that do not affect the success of the m-government at the Ministry of Housing in Oman were removed from the evaluation framework. The Fuzzy Delphi Method (FDM) was one of the methods used for this study to reach the experts' consensus on the framework's pillars and elements. The FDM is a quantitative method that combines the classical Delphi method with fuzzy set numbering or fuzzy set theory. The degree of agreement between the experts is measured using a similar method. To calculate the foggy valuation value from all experts, the consensus coefficient is used for each expert. The experts openly conveyed their opinions, ensuring that the group's perspective is comprehensive and uniform, taking into consideration the fuzziness that is unavoidable during the surveying process. This is not possible when questioning individuals due to time constraints or grouping, whereby the questions by the experts are a useful technique for data collection in the Delphi surveys (Azeez & Lakulu, 2018).

This section also explains the methodology adapted for the m-government evaluation and classification adoption factors in the Ministry of Housing in Oman. The proposed framework was developed based on the existing framework proposed by (Alaa et al., 2019). The experimental design was divided into three main phases. Phase one defined the design of the framework with FDM. In the second phase, the designed framework was validated and tested by collecting and analyzing the data. In phase three, a multi-criteria decision method (MCDM) was applied to select the subject experts. TOPSIS is one of the best solutions due to its high reliability in locating the most eligible among a set of alternatives with the chosen criteria. Furthermore, the best solution was chosen by simultaneously measuring the distances of each alternative to the negative ideal solution (NIS) and the positive ideal solution (PIS). Figure 1 presents a description of the research design, as well as the three implementation phases including pre-expert validation, Fuzzy Delphi Method and Multicriteria Decision Making.

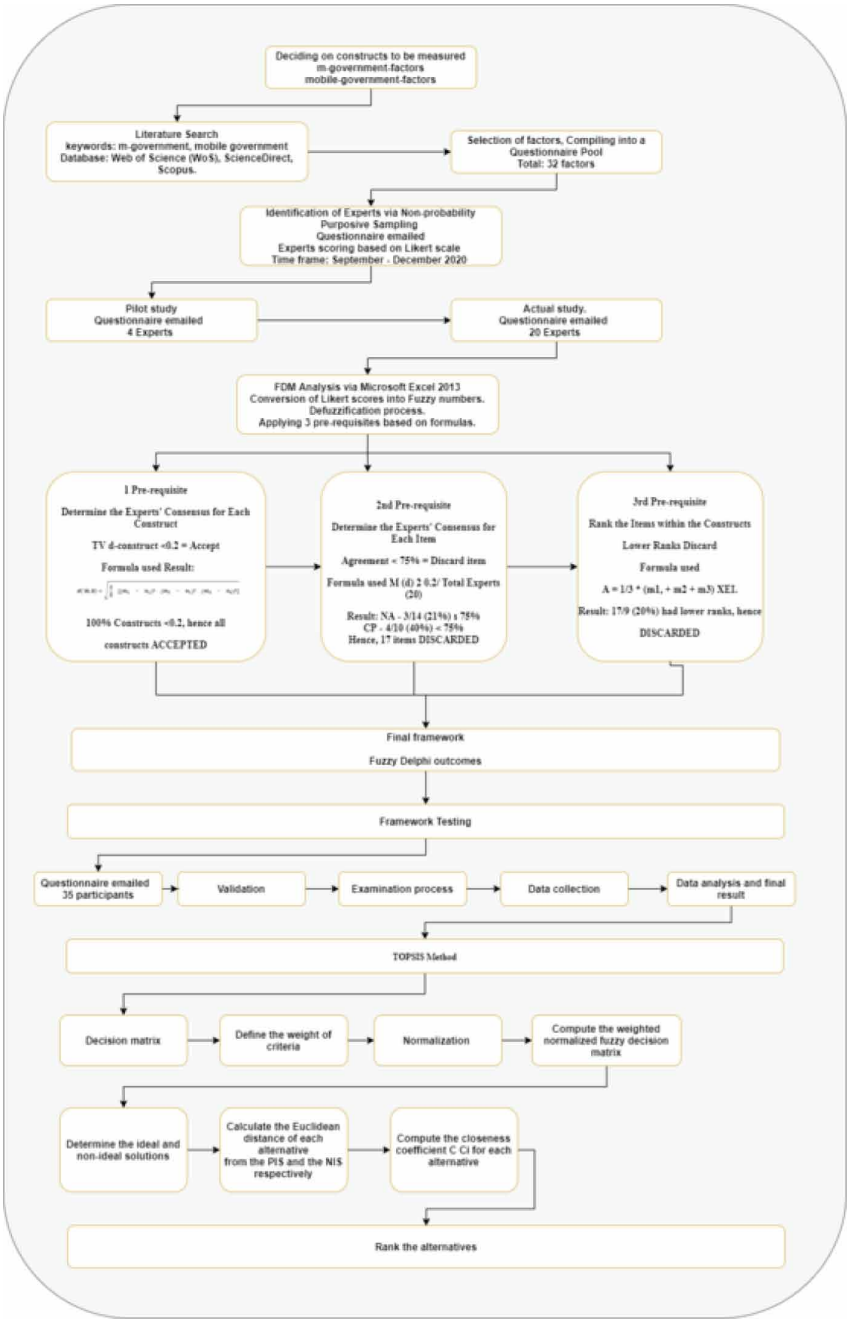
PRE-EXPERT VALIDATION

The details of experts from this study is illustrated in Table 1. The experiment presented four steps in evaluating the new framework.

Step One: Validation of updated tools for evaluating pre-service m-government institutions and to validate the m-government instruments or official acceptance or approval, in particular, the IT expert's instruments (m-government) before the examination.

