



Optimizing Quality Features in M-Health Systems for Diabetes Patient Engagement

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ABSTRACT: Mobile health (M-health) is a pivotal technological innovation for enhancing healthcare systems by providing accessible health information and increasing productivity in health distribution. Despite its potential, M-health adoption remains limited due to various constraints, notably the lack of motivation to use these services. This study examines how optimizing quality features of M-health systems can enhance user satisfaction and continuance intention among diabetic patients in the UAE. A survey of 292 diabetes patients was analyzed using Smart PLS. Results indicate that system quality and interaction quality significantly influence both user satisfaction and continuance intention, while information quality affects user satisfaction alone. Additionally, monetary cost moderates the relationship between satisfaction and continued use. This study proposes an integrated model combining IS quality



factors and M-health features, offering insights for improving M-health system design and user engagement.

Keywords: M-health, System, Quality, Features, Diabetics, Usage

1. INTRODUCTION

Because of the rising use of mobile devices, such as tablets and smartphones, the market demand for M-health has been developing worldwide. The rise of the M-health revolution and the rapid advancement of mobile technology has enabled mobile devices to act as multi-functional personal digital assistants in people's lives. According to research, one of the main drivers of M-health advancement is the availability of numerous types of high-quality mobile services/applications (mobile apps) [1]. In comparison to traditional electronic health services, mobile apps have unique features such as usage conditions, location awareness, adaptivity, customisation, ubiquity and broadcasting, allowing consumers to utilise mobile services/applications at any time from any location.

Because the present mobile service/application industry is highly demanding, company owners have focused on acquiring new consumers and maintaining existing ones [2]. According to research, the unit cost of attracting a new customer is significantly higher than that of retaining an existing customer [3]. Moreover, improving customers' and continuance intention to use is crucial to mobile app providers in cost efficiency and business growth [4]. As a result, many studies have been conducted to study important aspects impacting the desire to continue using such applications to offer corporate executives guidance for establishing beneficial long-term partnerships.

Many mobile apps are available for M-health, and users prefer to carefully consider which mobile application/service will best meet their unique needs before installing it. This is mainly caused by their anxiety over their mobile devices' limited storage capacity and operating capabilities [5]. As a result, high-quality mobile app support can boost consumers' satisfaction with their mobile app's user experience, reducing their desire to move to alternative applications.

Recently, the literature suggests that system service quality factors influence users' satisfaction and continuance intention to use the technology. However, the concept of system service quality was defined differently from one study to another. For example, some studies based on information quality influence users' satisfaction [6][7][8], and continuance intention to use technology and mobile health [8], [9]. Recently many studies such as [7], [10], [11], [12] found that information quality influenced several aspects of technology continuance intention to use and their satisfaction behaviour. However, other studies concluded that Information System (IS) success factors based on interaction quality and system quality do not affect satisfaction [13],[14], [14], or on the usage [14]. In addition, other studies went further to argue that system



quality has a negative effect on users' satisfaction [6]. This contradiction in the literature may be due to several reasons. First, past studies measured the relationship between IS success factors based on individual factors such as information quality or system quality separately rather than measuring quality success factors in a holistic model. Second, most past studies were conducted in specific contexts such as western countries and developed economies such as China and South Korea.

Third, the use of technology, including M-health, varied from one context to another. Finally, most of the past studies either paid attention to subjective behavioural factors such as perceived ease of use technology or objective technical factors such as the technological features. However, only a few studies integrated both. For example, few studies investigated factors affecting specific diseases such as diabetes 2 continuance intention to use, especially in the UAE, where no study has been conducted. This leaves a gap in the appropriate system service quality model that influences diabetes 2 continuance intention to use. Furthermore, while service quality variables, for instance, information quality, system quality, and interaction quality, impact users' satisfaction and intention to continue using M-health, other considerations, for example, service pricing, still influence the final choice.

This leaves another gap since most past studies paid attention to the direct relationship between IS success factors and users' continuance intention to use through satisfaction rather than evaluating the moderating effect of cost on this relationship. Therefore, this study further elaborates the service quality research in the IS domain via suggesting the M-health service quality model derived from the combination of the explanatory effect of objective and subjective factors.

