

A Two-Stage SEM-Neural Network Approach for Predicting the Determinants of Mobile Government Service Quality

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Rapid advances in technology have transformed the world, forcing governments worldwide to move from electronic government to mobile government (m-Govt) in delivering quality services. The m-Govt service quality (mGSQ) is an arrogant concept, but so far, it has been relatively rare in this growing field. Thus, this research intends to explore the most critical factors predicting mGSQ, especially overseas citizens' cognition of the mGSQ. The online survey was conducted to collect data on overseas Pakistanis living in mainland China. A multi-analytic approach verified the valid responses of 345 overseas users of m-Govt services. The structural equation model (SEM) was used as the input of the artificial neural network (ANN) model to predict the main factors influencing mGSQ. The outcomes revealed that infrastructure quality is the most important strength of m-Govt's quality of service. The outcomes of this investigation provide an aerial perspective for government and practice to improve mGSQ.

Key words: *m-Govt services; service quality; ANN; predictive modeling.*

1. INTRODUCTION

The electronic government (e-Govt) includes the use of information and communication technology (ICT) to bring government services and information to the individual effectively, business as well as between the government departments around the globe (Al-Hubaishi et al., 2017; Ebrahim & Irani, 2005; Rana et al., 2014; Shahzad, Xiu, Khan, & Shahbaz, 2020). Meanwhile, the active penetration of mobile devices increased the citizen habits to get government information using mobile services, which also push the governments to deliver efficient services using mobile technology in the podium of m-Govt (Al-Hadidi & Rezgui, 2010; Alsaadi et al., 2019; Iskender & Özkan, 2013; Kushchu & Kuscu, 2004). The trend of m-Govt services is rapidly growing, which denotes the provision of government services over mobile application or interactive messages (Al-Hubaishi et al., 2017; Almarashdeh & Alsmadi, 2017; Dutra & Soares, 2018; Kumar & Sinha, 2007; Shareef et al., 2014, 2016; Sheng & Trimi, 2008) However, despite the requirements, citizens cannot consider m-Govt services to be effective if they are not able to contact government services through their mobile phones to fulfill their expected tasks.

The service quality in its contemporary meaning refers to comparing user-perceived expectations and a service's perceived performance. However, numerous researchers (e.g., Cronin, Brady, & Hult, 2000; Parasuraman, Zeithaml, & Berry, 1988; Shareef, Dwivedi, Stamati, & Williams, 2014; Zeithaml, Parasuraman, & Malhotra, 2002) argued that the service quality of the virtual medium is diverse in various aspects of traditional service quality. As a result, poor public service performance can undermine government performance and negatively affect government systems' fundamental credibility (Shareef et al., 2014). To evaluate the mGSQ, the researchers must first understand the dimensions affecting mGSQ. Although the previous literature, particularly in mGSQ, is not robust compared to e-Govt from the citizen's perspective (Al-Hubaishi et al., 2017). The authors believe that this study will provide a conceptual base for studying the necessary conditions for determining m-Govt services' quality. This study offers a theoretical understanding of citizens' perception of mGSQ and provides practical acumens for government agencies and officials to improve the sustainability of mGSQ, especially for overseas citizens.

In response to this study's research question (what are the potential dimensions that affect improving the quality of the m-Govt service from overseas citizen perceptible), authors are interested in revealing the perception of overseas citizens on the service quality dimensions the podium of m-Govt. In examining the potential dimensions of mGSQ, considerable research has been conducted on literature related to e-Govt and mGSQ, which assist in exploring the concept in more detail. Literature related to e-Govt can be applied to understand the phenomena of mGSQ. However, due to the mobility of mobile technology, m-Govt has its own features which required investigation separately and need a comprehensive model to evaluate its service quality (Al-Hubaishi et al., 2017; Chanana et al., 2016; Shahzad, Xiu, Khan, & Shahbaz, 2020;

Tan & Chou, 2008). In addition, there is no single way to explore the same concept in each industry. The prior researchers applied the e-Govt service quality model to the mobile environment. In order to establish a new and inclusive model to predict the dimensions of mGSQ, it is of considerable significance to explore the factors that discuss sustainability mGSQ.

2. RELEVANT LITERATURE

2.1 Conceptualization of transition from e-Govt to m-Govt

The researchers define the concept of e-Govt according to its use in ICT systems and the provision of government services, which describe the governmental relationship with electronics (Ebrahim & Irani, 2005; Heeks & Bailur, 2007; Larosiliere & Carter, 2016; Shareef et al., 2015; Venkatesh et al., 2014). The scholars have claimed that m-Govt is a sub-division of e-Govt by wireless communication devices to provide government information and services (Althunibat et al., 2011; Bergman, 2001; Z. J. Chen et al., 2016). Meanwhile, it is suggested that m-Govt would not be supposed as a new type, but rather as a new method to permit an efficient government that allows accessing the services from anywhere and anytime. m-Govt is an emerging trend to reform, restructure, and transform public services to boost and modernize existing e-Govt services to make them more viable and adaptable (Shareef et al., 2014).