Step Two: Several variables are used for m-government in many different countries. This study is to identify which variables will be used in Oman. These examinations checked the variables of the m-government for each pre-service (m-government) because there were several weaknesses

Figure 1. Research Design for m-government (Pre-Expert, Fuzzy Delphi and TOPSIS)



in using the m-government services. In this study, numerous Oman citizens revealed that they experienced weaknesses in the m-government. Through early deep research, it was discovered that the study of m-government did not test the variables before being used in Oman. This study aims to test all the variables of m-government before use. Therefore, when the new framework was designed for the m-government, the first part of the evaluation was developed to examine all

Table 1. Experts background

No.	Job place	Job title	Years of experience
Expert 1	Ministry	Head of Department	5-10 Years
Expert 2	Ministry	Head of Department	5-10 Years
Expert 3	Ministry	Manager	10-15 Years
Expert 4	Ministry	Head of Department	15-25 years
Expert 5	Ministry	Head of Department	5-10 Years
Expert 6	Ministry	Head of Department	5-10 Years
Expert 7	Ministry	Head of Department	5-10 Years
Expert 8	Ministry	Manager	10-15 Years
Expert 9	Ministry	Head of Department	5-10 Years
Expert 10	Company	Head of Department	5-10 Years
Expert 11	Company	Manager	10-15 Years
Expert 12	Company	Head of Department	10-15 Years
Expert 13	Company	Head of Department	10-15 Years
Expert 14	Company	Manager	10-15 Years
Expert 15	University	Lecturer	5-10 Years
Expert 16	University	Lecturer	10-15 Years
Expert 17	University	Lecturer	5-10 Years
Expert 18	University	Lecturer	10-15 Years
Expert 19	University	Lecturer	5-10 Years
Expert 20	University	Lecturer	5-10 Years

the variables of m-government. Each purpose that requires the use of m-government is based on the appropriate m-government variables. Thus, the variables of pre-service of m-government are important in Oman. The current study attempted to choose the right variables of m-government for Oman's Ministry of Housing. The study obtained permission from the Graduate Research Institute on 25 November 2019, University Pendidikan Sultan Idris (UPSI) and the Ministry of Housing in Oman on 7 January 2020 for data collection purposes.

Step Three: Instruments for assessment and tools. In this study, the instruments applied to the m-government variables were presented in two parts. The first section consisted of interviews with the IT department experts and the second section consisted of a questionnaire with an approximately 30-minute response time.

Step Four: Data collection. The current study evaluated 17 variables pre-serviced by 20 experts from the IT department in a company, the Ministry and a university in Oman to build the application for Oman's Ministry of Housing. The researchers received permission (letter of consent) from the Graduate Research Institute, UPSI and the Oman's Ministry of Housing for data collection purposes prior to the examination for evaluation.

FUZZY DELPHI METHOD (FDM)

By using the FDM, this section designs and constructs the rigorous assessment system. This methodology depended on the collective reasoning of trained professionals, who affirmed the validity

Table 2. Five-point linguistic variable scale

Likert Scale	Allowing linguistic shift	FUZZY Likert		
1	Very important	0.6	0.8	1
2	Important	0.4	0.6	0.8
3	Neutral	0.2	0.4	0.6
4	Not important	0	0.2	0.4
5	Strongly not important	0	0	0.2

of the information collected. As described in Figure 1, the FDM was classified into nine phases: phase one was the multi-criteria recognition based on a literature review, phase two was the experts' collection dedication, phase three was a questionnaire for the experts, phase four was the analysis of data, phase five was the conversion of the Likert scale to fuzzy data collection scale determination, phase six was the analysis of data (triangular fuzzy number), phase seven was a percentage of experts' consensus, phase eight was the analysis of data and the final phase was interpreting the results. This study proposed five-point Likert scale that is mapped to Fuzzy Likert as shown in table 2.

MULTI CRITERIA DECISION MAKING (MCDM)

There is an ongoing need for rigorous assessment models that integrate multiple supplier requirements effectively. Therefore, with its multiple criteria that demonstrated vagueness and imprecision, which should be a trade-off, supplier's selection is a highly relevant multi-criteria dilemma of decision making. Classical multi-criteria decision-making (MCDM) methods that take into account deterministic or random processes, including imprecise and linguistic knowledge, do not effectively solve decision problems. In practice, a high degree of vagueness and imprecision is used for decision-making in the supplier's selection. One of the powerful instruments for dealing with ambiguity and vagueness is the Fuzzy set theory. In MCDM approaches, community decision-making is an important issue. To avoid bias and eliminate partiality in the decision process, multiple decision-makers are always favored. In this study, the proposed new method of MCDM based on the TOPSIS is shown below:

Phase 1: The DM was established, which reflected the columns of the matrix (CJ) parameters and rows representing the alternatives:

$$D = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\ \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \end{array}$$

Phase 2: Based on mathematical operations, such as AHP and BWM, the weight of the parameters was determined using various methods from the human approach or entropy.

Phase 3: The standardized DM was measured. The benefit of normalization in this step is to make the values have similar scales and eliminate the units:

$$\text{RIJ} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{a} x_{ij}^2}}$$

Phase 4: The weighted normalized fuzzy DM was computed. The weight was evenly split between the criteria in this study because the value of the criteria was equal among the experts.
Phase 5: Identified ideal and non-ideal solutions:

$$\text{PIS} = A^+$$

and:

$$\text{NIS} = A^-$$

for each criterion, they're calculated:

$$A^+ = \left\{\left(\left(\max_i r_{ij} | j \in J\right), \left(\min_i r_{ij} | j \in J\right) | i = 1,2,\ldots,m\right)\right\}$$

Max when the advantage is the criterion, and min when the cost is the criterion.

$$A^- = \left\{\left(\left(\min_i r_{ij} | j \in J^-\right), \left(\max_i r_{ij} | j \in J^-\right) | i = 1,2,\ldots,m\right)\right\}$$

Min when the advantage is the criterion, and max when the cost is the criterion.

Phase 6: This measured the Euclidean distance of each alternative from the PIS and the NIS. The measured distance was done using the Euclidean distance provided by the following measurement distance between each alternative in R and the ideal vector:

$$\text{A^+} D^+ = \sqrt{\sum_{j=1}^{n} \left(r_{ij} - r_j^*\right)^2}, \quad i = \left(1,2,\cdots m\right), \; D^- = \sqrt{\sum_{j=1}^{n} \left(r_{ij} - r_j^-\right)^2}, \quad i = \left(1,2,\cdots m\right)$$

Two values were presented at the end of Phase 6, namely D+ and D-, for each alternative that had been calculated. The distance between each alternative and the ideal and non-ideal alternatives was expressed by these two values.