2. THEORETICAL DEVELOPMENT

Quality is an essential concept entrenched in many business disciplines, including the domain of Information System (IS). It has also been considered the most imperative and multi-faceted factor for evaluating service performance due to its significant influence on customers' satisfaction [15]. According to [16], since there is no universal definition of excellence in literature, service quality is a complicated concept. Furthermore, research related to service quality is still unresolved due to its nascent nature [11]. Past researches employed the SERVQUAL model to evaluate service quality [17]. However, recognising the need to address the empirical and conceptual issues of SERVQUAL model suggested a context-specific and multidimensional model to measure service quality [18], [19]. Researchers have also attempted to define quality based on production-perspective and customer-perspective. Specifically, production-perspective uses objective and technical measurements to operationalise quality [11], [20]. In contrast, the customer-perspectives focuses on the subjective measurements of customers' satisfaction [11], [21]. Nevertheless, the latter has been widely used to define



service quality due to the complex nature of quality measured based on people's perception [11], [16]. [22] emphasised that measuring quality is the transformation of relative advantages into a cumulative quality evaluation, which is a summary evaluation of the experience of the quality evaluation process.

In this case, service quality has been recognised as one of the key drivers determining users' satisfaction with the information system. Evaluating quality services from the perspective of users provides a better understanding of entity performance. [23] investigate service quality measurements in the domain of IS, identifying system quality, interaction quality, and information quality as the most important metrics. However, an inquiry that focuses on customer perspectives needs to be cautious as the use of subjective measurements with heterogeneous sample may affect structural and measurements model validity due to bias findings [24], [25]. Researchers have made efforts to overcome the limitations of such investigations. [26] introduced a model visualising two basic IS measurements: system quality and information quality. Delone et al. [15] asserted that the IS success factors should comprise service quality to system and information quality. Nine dimensions were identified: five are for the quality of systems (i.e. reliability, efficiency, flexibility, privacy integration of systems), and four are for the quality of information (i.e. accuracy, completeness, currency and format). However, the generalizability of this model to other forms of technology forms a challenge because it was limited to specific contexts. [15] developed an integrated model, focusing on system quality and information quality. Although these studies contributed to the expansion of quality research in the use of information systems, they did not devote enough attention to the quality components and implications from the standpoint of service systems.

Motivated by the issues mentioned, this research operationalised the service system quality (SSQ) drawn from both the subjective and objective measurements approach. From the subjective view, the service system quality (SSQ) is defined based on users' judgment and perception of the superiority of a service system, aligning with the basic definitions in the literature [27]. The objective measurement of quality is represented by the service price, which can be more sensitive to some users, especially those who are jobless or from the low-income category. According to [28], the quality dimensions and factors to be used should be determined by the study's context. Moreover, [29] included system quality, information quality, interaction quality, continuous usage and satisfaction.

Meanwhile, we also added the monetary cost as the objective measurement. For results validation, we also specifically selected specific diabetes mobile health in Abu Dhabi rather than multi-functional devices. We also targeted young users to minimise the magnitude of the age and the high percentage of young people with diabetes. The following describes the constructs and the related hypotheses of the proposed model.



System Quality

The perceptions of users on the communication's technical level can be regarded as a measure of system quality [30]. The capacity of a system's data processing capabilities to combine data from several sources can effectively impact high use and enhance user satisfaction [31]. When a system is helpful, available, dependable, flexible, and provides a quick response, it is considered high quality [31]. According to [32], three essential aspects positively affects system quality: system dependability, privacy, and system efficiency. Users' perceptions of the technological level of communication are reflected in the quality of systems in the M-health service system [1], [33]. System quality has been recognised as one of the key drivers towards technology sustainability. For example, the implementation of system quality in terms of ease of use, flexibility, and functionality improves the technology users' satisfaction and continuous intention. Through meta- and weight analysis derived from 115 empirical studies [34], system quality has a positive effect on users' satisfaction but no effect on the usage of (WBCLIS). In a similar vein, [35] found that system quality has a positive relationship with users' satisfaction with m-payment in China. Another study from Korea conducted by [8] revealed that system quality influence customers satisfaction with knowledge sharing platforms.