The technological revolution in the field of the internet is not just for e-Govt. It gets the researcher's attention towards the implementations and adoption of the m-Govt system and explores the shift from wire to wireless-based applications in public and private sectors (Kumar & Sinha, 2007). The m-Govt adds value to e-Govt because people can access government services using wireless electronic devices such as smartphones, personal digital assistants (PDAs), and Wi-Fi-enabled devices (De Lima, 2017). Regardless of its infancy, the m-Govt is growing with a set of composite tools and strategies that will change traditional governance's existing functional roles. People can carry an m-Govt access terminal while traveling, strengthening the citizen-government relationship (Al-Masaeed, 2013). This shift from e-Govt to m-Govt will raise several questions regarding the delivery and quality of m-Govt services. Therefore, this study is systematized to categorize the potential dimensions associated with the service quality of m-Govt.

2.2 Mobile Government service quality (mGSQ)

The service quality can be termed as the level of difference between customer experience and perceived service performance (Zhou et al., 2010). It is also described as the link between customer and service provider and between perceived services and delivered services (Almuraqab & Jasimuddin, 2017; Markovic & Raspor, 2010). In terms of online services, e-

services have been recognized as the electronic provision of interactive network-based services over the internet (Alsamydai, 2014).

However, this concept is critically increasing in service organizations where the service organizations are suggested to enhance service quality by understanding user perceptions, particularly in e-Govt or m-Govt services (Brady & Cronin, 2001; Shareef et al., 2014; Yang, 2012). Former studies have revealed that service quality can trigger several positive customer reactions, such as loyalty, creating trust, satisfaction response of citizens to significant drivers of e-service adoption (Hao, 2016; Reichheld & Scheffer, 2000; Schaupp & Belanger, 2005; Shahzad, Xiu, Khan, Shahbaz, et al., 2020; Welch et al., 2005).

When it comes to mGSQ, research must be more specific, signifying that conceptualization and measurement should be grounded on user perception (Alsaadi et al., 2019; Chanana et al., 2016). We have not found any comprehensive way to define the quality of service of e-Govt and m-Govt. Some researchers (Ostrom et al., 2015; Shareef et al., 2014) believe that due to different service modes, the quality of virtual media service may differ from the traditional quality of service in several dimensions.

Most researchers try to reveal m-Govt's service system from the e-Govt literature, focusing on exploring its various adoption factors, which not only imitates m-Govt's service perspective but also reflect the product, facility, and technology issues distinct to the service system, such as resource availability, awareness, cost and software (Ahmad & Khalid, 2017; Shahzad et al., 2019; Shanab & Haider, 2015; Shareef et al., 2012). Therefore, in this study, we take the prior concepts of e-commerce or e-Govt service quality as an entry point to conceptualize the public administration service quality provided through mobile devices. Consequently, this intends to categorize the influential factors affecting mGSQ, particularly on a user-centric approach.

3. MODEL DEVELOPMENT AND HYPOTHESES

In this part, we explored the design of the m-Govt quality of service framework theoretically and methodologically. This study explores the critical constructs as perceived by overseas users in the cognition of mGSQ, which was not previously focused on by researchers.

3.1 Effort expectancy

Effort expectancy mentions the extent of simplicity linked with a particular system (Davis et al., 1989). In line with the study of Venkatesh et al. (2003), effort expectancy summarizes the concept from previous adoption theories like the perceived ease of use and complexity. Similarities between these factors have been discussed in the previous literature concerning the user's intention to use technology adoption research (Davis et al., 1989; Dwivedi et al., 2017; Lin et al., 2011; Shahbaz, Gao, Zhai, Shahzad, & Arshad, 2020; Shahbaz, Gao, Zhai, Shahzad, Abbas, et al., 2020; Weerakkody et al., 2013). In m-Govt services, the comprehensive and

straightforward system can reduce user efforts, increase its intention to use the system, and improve service quality. Therefore, we proposed the following hypothesis:

H1. Effort expectancy will have a significant impact on mGSQ.

3.2 Perceived reliability

Perceived reliability involves the user's perception that the service provider delivers the promised services accurately and reliably (Gefen, 2002). In m-Govt services, it refers to citizens' confidence in government services delivered by using mobile technology to facilitate the citizens (Ndou, 2004). Citizens are concerned with the accuracy and on-time delivery of services (Onashoga et al., 2016; Papadomichelaki & Mentzas, 2012). Reliability plays a pivotal role in ensuring citizen loyalty towards the use of m-Govt services (Gaviria-Marin et al., 2018; Hao, 2016; Shareef et al., 2014). Perceived reliability among citizens regarding the accessibility and availability of service contents would ensure that the transaction process and quality of m-Govt services will not fluctuate from the user's end. Therefore, we proposed the following hypothesis:

H2. Perceived reliability will have a positive impact on mGSQ.