Phase 7: For each option, the closeness coefficient (Ci) was computed:

$$C_{i^*} = D_i^- / \left(D_i^- + D_i^*\right), i = \left(1,2,\cdots m\right)$$

Table 3. Proposed framework's variables

Variables		
Acceptance to New	Attitude	Culture
Mobility	Social influence	Perceived efficiency
Quality	Trust	Intention
Perceived Image	Usefulness	Perceived Compatibility
Complexity	Ease of use	Observability
Self-efficacy	Behavioral	

Phase 8: The alternatives are ranked and the best solution is the alternative with the highest coefficient of closeness.

DISCUSSION AND RESULTS

In this study, three main steps were decided. In the first step, a model of the design was built using the FDM. The results of the proposed assessment system for Oman's m-government pre-service had been checked. The second step was to solve the preserve selection problems, whereby TOPSIS was used for the m-government, and the findings of the validity ranking were presented. The third step showed the experimental results of the framework design.

FIRST STEP PRE-EXPERT VALIDATION

Stage 1: The assessment variables emerged from the review literature, whereby Table 3 shows the variables from previous studies for the significance of m-government assessment criteria. The variables involve ease-of-use, mobility, active control, behavioral, observability, etc.

Culture: According to Hofstede (1993), culture is a dynamic phenomenon linked to people's beliefs. When introducing technology into a new setting, it is crucial to take into account important cultural differences and that the Hofstede's dimensional system of cultural differences is reaffirmed, which means that ambiguity avoidance can be used to substitute for community. Cultural differences can serve as an obstacle to m-government service adoption in some countries, so it is critical to understand these countries' cultural settings when developing strategies to increase the m-government services. Culture is divided into various classes, such as national and organizational cultural levels (Al-Hujran, Al-Debei, Chatfield, & Migdadi, 2015). Furthermore, culture is characterized as the collective mental conditioning that distinguishes members of one human community from those of another (Al-Okaily, Lutfi, Alsaad, Taamneh, & Alsyouf, 2020).

Perceived Compatibility: According to (Jaradat, Moustafa, & Al-Mashaqba, 2018), perceived compatibility (PC) is the degree to which a new idea is thought to be compatible with potential adopters' current beliefs, past experiences and needs. It was stated that technological advancement might be compatible or incompatible with sociocultural values and beliefs. As a result, when new technology or services are consistent with the user's needs and desires, they will see these technologies or services as beneficial to them. On the other hand, if new technologies or services are incompatible with a user's needs and desires, the user is less likely to use them.

Social influence: The degree to which a person perceives the value of others to assume that he or she can use the new system is known as social influence. In a similar vein, the social factors construct is a strong indicator of the use of information technology (Al-Okaily et al., 2020). The degree to which consumers believe that it is important for others (such as family, friends, colleagues, etc.)

to use a particular technology, is known as social influence (Sharma, Al-Badi, Rana, & Al-Azizi, 2018). In other words, the knowledge and support given by those around customers might play a significant role in increasing customers' understanding and desire for technology (Alalwan, Dwivedi, & Rana, 2017). It is argued that when consumers have little or no knowledge of a new service, the reference groups affect their decisions to implement it.

Attitude: An individual's behavioral purpose to use and adapt any information system (IS) or technology is heavily influenced by his or her attitude (Saxena, 2018). The positive or negative feelings that a person has on performing the target behavior are referred to as attitude (Davis, 1989). In voluntary settings such as e-commerce, e-banking, m-governance and e-government, the existing literature indicated that attitude was related to an individual's intentions (Saxena, 2018; Dwivedi et al., 2017).

Ease of use: Perceived ease of use (PEOU) refers to "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989). The level difficulty of in understanding and using technology can be characterized in this way (Hebbar & Kiran, 2019). In previous studies, PEOU was the most important factor influencing the behavioral intention to use m-government (Hebbar & Kiran, 2019; Al-Hujran et al., 2015; Shareef, Kumar, Dwivedi, & Kumar, 2016; Althunibat, Alrawashdeh, & Muhairat, 2014; Saxena, 2017). In fact, mobile internet may be considered a new technology that will necessitate a certain amount of experience and expertise from clients in order to be securely and effectively utilized (Alalwan, Baabdullah, Rana, Tamilmani, & Dwivedi, 2018). Previous researchers had found that when potential adopters considered a new innovation to be simple to use, their likelihood of adopting it increased (Mandari & Chong, 2020;Alalwan et al., 2018; Lu, Papagiannidis, & Alamanos, 2019).

Trust: Trust plays a key part when m-government services are adopted (Lallmahomed, Lallmahomed, & Lallmahomed, 2017). Using the mobile internet is a screen-to-screen engagement rather than a face-to-face interaction. As a result, users are more reliant on trust mechanisms to limit risk and support their decisions to use new technologies, such as the mobile internet (Alalwan et al., 2018). Previous researchers had found that trust had an impact on people's intention to use m-government services (Lallmahomed et al., 2017), (Al-Hujran et al., 2015). Because of the accompanying risk, online environments require a high level of trust. Moreover, to encourage the citizens to use m-government services, the citizens should have faith in the government that delivers these services, as well as the electronic channels through which these services are delivered (Al-Hujran et al., 2015).

Perceived Usefulness: Perceived usefulness (PU) is defined as the degree to which a person believes that using a particular system would enhance his or her job performance (Davis, 1989). Customers might see using the mobile internet as a more productive method of doing things, saving them time and effort compared to utilizing traditional methods to access the same services (Alalwan et al., 2018). The PU construct assesses whether people believes technology will help them improve their performance (Camilleri, 2019).