Furthermore, [36] performed a survey consisting of 80 students using the Malaysian web-based collaborative learning information system (WBCLIS) and discovered that system quality has a favourable impact on user satisfaction but had no impact on usage (WBCLIS). The relationship between the quality system and continuous intention to use can be improved by other factors such as users' satisfaction. In contrast, [37] reported no relationship between the quality system and satisfaction and continuous intention to use WeChat Game in China. In addition, (Rahi & Abd Ghani, 2019) examined internet banking users' continuance intention, revealing a negative relationship between system quality and user satisfaction of internet banking.

M-health system quality is affected by the innovative organisation of the platform information, which should bring a new value-added to customers [32]. The importance of continued use of IS system in mobile health improves healthcare sustainability. As a result, from a practical standpoint, continuation behaviour is a highly significant concept because service consumption definitely continues far beyond the initial acceptance [32]. Several studies, such as [10], examines the quality system on the users of M-health apps and found that the National Health Information Portal in Korea influence users' satisfaction, but there is no effect on their continuous usage intention. However, a study by [11] revealed that service system quality driven by system quality, information quality, and interaction quality has a significant positive relationship with users' satisfaction and continuous use of M-health. Even though this study reported a significant relationship with the continuous intention to use M-health, this study



lacks generalisation because it was conducted in Bangladesh. In addition, this study paid considerable attention to subjective factors of motivation factors rather than objective factors such as the type of M-health and what is the targeted disease. Another issue is that the system quality was measured under service system quality as a hierarchal second order construct with a single hypothesis. This may underestimate the correlations between the second-order construct and other constructs in the literature. Thus, [38] suggests that it is wise to measure the first-order construct to determine the relationship between single factors and avoid underestimating the correlations between the single factors.

H₁: System quality positively influences the continuous intention to use M-health

H₂: System quality positively influences the satisfaction of M-health users

Interaction Quality

Due to the intangible service's nature, human connection is a vital element in influencing client satisfaction [39]. The duration of time in which a customer engages directly with a service provider is known as interaction [40]. The interpersonal process is critical in determining the customer's overall impression of the service provider's performance (Dagger et al., 2007; Chang, Chen, and Huang, 2015). According to Wu et al. [41] frontline personnel's interpersonal skills significantly influence service quality. The survey was collected from 328 Bangladeshi M-health users [11], revealing that system quality services driven by system, information, and interaction quality positively influence users' satisfaction and intention to continuously use M-health. However, interaction quality was measured under service system quality as a hierarchal second-order construct with a single hypothesis, which may underestimate the correlations between the second-order construct and other constructs in the literature [38]. Another study by [42] reported that interaction quality has a positive effect on users' satisfaction and their intention to continue using M-health. However, this study is limited to maternal healthcare among women in rural areas in Ghana with a general type of M-health rather than focusing on specific types that target a specific disease, affecting M-health level of usage. Despite, many studies such as [13], [36], [43], [44] confirm the positive relationship between interaction quality and users satisfaction with continuous intention to use, most of them confirmed the relationship between interaction quality and users satisfaction with no impact on continuous intention of usage. In addition, other studies such as [14] reported that there is no relationship between quality interaction and WeChat users satisfaction. This may be because these studies defined interaction quality from the perspective of cooperation in solving technical issues rather than touching human feeling through care and confidence. The use of technology varies according to the type of users. For example, in health care, interaction through care, cooperation, and confidence are crucial to reach patients' satisfaction and loyalty. In addition, the level of using M-health depends on the type of diseases. For example, patients



with diabetes type 2 require extra care, and they need consultations consistently. Therefore, the literature arrived with contradictory findings, further investigating the relationship between service system quality driven by interaction quality on M-health users' satisfaction and continuous intention to use M-health. This is especially among the diabetes users in the UAE where no study has been conducted. To bridge these gaps, the hypotheses listed below are suggested:-

H3: Interaction quality positively influences continuous intention to use M-health.