3.3 Security and privacy

People are more conscious regarding security and privacy infringement when interacting with virtual media such as e-Govt, e-commerce, or m-Govt, including identity theft, information, eavesdropping, and credit card abuse (Shareef, Kumar, Dwivedi, & Kumar, 2016). It also includes citizen perception regarding the security of personal information, the anonymity, risk of scam, and about the whole transaction carried by using such system (Colesca, 2009; Giovanis et al., 2012; Lallmahomed et al., 2017; Onashoga et al., 2016; Shareef et al., 2014; S. K. Sharma, 2015). The m-Govt services should require enhancing personal security and privacy by scrambling messages, gaining access to monitor, applying digital signatures, and getting usernames and passwords. Grounded in these arguments, citizen perception regarding the security and privacy issue of m-Govt is conceptualized as a pivotal factor in generating beliefs to remove the cognitive dissonance among citizens. Therefore, we proposed the following hypothesis:

H3. Security and privacy will have a positive impact on mGSQ.

3.4 Information quality

Information quality refers to “the system's ability to convey the intended meaning of information” (Wang & Lin, 2012). It determines the quality of information and system design and cost, completeness, accuracy, and format characteristics (AL Athmay et al., 2016; Alomari

et al., 2013). Therefore, in m-Govt services, information quality can be defined as the m-Govt system's ability to deliver the citizens with a novel, accurate, complete, transparent, and understandable information proposed as a key success factor to improve the mGSQ (Liu et al., 2008; Shahzad, Xiu, Khan, & Shahbaz, 2020; Shan et al., 2017). Due to the dearth of research in the m-Govt context, it would be fascinating to explore the government's information quality using mobile services and its impact on mGSQ. Therefore, we proposed the following hypothesis:

H4. Information quality will have a positive impact on mGSQ.

3.5 Perceived valence of information

Valence is mostly used in psychological research, especially when discussing individual emotions, which refers to the intrinsic attraction of an event, object, or situation (Antheunis et al., 2010). Meanwhile, the perceived valence of information refers to the degree of positive (goodness) or negative (badness) information about the target person, system, or service provider, regardless of its credibility or excellence (Al-Hubaishi et al., 2017; Dai et al., 2015; Liébana-Cabanillas & Alonso-Dos-Santos, 2017). It also affects the level of user uncertainty, which would harm the perceived service quality of the m-Govt system (Z. Chen & Dubinsky, 2003; Ismagilova et al., 2019). Therefore, we can assume that the user-perceived valence of information is a significant parameter to measure the mGSQ. Thus, we proposed:

H5. Perceived valence will have a positive impact on mGSQ.

3.6 Infrastructure quality

The quality of infrastructure can provide pivotal insight into system characteristics such as quality, comprehensiveness, accuracy, instant connectivity, and network availability, which assist in building and stabilizing user trust in service quality (Hole, 2016). The availability and quality of network infrastructure are significant to estimate the quality of mobile-based service systems (Chae et al., 2002; Das et al., 2017; Hsiao et al., 2010; R. Sharma & Jayasimha, 2016). The infrastructure quality of the network, would affect the user intends to engage in such a system because users are apathetic to use mobile services because of disconnection and lack of access (Al-Hubaishi et al., 2017). So, the government should be more focused on improving or establishing a high-quality infrastructure for the provision of m-Govt service, which increases the mGSQ and user intention towards government services. Thus, we proposed:

H6. Infrastructure quality will have a positive impact on mGSQ.

3.7 Responsiveness

Responsiveness generally refers to the willingness to interact with service providers to respond to customers and expected efficiency in time and user convenience (Parasuraman et al., 1988;

Shanab & Haider, 2015). Because services are essentially intangible, an interaction that occurs during service delivery and quality of responsiveness has the maximum impact on service quality (Al-Hubaishi et al., 2017; Balasubramanian et al., 2003; Shanab & Haider, 2015). Because the government is offering only services over the m-Govt system instead of a tangible good, in dealing with citizen issues, the government should pay more attention to employees' attitudes (Saghafi et al., 2016; Wulandari, 2019). A government official responsible for dealing with citizens using mGSQ should deliver quality responses to build citizen trust in them. Because, positive response from the service provider or the government, in the case of m-Govt services, will raise service quality and citizen satisfaction. Thus, we proposed:

H7. Responsiveness will have a positive impact on mGSQ.

3.8 Perceived Empathy

Empathy reflects the consumers' belief that they receive personalized consideration from the service provider (Parasuraman et al., 1988). Logically, these procedures do not reconstruct the extent of empathy as a human service provider; however, they interact with vendors individually and provide personalized services to a reasonable standard. The m-Govt services are provided in a virtual medium, apparently without any physical contact with the service provider; however, the firm belief that customer service exists at the rear of the screen can offer a constructive attitude to m-Govt (Moon & Norris, 2005). Empathy in the context of m-Govt can be referred to as an emotional belief that is a sincere and timely response in government service systems to meet special citizen requirements (Balasubramanian et al., 2003; Markovic & Raspor, 2010; Shareef et al., 2016). Therefore, it is required to provide IT-mediated content functions on the m-Govt system to provide service customization features, and they only work with minimal interactivity, which improves mGSQ. Thus, we proposed the following hypothesis:

H8. Empathy will have a positive impact on mGSQ.