Behavioral: Behavioral uncertainty arises when users cannot ascertain the behavioral actions of other LBS parties, especially in extreme events (Aloudat, Michael, Chen, & Al-Debei, 2014). Behavioral intention (BI) is a major factor that aims to predict the user's intention to use the new technology again (Almarashdeh & Alsmadi, 2017). The user's intention to use m-government services was related to real usage of the services (Almarashdeh & Alsmadi, 2016). Benevolence refers to an individual's belief that the trustee cares about her/him and acts in her/his interests. BI refers to a person's subjective probability that he/she will perform some behavior (Liu, Mezei, Kostakos, & Li, 2017). It is defined as an individual's subjective probability that he/she will use some m-services (Davis, 1989; Saxena, 2017).

Perceived efficiency: This is defined as the degree to which an individual perceives that the service will reduce the time spent and effort to go to the public service office or to use another channel (Sultana, Ahlan, & Habibullah, 2016). This study found that there were 15 beliefs which might

influence the citizens to use or reject the service. The factors perceived included ease-of-use, perceived efficiency in time and distance, perceived value for money, perceived responsiveness, perceived convenience, trust in the SMS technology, perceived usefulness, perceived relevance, quality and reliability of the information, perceived risk to user privacy, perceived reliability of mobile network and system performance, trust of the government and perceived quality of public services, perceived risk to money, perceived availability of device and infrastructure, perceived compatibility, and self-efficacy in using the SMS. However, the relationship among the variables was not investigated in this study. Moreover, the results might not be the same for the developing countries, because the respondents for this study mainly comprised the citizens with internet access (Saxena, 2018; Abu-Shanab & Shihadeh, 2016).

Observability: Observability is the degree to which the results of an innovation are visible to others and how easily the benefits can be communicated to others. Previous studies indicated that observability incorporated two specifically different dimensions, which were result demonstrability and visibility. The former refers to the outcomes of using the innovation, while the latter is the observability of the innovation itself. The results of using some innovations are easy to observe and visible to individuals, thus, they will likely adopt them quickly and easily. For example, the results of using Mobile Parking Services are observable and visible to individuals, so this system would be diffused faster than an innovation that is not so visible. Therefore, some studies stated that there was a positive relation between observability and adoption, which led to the hypothesizing that higher levels of perceived observability would positively relate to higher levels of intention to use the m-government services, which was supported by (Saadi, Ahmad, & Hussain, 2017; Jaradat et al., 2018).

Mobility: In mobile computing, mobility refers to the characteristics of a device to handle information access, communication and business transactions. Whereas, motion mobility is considered to be the typical characteristics of m-government, which facilitates users to use wireless portable devices anywhere and anytime to deliver information between different wireless devices without the need for a wired network, which increase the value to users (Wang, 2014; Faisal & Talib, 2016).

Quality: Interaction quality refers to the quality of customers' interactions with m-service providers (government) or the systems during the service delivery. In a mobile context, environment quality represents "how the consumer considers the overall environment of the service delivered by the service provider". Information quality is "the ability of the system to convey the intended meaning of information". System quality refers to "the user's perceptions regarding the technical level of communication". Network quality refers to "indoor and outdoor coverage without connection breakdowns". Outcome quality is "what the customer is left with, after the service is delivered" (Al-Hubaishi, Ahmad, & Hussain, 2017). The quality of service from a user's perspective is defined as "the degree of goodness of the m-service in respect of its perceived usefulness" (Jaradat et al., 2018). Information quality refers to "measures of the output of public information systems", namely the quality of information that the system produces primarily in the form of reports, which captures "the content issues", whereby the mobile content should be personalized, complete, relevant and easy to understand (Wirtz & Birkmeyer, 2018).

Perceived Image: Since the adoption of m-government offers the adopters the advantage of accessing the latest government information, they consequently become an important source of information among peers, which may help improve their image. Moreover, the enhanced social status that users received as a result of adopting an IT innovation might contribute to a kind of social pressure on others, which would force them to adopt innovation. A number of researchers had included the image construct to investigate the adoption of the e-government (Liu et al., 2014). Image refers to "the citizens' perceptions that the adoption of the m-government would enhance the adopters' status in the social system" (Liu et al., 2017).

Complexity: Complexity is defined by Rogers (2003) as "the degree to which an innovation was perceived as relatively difficult to understand and use". Complexity has a negative relationship

with the adoption rate, therefore, it will have a negative influence on technology usage, complexity, and the Davis' perceived ease-of-use are the opposite of each other. Several previous studies found that complexity was a significant factor, however, some studies did not find any significant effect of complexity (Jaradat et al., 2018).

Self-efficacy: Self-efficacy implies the extent to which an individual perceives his/her competence in handling a particular system, and this entails that the individual possesses the requisite technological knowledge and skills to use the technology or system. An individual is able to assess the extent to which he/she finds it easy or difficult to perform a specific action (Saxena, 2018).

Stage 2: Determining the selection of experts. Experts performed a poll to determine the pillars in the m-government framework for the Ministry of Housing in Oman. Twenty specialists with backgrounds in mobile services, mobile technology and applications participated in this study and answered the survey. Experts from the universities, ministries and companies with relevant experience were chosen to provide feedback on the proposed framework for the Oman's Ministry of Housing. Previous literature had failed to achieve a consensus on the number of experts to be studied (Azeez & Lakulu, 2018). Former researchers stated that a group of 10 to 15 experts was ideal for a Delphi study (Azeez & Lakulu, 2018). Meanwhile, other researchers felt that a group of 10 to 20 experts was ideal for a Delphi study (Khawagi, Steinke, Nguyen, Pontefract, & Keers, 2021). However, this study utilized 20 experts to form a developed framework for more input for the Oman's Ministry of Housing.

Stage 3: Expert Questionnaire. The survey questionnaire is a study instrument, which consisted of multiple choice questions. The aim of collecting information from the IT experts was to determine whether the framework requirements of a proposed m-government service should be evaluated. The experts had the ability to offer views on their experiences in terms of m-government parameters. Questionnaires on the opinions of experts were created for the data collection. The elements acquired from evaluating and synthesizing information on the current frameworks and guidelines were used to create the surveys. They were disseminated through an online survey tool. The surveys were uploaded on the internet to reduce delay (Rachid, Toufik, & Mohammed, 2019).