H4: Interaction quality positively influences the satisfaction of M-health users.

Information Quality

Information quality denotes the extent of information service usefulness to accomplish a specific task and the extent to which comprehensive, precise, and timely information is delivered during the communication process (Zhao et al., 2016; Lee et al., 2018). The use of system software and hardware, as per Almaiah and Alismaiel (2019), determines the quality of an information system. Considering the significance of information quality in technology usage, few studies have looked at the impact of information quality on satisfaction with the long-term desire to use M-health systems. The quality of information is measured in terms of hedonic and utilitarian information systems. In its simplest form, engagement with a hedonic information system is constructed to give self-realisable benefit to its end users (Van Der Heijden, 2004). Meanwhile, the efficiency and effectiveness that come from the utilisation of information are directly connected to utilitarian information systems. The utilisation of the service is viewed to achieve some task-related objective from a utilitarian value standpoint (Ramírez et al., 2019). Previous studies have shown the importance of information quality in enhancing technology user satisfaction, which is deemed among the crucial sustainability and market competition factors.

According to Almaiah and Alismaiel (2019), the quality of information system results from the utilisation of system software and hardware. Because consumers make logical, calculated judgments of the functional advantages and sacrifices of using IS, most research in the IS field have firmly supported utilitarian and hedonic as important drivers of encouraging behavioural intention to use and adopt IS (Akter et al., 2019; Akbar et al., 2020). Furthermore, in the context of IS in the healthcare setting, like mobile health, the delivery of a self-realisable value that results from information with current delivery is crucial for information quality (Kim and Han, 2011). Personalised, relevant, comprehensive, relevant, easy to comprehend, and secure information should be provided (Delone and McLean, 2003). Through a survey gathered from 161 WeChat users in China, [7] found that Information quality driven by precise, reliable, and appropriate information has a positive relationship with users satisfaction. In addition, [10] surveyed 506 adults of the National Health Information Portal (NHIP) in South Korea. The



authors found that Information quality had a substantial effect on user's satisfaction. The quality of information has a significant impact on customer satisfaction and their continued desire to use M-health. Furthermore, (Masri et al., 2020) investigated the impact of Information System Quality on Continuance Intention to Use E-Tourism and discovered a significant positive link between E-Tourism and visitors' satisfaction with their continuous usage intention. Conversely, (K. H. Kim et al., 2019) investigated the factors influencing users' continuous intention to use a mobile health service called Onecare. The authors discovered a positive relationship between quality information (engagement and reliability, content quality, and user satisfaction) and users' continuous intention to use. The outcomes of prior studies range from a favourable to a negative association between information quality and long-term intention to use. This may be because the term of information quality was measured by four items describing the instrument value rather than self-fulfilment value based on the user's perspective. To bridge this gap, a study from Ghana [52] and Bangladesh [11] found a positive relationship between information quality driven by hedonic benefits (self-realisable value) and utilitarian benefits (purpose fulfilling) as well as M-health users satisfaction and continuous intention to use M-health. In a similar vein, [53] found that information quality driven by (Hedonic and utilitarian benefits) positively affects continuance intention in location-based applications information. However, IS in the healthcare setting was not included in those studies. Like in mobile health, the delivery of a self-realisable value that results from the use of information with current delivery is crucial for information quality (Kim and Han, 2011). According to (Karjaluoto et al., 2019), to get the most out of mobile health providers, health institutions must evaluate their existing features and examine their effects on users' behavior and intentions.

H5: Information quality positively influences the continuous intention to usage M-health.

H6: Information quality positively influences the satisfaction of M-health users.

User Satisfaction

User satisfaction is a critical component in ensuring long-term usage (Alawneh et al., 2013). According to (Foroughi, Iranmanesh, & Hyun, 2019), satisfaction is the biggest indicator of consumers' desire to continue using mobile banking in Malaysia. Several studies from various disciplines such as fintech [55], e-government [56] or Chatbot [57] confirm the relationship between users satisfaction and users continuous intention to use. Another study by [58] found a positive relationship between users' satisfaction and continuous usage of e-government.