In this study, an inclusive interpretation of the concept of mGSQ has been constructed on prior literature. We conceptualized a comprehensive research framework to measure mGSQ. Figure 1 shows the proposed research model, which demonstrates the critical factors influencing mGSQ.

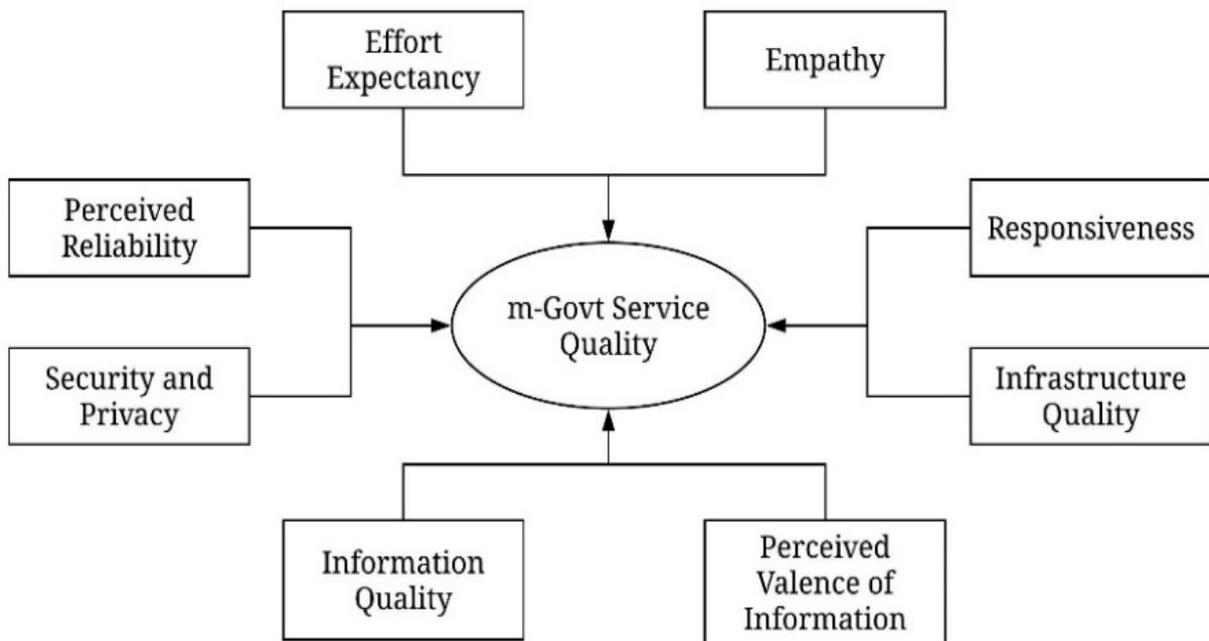


Figure 1 Research model for mGSQ

4. RESEARCH METHODOLOGY

4.1 *The context of the research*

Literature shows that citizens' intentions are crucial and measured before and after the implementation of m-Govt systems, which have an impact on its service quality (Almuraqab & Jasimuddin, 2017; Burja et al., 2006; Djamal & Renaldi, 2018; Dwivedi et al., 2018; Hameed et al., 2014; Shahzad et al., 2019; Shareef et al., 2016). However, these studies collect the required information from the citizens living and using mobile services within the country. Keep into consideration the mobility of m-Govt services, and this study tries to explore the intentions of overseas citizens concerning the quality of m-Govt services, which previous scholars potentially ignored. It is important because they have an imperative contribution to the country's economic growth and are required to keep in contact with the country's matters.

Therefore, the required data were gathered from the overseas Pakistani nationals, mainly living in mainland China. Citizens living abroad (short or long-term) have no direct physical access to government services and can only use electronic or mobile services to establish contact with government affairs. The m-Govt platform facilitates citizens worldwide to make explicit content to the government using mobile applications for their queries and other matters. The availability and quality of mobile services from the government do matter for these overseas citizens. Therefore, for the first time in this study, the researchers targeted overseas citizens to investigate the potential dimensions contributing to the expansion of mGSQ according to their point of view.

4.2 Measurement development

A structured questionnaire was developed for data collection and answers to the research question to ensure the research framework's content validity. All measuring items were operationalized and adapted from the preliminary investigations. The questionnaire initiates with a summary explaining the study's aim and significance, comprised of close-ended questions. To encourage respondents to express themselves freely, precise and straightforward language was used to write the scale items. The questionnaire of this study was established using a seven-point Likert scale from 1 “Strongly Disagreed” to 7 “Strongly Agreed” as strongly recommended by (Kurfalı et al., 2017; Nathan & Scobell, 2012; Rana et al., 2017; Shahzad et al., 2019).