The questionnaire was divided into two sections. The first section dealt with the expert's personal information. The second section had 17 questions designed to get an expert's perspective on the proposed structure for Oman's Ministry of Housing. Table 1 shows the content factors of the questionnaire.

A pilot study is essential in order to discover whether the question-wording, questionnaire layout, training and fieldwork best methods are on track, along with getting acquainted with respondents and calculating response time to be viable (Geisen & Bergstrom, 2017). A pilot study was therefore performed to observe how the questions were understood and interpreted, the extent of the questionnaire, and whether the feedback would interfere with the respondent's ability to provide the required answers (Mwenje, 2016). The size of the pilot study might range from 2 - 4 experts. According to (Connelly, 2008), it was stated that a pilot study should consist of 10% of the actual study. Before distributing the questionnaires, a pilot study was carried out that included three sectors in the Sultanate of Oman, namely the education sector, government sector and private sector. These three sectors were chosen intentionally because the researcher had easy access to the participants, which indicated the relationship between the researcher and these sectors.

The structure of the questionnaire was designed to target the experts who had more than five years of experience from the IT departments. The aim was to test the survey instrument and check the content and question validity, suitability of the validity test measure, understanding the instructions and requirements and to check if the best method to measure the DV had been selected. A total of ten surveys were distributed in Oman (four surveys to the experts in four ministries, three surveys to the experts in three universities and three surveys to the experts in three companies). However, only four surveys were collected (40% response rate) and thereafter, the results were analyzed using the FDM.

Table 4. Questionnaire data analysis

Main criteria	Triangular Fuzzy Number		Defuzzification Value	
Variables	Average Threshold value (d)	Average of Expert percentage Consensus (%)	Average Fuzzy Score (A)	Criteria Results
Acceptance to New	0.30	25%	5.47	Rejected
Mobility	0.27	30%	5.07	Rejected
Quality	0.26	25%	3.39	Rejected
Perceived Image	0.23	35%	4.33	Rejected
Complexity	0.30	20%	4.67	Rejected
Self-efficacy	0.32	20%	4.40	Rejected
Perceived Compatibility	0.18	90%	13.40	Accepted
Attitude	0.18	90%	13.40	Accepted
Social influence	0.18	90%	13.40	Accepted
Trust	0.18	90%	13.80	Accepted
Usefulness	0.18	90%	13.60	Accepted
Ease of use	0.18	90%	13.60	Accepted
Behavioral	0.18	85%	13.80	Accepted
Observability	0.20	90%	13.40	Accepted
Culture	0.18	90%	13.80	Accepted
Perceived efficiency	0.20	85%	14	Accepted
Intention	0.18	90%	13.40	Accepted

SECOND STEP FUZZY DELPHI METHOD (FDM)

Stage 4: This study gathered data from the experts' opinions using a standardized questionnaire. The experts were requested to determine the variables and measurements, and to check on the validity of the information through a survey using a five-point Likert scale.

Stage 5: Conversion to the fuzzy scale using the Likert scale. The questionnaire survey used a Likert scale of five points, which included responses such as 'very important', 'important', 'neutral', 'not important' and 'strongly not important'. Table 4 describes the linguistic variables for weighing the agreement of the experts.

Stage 6: Data analysis. Microsoft Excel was used to compile and evaluate the results of the questionnaires. Former researchers believed that if a factor received 75% of the vote, the elements were regarded to be in agreement (Alaa et al., 2019). Therefore, if at least 75% of the experts agreed on an element, the element is said to have reached a consensus. Table 6 is a summary of the experts' consensus conclusions on the m-government framework for Oman's Ministry of Housing.

Stage 7: Data analysis. The mean fuzzy score was believed to be 0.5. If the average fuzzy score (A) is more than or equal to 0.5, then the experts will identify the elements "to achieve the consensus of the experts".

Stage 8: Data analysis and interpretation. FDM or versatile decision-making technique was used to solve the issue of the conventional Delphi process. This approach relied on mathematical techniques. The data obtained by the FDM experts were analyzed to find the parameters that

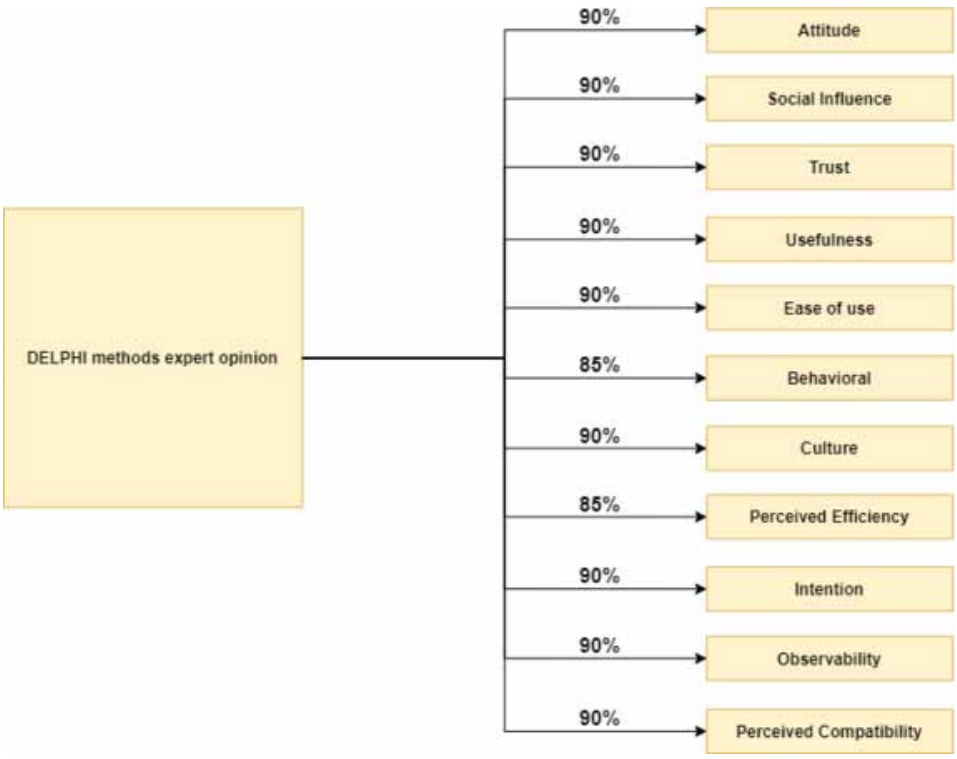
were selected by the 20 experts (Table 6). The results for Acceptance to New equaled 25% and was rejected, Mobility equaled 30% and was rejected, Quality equaled 25% and was rejected, Perceived Image equaled 35% and was rejected, Complexity equaled 20% and was rejected, Self-efficacy equaled 20% and was rejected, Perceived compatibility equaled 90% and was accepted, Attitude equaled 90% and was accepted, Social influence equaled 90% and was accepted, Trust equaled 90% and was accepted, Usefulness equaled 90% and was accepted, Ease-of-use equaled 90% and was accepted, Behavioral equaled 85% and was accepted, Observability equaled 90% and was accepted, Culture equaled 90% and was accepted, Perceived efficiency equaled 85% and was accepted and Intention equaled 90% and was accepted.

Evaluating and Selecting the Final Structure

The framework's aim was to investigate factors for pre-service m-government for Oman's Ministry of Housing. The mechanism strongly emphasized the factors, which the developers had to pay attention to while building the m-government. This framework took a look at the primary characteristics that could shape the m-government, which include the influence factors before the government service delivery and after analyzing the electronic service designs. Through the application of this system, the organizations would be able to identify the m-government issues in the future. Finally, the final version of FDM managed to generate 17 variables for evaluation and selection for the final system. This task was to assess the m-government institutions and their capability and versatility before developing the software for the Ministry of Housing. Figure 2 highlights the accepted variables based on the experts' opinions.

Since there were limited studies conducted on adopting the m-government services using the FDM, it was difficult to verify the results of this study. However, previous studies on m-government

Figure 2. Accepted variables based on experts' opinion



services were conducted using other methods, such as the Technology Acceptance Model (TAM), the Unified Theory of Acceptance and Use of Technology (UTAUT), Theory of Reasoned Action (TRA), Diffusion of Innovation (DOI) theory and Theory of Planned Behavior (TPB). Table 5 compares the common variables with other previous studies.

On the basis of the above Table 5, the accepted variables in the results of the study confirmed most of the previous studies' results. However, some variables of this study were contradicting the previous studies' results, such as mobility and quality factors. Since the previous studies used different methods, it is not fair to compare the results with these studies. On the other hand, most of the previous studies adopted the TAM model to examine their factors. On the basis of that, TAM as a widely used model was adopted to formulate the conceptual framework in order to examine the results with the end-users. Figure 3 presents the conceptual framework of the study.

Results of Experiment Two: Framework Test Results

As listed in Figure 2, the final findings of the framework evaluation for the 35 participants were from the faculty of information technology from various universities in Oman. To put the framework to the test, data were chosen as paradigms. The framework used the calculation of each component received during the evaluation to measure the change in the factors for M-Government with students in the faculty of IT at various institutions in Oman.

THIRD STEP MULTI CRITERIA DECISION MAKING (MCDM)

There are two components to this experiment. The first part covers decision-making approaches (TOPSIS), while the second part covers statistical analysis, as seen in Figure 4.

Discussion of TOPSIS Results

The use of FDM to shortlist the most important criteria is offered as a methodology for selecting pre-service m-government providers (Figure 4). TOPSIS was utilized to determine the final ranking of the alternative that was closest to the ideal (best) answer after the framework had been tested. The criteria that are used to determine the overall success of m-government. Furthermore, the outcomes of the discussion and evaluation are based on the procedures below.

Decision Matrix (DM) Results

The results of the Oman Ministry of Housing's pre-service M-Government factor evaluation are presented in this section. This section concentrates on the data and how it is used, from its raw form to the DM findings.

Raw Data for DM Result

A sample of 35 pre-service Information technology engineers from the Faculty of information technology at various universities in Oman was used.

The dataset for the eleven criteria of pre-service m-government includes perceived compatibility, attitude, social influence, trust, usefulness, ease of use, behavioral, observability, culture, perceived efficiency, and intention for each applicant.

Results for the Framework Development From Experts

In two subsections, the outcomes of the development of a selection framework are provided. The weighted result is discussed in the first section, and the TOPSIS result is presented in the second section. Ideal pre-service engineers are selected from the study's sample based on their M-Government skills and performance in information technology. Information technology capabilities and performance

Table 5. The common variables comparison with previous studies

Factors	(AZEEZ & LAKULU, 2018)	(Hebbar & Kiran, 2019)	(Saadi et al., 2017)	(Albayati, Kim, & Rho, 2020)	(Xianjun, Minghong, & Xiaoli, 2019)	(Saxena, 2017a)	(Eid, Selim, & El-Kassrawy, 2020)	(Aljarrah, Elrehail, & Aababneh, 2016)	(Ma, Zhang, Ding, & Wang, 2018)	(Liu et al., 2017)	This Study	Result
Model	TAM	DOI	TAM	TAM	TAM and TPB	TAM,UTAUT, TPB	TAM and TRA	TAM	TAM	FUZZY	FUZZY DELPHI	
Trust	A	R	A	A	A	A	A	A	A		A	Confirm with most other studies
perceived ease of use	R	R	R	A	A	A	A	A	A	A	A	Confirm with most other studies
perceived usefulness	A		R	A	A	A	A	A	A	A	A	Confirm with most other studies
Perceived efficiency	A				A	A					A	Confirm with all other studies
Behavior		A	A	A			A			A	A	Confirm with all other studies
Perceived compatibility	A	R				A		A			A	Confirm with most other studies
Social influence		R	A	A		A			A		A	Confirm with most other studies
Attitude				A	A	A	A	A	A		A	Confirm with all other studies
Intention	A	A	A	A	A		A	A		A	A	Confirm with all other studies
Self-efficacy	R					A					A	Confirm with all other studies
Mobility											R	Contradict with the other study
Quality	R	A									R	Contradict with the other study
Perceived Image		R								A	R	Confirm with one study and contradict with the other study