4.3 Data collection and sampling

Questionnaires were distributed by generating online survey forms and spread electronically to the target population. By availing of authors' links in mainland China, friends are requested to circulate the prescribed link of an online questionnaire among Pakistani citizens. Using a snowball sampling technique, they are requested to share the survey link to others who have experience using any m-Govt services such as m-banking, m-health, m-education, m-complaint many more. The respondents are free to respond to the questionnaire, and no reward was granted to them. Approximately in three months, we received 371 responses against the survey' and decided to perform the empirical analysis. To ascertain the effect of independent constructs on mGSQ, we applied Structural Equation Modeling (SEM). As per the studies (Kline, 2005; Shareef et al., 2011), a sample size of more than 200 is considered satisfactory and can be used for SEM. During the primary screening of data, 26 responses were excluded, out of which 11 were not completed, and in 15 responses, the respondents select the one option for all items showing a non-serious attitude towards the survey. The eligible sample size was determined as $n=345$.

5. STATISTICAL ANALYSIS AND RESULTS

5.1 Sample Descriptive

The present study is based on the sample of 345 respondents shown in Table 1, out of which 58.6% are male, and 41.4% are female actively joined in the survey. Around 22.3% of respondents belong to the age group less than 20 years, 50.7% belong to 20 to 29, and 18.8% belong to 30 to 39 years old. The rest, 8.1%, belong to the more than 40 years of age group. The results showed that relatively young people respond to the questionnaire. The sample comprises comparatively well-educated respondents, as 35.9% are graduates, and 26.4% are postgraduates. Meanwhile, 27.2% of respondents are undergraduates, and the rest, 10.4%, have other educational backgrounds. The overall results from Table 1 described that mostly young

and educated individuals who can comprehend the importance of mobile services usage provided by the government; are the respondents in this study.

Table 1 Demographics of respondents

	Category	Frequency	Percent
Gender	Male	202	58.6
	Female	143	41.4
	Total	345	100.0
Age	Less than 20 years	77	22.3
	20-29	175	50.7
	30-39	65	18.8
	40-49	21	6.1
	Above 50 years	7	2.0
	Total	345	100.0
Education	Undergraduate	94	27.2
	Graduate	124	35.9
	Postgraduate	91	26.4
	Other (Diploma/ Professional education)	36	10.4
	Total	345	100.0

5.2 Reliability analysis

The constructs' reliability is used to gauge the consistency among the measurement items. Cronbach's alpha is applied to calculate the inter-item consistency, and the threshold value for the reliability scale is above 0.70 (Fornell & Larcker, 1981). The values of Cronbach's alpha of the current study data were summarized in Table 2, ranging from 0.883 to 0.980 for all constructs showing that there is not reliability concern.

Table 2 Results of factor loadings, convergent validity, reliability, and descriptive statistics

SR	Variables	Items	Loadings	Cronbach's Alpha	CR	AVE
1	Effort expectancy	EE1	.826	0.980	0.980	0.925
		EE2	.831			
		EE3	.852			
		EE4	.834			
2	Perceived reliability	PR1	.875	0.923	0.926	0.759
		PR2	.761			
		PR3	.872			
		PR4	.730			
3	Security and privacy	SP1	.741	0.933	0.937	0.789
		SP2	.883			
		SP3	.860			
		SP4	.863			
4	Information quality	IQ1	.803	0.962	0.961	0.859
		IQ2	.809			
		IQ3	.828			
		IQ4	.853			
5	Perceived valance of information	PV1	.756	0.895	0.898	0.688
		PV2	.821			
		PV3	.863			
		PV4	.755			
6	Infrastructure quality	InfQ1	.757	0.883	0.885	0.658
		InfQ2	.782			
		InfQ3	.768			
		InfQ4	.707			
7	Responsiveness	RPN1	.810	0.945	0.947	0.858
		RPN2	.865			
		RPN3	.833			
8	Perceived empathy	PE1	.772	0.889	0.900	0.692
		PE2	.783			
		PE3	.775			
		PE4	.747			
9	mGovt service quality	mGSQ1	.747	0.915	0.914	0.681
		mGSQ2	.792			
		mGSQ3	.777			
		mGSQ4	.706			
		mGSQ5	.734			

5.3 Measurement model

Principal component analysis (PCA) was applied to observe items' exactness in their corresponding factors as per the threshold value of greater than 0.7 (Hair et al., 2010; Shahzad et al., 2019; Venkatesh et al., 2016). One of the items from responsiveness was excluded due to a low level of factor score. Table 2 describes that EFA values for all items are ranging from 0.707 to 0.875 in their respective factors. Moreover, confirmatory factor analysis (CFA) was applied to confirm model goodness-of-fit, assessment of convergent validity, and discriminant validity of the constructs in AMOS 23.

5.3.1 Convergent and discriminant validity

The outcomes from Table 2 shows the values of the average variance extracted (AVE) and composite reliability (CR). The values of CR and AVE are above the threshold values of 0.7 and 0.50, respectively, which confirm the high level of convergent validity (Fornell & Larcker, 1981; Henseler et al., 2014).