Figure 3. The conceptual framework of the study

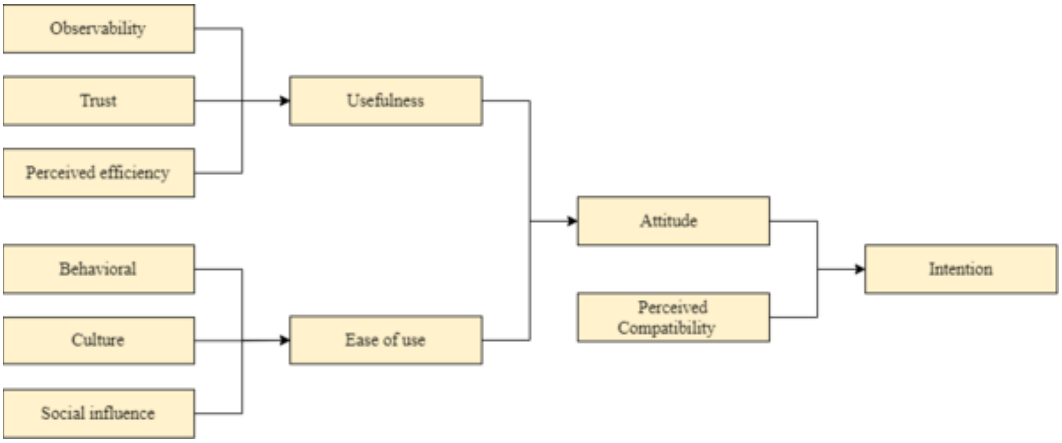


Figure 4. Decision-making technique application in the evaluation process

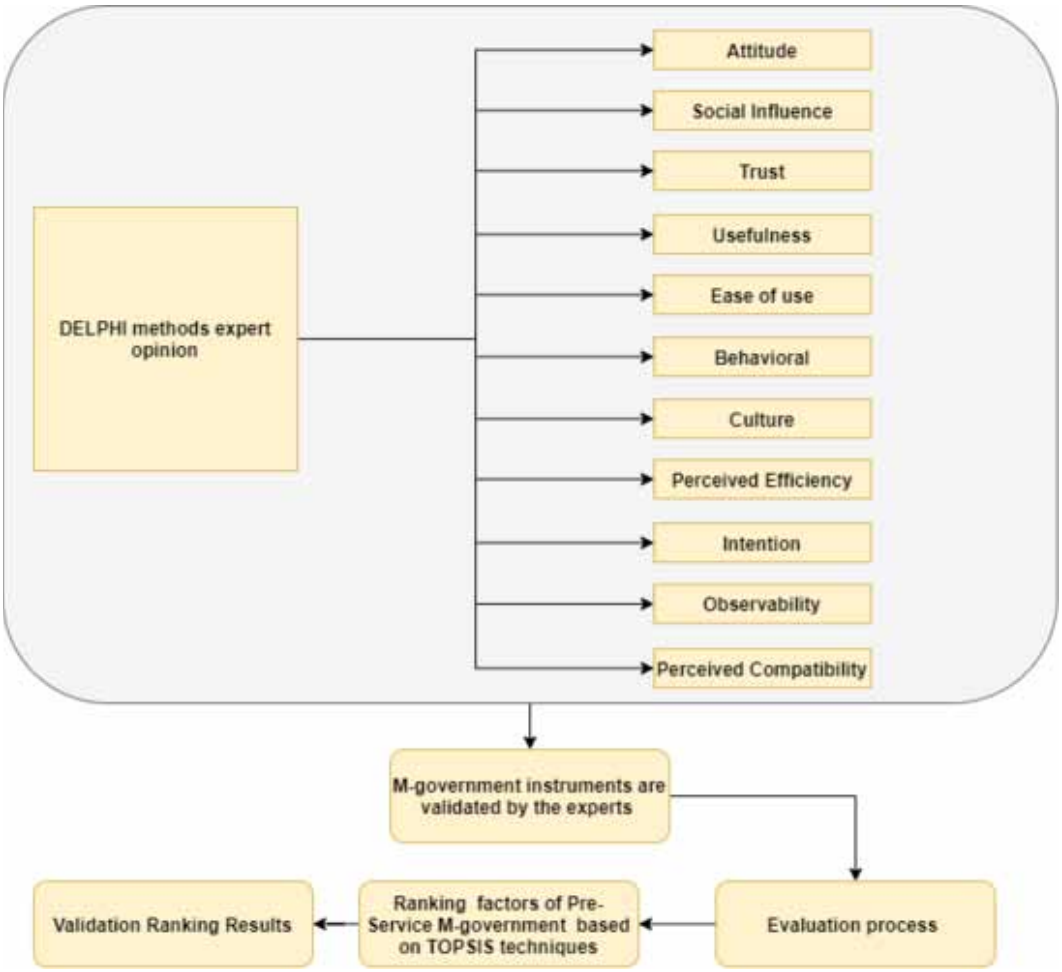


Table 6. Weighted criteria

0.91			0.91			0.91			0.91			0.91			0.91			0.91			0.91			0.91			0.91		
Perceived Compatibility			Ease of use			Usefulness			Observability			Trust			Behavioral			Intention			perceived efficiency			Attitude			Social influence			Culture		
0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333	0.3333

are critical to any pre-service engineer's overall success. The results of the evaluation are discussed in this section through two primary steps: weighted criteria and ranking outcomes.

Weighted Criteria

The human approach or entropy, which is based on mathematical procedures, is used to calculate the weight of criteria. The estimated weight for each condition is shown in Table 6.