Table 3 explains the values of inter-construct correlations and the square root of AVE, which depict the survey instrument's discriminant validity (Fornell & Larcker, 1981). The diagonal values of the square root of AVE are higher than the values of inter-construct correlation across the table, confirming the survey's discriminant validity. The results verified that convergent and discriminant validity is not a problem in the selected survey questionnaire.

Table 3 Inter-construct correlations and validity concerns

	Mean	S. D	mGSQ	EE	SP	IQ	PR	PV	PE	InfQ	RPN
mGSQ	0.361	0.920	0.825								
EE	0.389	0.986	0.601	0.962							
SP	0.254	0.961	0.504	0.448	0.888						
IQ	0.377	0.962	0.578	0.533	0.502	0.927					
PR	0.242	0.972	0.492	0.436	0.408	0.445	0.871				
PV	0.250	0.908	0.500	0.440	0.339	0.455	0.413	0.830			
PE	0.389	0.904	0.574	0.623	0.406	0.563	0.467	0.496	0.832		
InfQ	0.377	0.891	0.583	0.578	0.463	0.614	0.416	0.498	0.536	0.811	
RPN	0.281	0.956	0.530	0.463	0.492	0.519	0.388	0.430	0.467	0.496	0.926

Values are significant at <0.001. "Inclined lines rendered in Boldface show the Square Root of the AVE."

5.3.2 Measurement model assessment

CFA was employed to test the reliability and validity concerns for all factors in AMOS 23. The CFA model fit was measured using popular indices based on collected data. The values of CMIN/DF=1.803, CFI=0.965, NFI=0.925, TLI=0.960, SRMR=0.044, RMSEA=0.048, and PClose=0.716 are obtained from the results, which fulfill the minimum threshold requirements (Byrne, 2010; Hair et al., 2010). The results mentioned above lead toward confirmation of the good fitness of the measurement model.

5.4 Structural model

A structural model has been used after the confirmation of reliability and validity. The results from Figure 2 describe the overall goodness-of-fit for the path model. The values of CMIN/DF=1.363, CFI=0.996, NFI=0.985, TLI=0.987, SRMR=0.055, RMSEA=0.032, and PClose=0.807 confirm the overall model fit (Byrne, 2010; Hair et al., 2010). R-square's value is 0.60, which revealed that the selected constructs caused 60% of the total variance in mGSQ in the research framework.