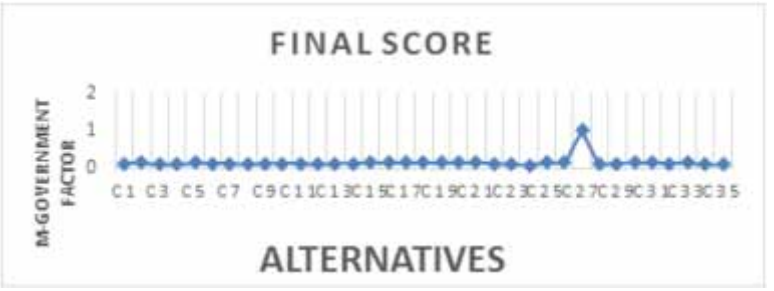
Ranking of TOPSIS Decision-Making Contexts

TOPSIS is used to rank the options based on the DM results, which reflects the criteria weight and importance, respectively. TOPSIS evaluates each alternative to the PIS highest criteria value and NIS lowest criteria value and identifies the highest and lowest scoring results for each alternative lowest criteria value. S denotes how near an option is to the lowest value, whereas S* denotes how close an alternative is to the maximum value score. The separation measurements determined by computing the distance between each possibility are denoted by the letters S− and S+. The separation measure in Phase 6 of Section multi-criteria decision making is completed by utilizing the Euclidean distance to calculate the distance between each alternative in R and the ideal vector A^+. The ranking of TOPSIS results for pre-service engineer reveals that one student obtaining the highest results, as seen in Figure.5, C27 with a score 1.six other students obtain a high score: C18=0.159159, C19=0.159159, C20=0.159159, C21=0.159159, C25=0.159159 and C31=0.159159. Moderate results are determined for 7 students. The result values for each are C2=0.157248, C16=0.156975, C5=0.156068, C26=0.153684, C30=0.153058, C33=0.153049 and C15=0.15123. Two other students obtain a moderate score but less than the student results above. The result values for each are C17=0.146108 and C10=0.144765. Four students obtain a moderate score but less than the moderate results above. The result values for each are C7=0.13945, C22=0.138609, C13=0.13611 and C14=0.131434. Six students obtain a moderate score but less than the moderate results above. The result values for each are C1=0.128885, C11=0.127911, C32=0.126678, C6=0.126672, C9=0.124359 and C28=0.122018. Seven students obtain a moderate score but less than the moderate results above. The result values for each are C35=0.119277, C8=0.117135, C34=0.116162, C3=0.112243, C23=0.110281, C12=0.107438 and C4=0.105607. The lowest result is obtained by one student, C24= 0.09999.

Validation of TOPSIS Results

The participants were chosen based on the results of the selection process, and we used TOPSIS to verify our findings. Validation is accomplished by the use of two methods generated from a statistical platform, which should demonstrate that the group should attain the highest score value by measuring the mean (m) and standard deviation (SD) (SD). As a result, this method reveals which is the best. The first C27 is statistically demonstrated to be the best among the others, according to the systematic ranking findings. Shows the comparative results of the participants amongst the eleventh M-Government criteria. In the perceived compatibility, with mean (m) value results = 2 ± 5. The range is between minimum (min) values = 2 and maximum (max) values = 5 However, In the Ease of use, with mean (m) value results = 1 ± 5. The range is between minimum (min) values = 1 and maximum (max) values = 5. The mean value of usefulness is mean (m) value results = 1 ± 5. The

Figure 5. Final rank for alternatives



range is between minimum (min) values = 1 and maximum (max) values = 5.Observability, with mean (m) value results = 3 ± 5. The range is between minimum (min) values = 3 and maximum (max) values = 5.Trust, with mean (m) value results = 1 ± 5. The range is between minimum (min) values = 1 and maximum (max) values = 5.Behavioral, with mean (m) value results = 1 ± 5. The range is between minimum (min) values = 1 and maximum (max) values = 5.Intention, with mean (m) value results = 1 ± 5. The range is between minimum (min) values = 1 and maximum (max) values = 5.perceived efficiency, with mean (m) value results = 2 ± 5. The range is between minimum (min) values = 2 and maximum (max) values = 5. Attitude, with mean (m) value results = 2 ± 5. The range is between minimum (min) values = 2 and maximum (max) values = 5.Social influence, with mean (m) value results = 1 ± 5. The range is between minimum (min) values = 1 and maximum (max) values = 5. Culture, with mean (m) value results = 1 ± 5. The range is between minimum (min) values = 1 and maximum (max) values = 5. Figure 5 illustrates further on the ranking results.

SUMMARY

For many developing countries, the adoption of m-government systems is increasing. There has been minimal research on the public offers of location-based services in m-government services concerning the Ministry of Housing. Issues related to the rural and remote areas and increasing technologies are just some of the problems that relate to digital literacy and services. In this study, several problematic factors were identified related to introducing the m-government framework in Oman. The experts assessed 17 variables to formulate a proper and comprehensive framework for m-government services' adoption from the literature. The Fuzzy Delphi analysis results accepted 11 out of 17 variables. Furthermore, the literature review did not find any study in the context of the m-government to acquire the same variables using the Fuzzy Delphi to compare all the results.

Additionally, 35 pre-service engineers tested the suggested framework in the second round. The third stage employs TOPSIS, an MCDM approach, to rank and pick pre-service engineers and choose perfect solutions. Statistical analyses are carried out at this stage to validate the ranking outcome.

The experts had evaluated the defined factors using findings of the proposed approach that were published. Therefore, this study contributed to the scholarly literature in a relatively new field.

CONCLUSION

The new model proposed in this study is intended for m-government services for the Ministry of Housing of Oman since there are no unique factors in the Omani context. Additionally, the new model has potential benefits for many countries considering m-government services for the Ministry of Housing. Furthermore, this includes the delivery to clarify the factors that influence/impact

the intentions to use the m-government services for the Ministry of Housing and add to existing information.

Decision-makers could benefit from the model of intention to use m-government services in Oman's Ministry of Housing. The novel model would assist them in understanding the difficulties they would face in implementing m-government services, thus resulting in the more successful implementation of these services. Additionally, the study would assist other stakeholders in the field of m-government services to better understand and adopt m-government services to reap the benefits and meet the citizens' needs. In future research, the framework of this study will be tested on the citizens in Oman to examine their intention to adopt m-government services in the Ministry of Housing.

Conflicts of Interest

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

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