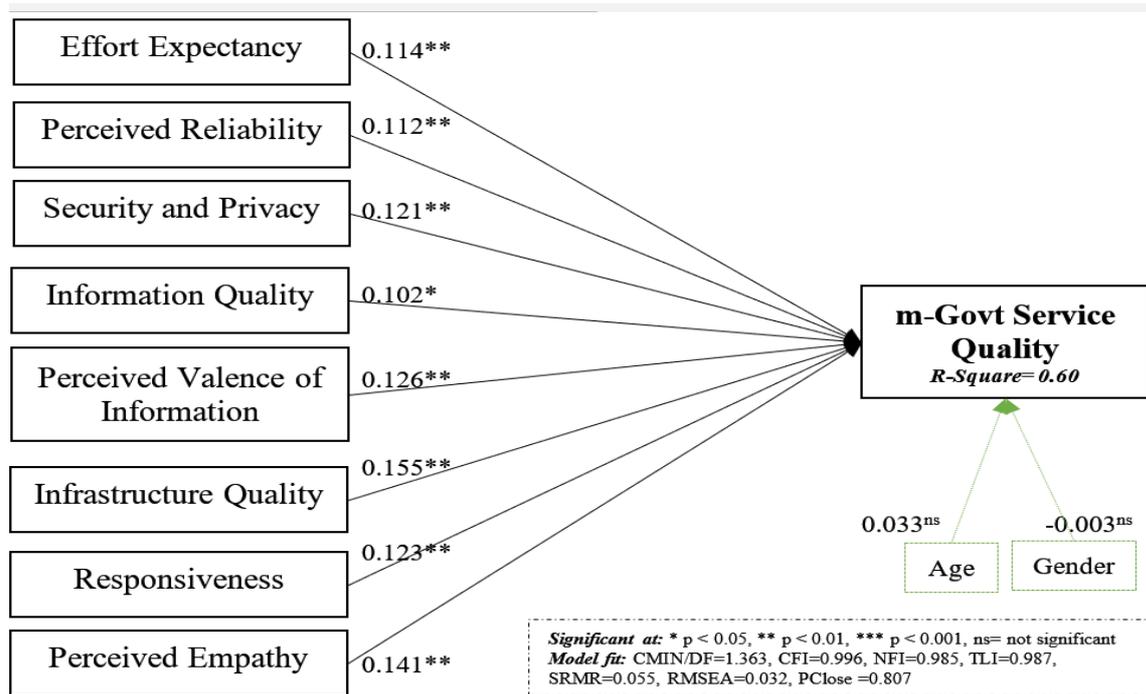


Figure 2 SEM results for hypotheses testing

To verify the support of the assumed relationship, the threshold value of the standardized path coefficient should reach the minimum value of significance at $p < 0.05$ (Byrne, 2010, 2013). The result from Table 4 explains that the coefficient's beta values are significant at 0.01 level except "information quality," which is significant at 0.05. All values of the path coefficient are significant, described in Table 4 and Figure 2. Infrastructure quality contributes to mGSQ, followed by perceived empathy, perceived valence of information, responsiveness, security and privacy, effort expectancy, perceived reliability, and information quality. Gender and age were measured as a control variable and did not find a meaningful relationship. Based on this empirical analysis, it is decided that the theoretical model is significantly acceptable.

Table 4 Hypotheses results

			Estimate	S.E.	C.R.	P
mGSQ	<---	EE	.114	.039	2.935	.003
mGSQ	<---	PR	.112	.031	2.639	.008
mGSQ	<---	SP	.121	.047	2.789	.005
mGSQ	<---	IQ	.102	.043	2.056	.040
mGSQ	<---	PV	.126	.046	2.830	.005
mGSQ	<---	InfQ	.155	.044	3.008	.003
mGSQ	<---	RPN	.123	.041	2.724	.006
mGSQ	<---	PE	.141	.053	2.723	.006
mGSQ	<---	Gender	-.003	.049	-.088	.930
mGSQ	<---	Age	.033	.027	.968	.333

5.5 Artificial neural network (ANN) approach

An artificial neural network (ANN) is defined as a “massively parallel distributed processor made up of simple processing units, which have a natural propensity for storing experimental knowledge and making it available for use” (Tadeusiewicz, 1995). ANN model is more vital that can offer higher prediction accuracy, which conventional methods cannot perform, such as multiple regression analysis (MRA) and SEM (Chong, 2013a).

The ANN has been extensively used in information system research because of its powerful computing ability and its convenience to predict the influencing factors accurately. Therefore, this study utilized the ANN model's strength to examine the most important predictor of mGSQ, which was not discussed yet (as per our best knowledge). Among various types of ANN models, this study used the most common type of Back-Propagation Multilayer Perceptron (MLP) in SPSS v25. The input layer consists of eight independent variables (EE, PR, SP, IQ, PV, InfQ, RPN, and PE), having significant SEM analysis results.

In comparison, the output layer comprises a single variable named mGSQ. As per the literature, no rule-of-thumb is accessible to limit the number of hidden neurons in ANN. Therefore, this study examines the ANN model with 1 to 10 different hidden neurons, as suggested by (S. K. Sharma et al., 2017), using Hyperbolic tangent-activation function for both hidden-layer and output-layer. The results on seven nodes in a hidden layer are considered more complex and accurate to predict input variables' importance.

5.5.1 Validation of neural network

In order to evade the issue of over-fitting, 10-fold cross-validation was executed, in which 70% of data points were used for network training, and the rest 30% were used for testing to

investigate the prediction exactness of the training network (Chong, 2013b; S. K. Sharma et al., 2017). The Root Mean Square of Error (RMSE) is commonly used as an indicator to evaluate the ANN model's predictive accuracy of both training and testing data of all ten neural networks. The average value for both training and testing datasets are also calculated and given in Table 5. From Table 5, average (training = 0.124, testing = 0.128) values of RMSE in the ANN model are also small, indicating that the prediction is entirely accurate and reliable.

Table 5 Validation results of ANN model (RMSE values)

Network configures	Training	Testing
ANN1	.124	.128
ANN2	.124	.126
ANN3	.125	.122
ANN4	.123	.123
ANN5	.126	.129
ANN6	.123	.126
ANN7	.127	.137
ANN8	.122	.133
ANN9	.121	.130
ANN10	.119	.126
Average	.124	.128

5.5.2 Sensitivity analysis

The sensitivity analysis is described as the “importance of each independent variable” to investigate the extent to which the NN model's predicted value changes with the value of the independent variable (Chong, 2013b). Based on the findings shown in Table 6, “Infrastructure quality” is the most influencing predictor, which is consistent with SEM analysis outcomes. However, in contrast with the SEM results, security and privacy is the second most influencing factor from ANN analysis. Responsiveness is the third important factor, followed by effort expectancy, perceived empathy, perceived valence of information, perceived reliability, and information quality. Meanwhile, the normalized importance is arranged to describe influencing factors from higher to lower in Table 6.

Table 6 Independent variable importance

Variables	Importance	Normalized Importance
Infrastructure quality	.275	100.0%
Security and privacy	.149	54.3%
Responsiveness	.123	44.7%
Effort expectancy	.109	39.6%
Perceived empathy	.103	37.4%
Perceived valence of information	.096	34.9%
Perceived reliability	.073	26.4%
Information quality	.071	25.7%

6. DISCUSSION AND IMPLICATIONS

This study intends to discover the sustainability of mGSQ by predicting the factors that affect overseas citizens' perceptions. Based on our research analysis, we will address several imperative discussions. The developed model was tested in two stages; first, the causal association among the latent factors was analyzed using SEM; the second ANN model was applied to predict the most influencing factor contributing to m-Govt services quality from user perspectives. The SEM results confirmed that the proposed model could reach an acceptable level in the predictive capability of mGSQ. Meanwhile, all the structural model results are significant, and the indicators of measurement and structural models are within the threshold limits. The value of R-square describes the 60% variation due to selected factors. The values of the beta coefficient for all constructs are also significant; therefore, hypotheses are accepted. Moreover, SEM results indicated that "infrastructure quality" is the most influencing factor predicting the quality of the m-Govt services based on the overseas citizen's perception. Providing government services to overseas nationals is not an easy task. It requires an up-to-date and vast development of organizational and technical infrastructure (R. Sharma & Jayasimha, 2016). Low quality of infrastructure will not be able to stipulate the necessary services to the overseas citizen and the rural areas. Therefore, the infrastructure quality of m-Govt services influences the overall service quality, as also proved in the current study context. Meanwhile, the perceived empathy is the second imperative predictor of mGSQ, followed by the perceived valence of information, responsiveness, security and privacy, effort expectancy, perceived reliability, and information quality from the SEM outcomes. The positive outcomes are consistent with previous literature; however, the importance of these factors contributing to mGSQ is collectively investigated for the first time in this study.

Similar to SEM analysis results, the results from ANN analysis found the "information quality" as the most influencing predictor of m-Govt services quality. However, unlike the SEM results, "security and privacy" is the second most influencing predictor, followed by responsiveness, effort expectancy, perceived empathy, the perceived valence of information, perceived

reliability, and information quality. This may be because the NN model detects the non-linear relationship between decision factors rather than the linear as detected in the structural model.

6.1 Theoretical implications

The outcome theoretically contributes by integrating the prior narrative on the concepts of mGSQ. Second, this research model focuses on expanding the knowledge that affects the quality dimension of m-Govt services to formulate guidelines for the development and enactment of the m-Govt system. Third, from the theoretical viewpoint, this research will provide further information in improving online service quality aspects and particularly in mobile application research. Finally, an innovative two-stage (SEM-ANN) modeling is applied to provide an overall understanding from an analytical perspective, which overcomes the limitation in several prior studies on m-Govt services. Moreover, the ANN model's non-compensatory feature overcomes the deficiency of the compensatory nature of linear SEM. SEM evaluated the causal relationship among the constructs and verified by the ANN model, which allows sorting independent constructs based on their importance.

6.2 Practical implications

Practically, this investigation supports the researchers and practitioners to develop an understanding of the most influential factors of mGSQ. The findings are based on data collected by overseas individuals, which represent their preference for mGSQ. This presents a bird's eye view for the government to design a better mobile service system, especially when providing m-Govt services to overseas citizens. The findings broaden the insight of the mGSQ and factors that might involve m-Govt service development from the outset. Moreover, the results revealed that infrastructure quality is a highly stimulating factor in predicting mGSQ. Government officials are recommended to make strategies to improve the organizational and technical infrastructure quality to improve the service quality of m-Govt systems. The service quality of any system cannot be separated from personal data's security and privacy, which is also verified in the context of mGSQ. Therefore, the developers should ensure the "security and privacy" of citizens' data, which raises the willingness to adopt such services and perception regarding service quality.

7. CONCLUSION, LIMITATIONS, AND RESEARCH DIRECTIONS

With the rapid development in mobile phones, governments around the globe are using technological advancements to discover innovative ways for service delivery while the demand for improved government service quality is also increasing over time (Al-Hubaishi et al., 2017; Chanana et al., 2016; Shareef et al., 2014). Because the m-Govt initiative is required to put tremendous efforts and the government's budget allocations. Therefore, user perception regarding the mGSQ is affected by several critical factors required to be explored before



establishing and implementing such systems. Therefore, based on the two-stage analysis (SEM-ANN), this research extended the existing literature on mGSQ, which has different features from the e-Govt and any other online services with crucial consideration to technical and non-technical aspects. The results from both analyses founded that “infrastructure quality” is the most influencing predictor of mGSQ. The model outcomes could serve as a steppingstone to fill the existing gap in a growing field of mGSQ, particularly in emerging nations.

Regardless of the prodigious contribution, the study acknowledges some limitations. First of all, the research's cross-sectional nature allows future researchers to conduct longitudinal research to evaluate user preferences more accurately over time. Second, keep in view the unique characteristics of culture; the proposed model can be applied to various cultural contexts to measure its impact on mGSQ. Third, the researchers collected the data only from those overseas citizens who have the experience to use m-Govt services only from China. Future researchers are recommended to obtain data from citizens across the globe to prove this research's generalizability. Finally, this study used snowball sampling for the collection of data. Larger sample sizes allow for the use of efficient sampling techniques, such as cluster sampling should be used to authenticate the results.



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