Moreover, Zhou (2013) revealed that if users are not satisfied with the mobile payment service, they may not continue. However, those studies have been widely conducted in China and Korea and somehow Malaysian context. Meanwhile, the literature in the Arab region countries still lacks sufficient studies. The main construct for M-health services may be termed as customer



intention to use. The literature suggests that the use of mobile technology in health services has been rapidly growing, attracting academic and healthcare policymakers' attention. Previous researches have focused on finding the variables that influence either adoption (Deng et al., 2014; Deng et al., 2018; Zhao et al., 2018) or intention to use (Deng et al., 2015; Dwivedi et al., 2016; Huang and Yang, 2020). Past studies tend to identify and examine the key drivers for customers' continuous intention to use mobile health. For example, In China, Gu et al. (2018) discovered that patient's satisfaction had a favourable impact on their continued desire to utilise mobile health. The research on the continuation of M-health technology services found that users' satisfaction substantially influences users' continued intention to use (Akte et al., 2019) and (Oppong, 2021). However, these studies lack generalisation because mobile health has been investigated for general purposes, and the targeted sample is specific either in Bangladesh or rural women in Ghana. This may affect the outcome of the analysis since the use of M-health varies from one patient to another according to their needs for healthcare and their experience. For example, patients suffering from diabetes 2 are more likely to need further care compared to diabetes 1. To bridge these gaps, these research hypotheses that:

H7: Satisfaction has a positive relationship with intention to use M-health.

H8: The relationship between system quality and the continuous intention to use M-health is mediated by the satisfaction of M-health users.

H9: The relationship between interaction quality and the continuous intention to use M-health is mediated by the satisfaction of M-health users.

H10: The relationship between information quality and the continuous intention to use M-health is mediated by the satisfaction of M-health users.

Monetary cost

Consumer satisfaction has been linked to monetary costs [66], [67]. and continuous usage [68], [67]. Previous research focused on the functional and non-functional value of M-health (for example, information quality, interaction quality and system quality) (Eslami et al., 2017; Lim et al., 2019), while other research focused on the related financial cost as a barrier to utilising M-health (Kruse et al., 2019; Zhou et al., 2019). The cost or utility of utilising M-health was not adequately addressed in the literature. The degree to which the price of an M-health service has realisable value might be described as monetary cost in this situation [69]. Cost concerns were shown to be crucial and received significant attention from consumers when they were considering whether or not to embrace or reject innovations [70].

Furthermore, buyers appear to be weighing the benefits obtained as well as the financial cost of adopting new technologies [71]. Past studies introduced monetary cost as an external variable in linking customer satisfaction and customer loyalty [72]. Customers are less inclined



to embrace mobile banking technology if they perceive a greater efficient cost in contrast to other classical channels, according to research by [71]. According to Lee et al., [69] the monetary cost of mobile phone service moderates the relationship between customer's satisfaction and loyalty. In other words, if the monetary cost is high, the relationship between customers' satisfaction and their loyalty is low. In a similar vein, the study by [73] found that switching costs significantly moderates the relationship between customer satisfaction and customer loyalty in retail banking. Besides, according to [1], the perception of mobile health users about monetary cost moderates the relationship between their satisfaction and continue to use M-health.

To summarise, numerous research looked at the link between service system quality and user satisfaction, which directly impacted consumers' continued desire to utilise technology. However, most of the past studies, generally and in mobile health, particularly neglected the role of monetary cost [10], [11], [53]. This includes how the interaction of monetary cost influence users satisfaction and intention to continue to use M-health. This may be applicable with public services such as e-government or services with no big charge, such as e-banking and ulearn. However, providing unique services of M-health with high quality is often associated with cost, which varies from one country to another. Note that neglecting the cost leaves a gap in which mobile health users may be satisfied with the quality of mobile health application and services. Still, they can't continue using the service because of the cost. Thus, the users' perception about the cost may influence the stability of using mobile health, especially when the service is provided with high quality and associated with high cost. Users tend to use mobile health frequency such as M-health that targets the users of diabetes type 2. Since UAE is one of the countries with a high ratio of people who are suffering from diabetes type 2, This study aims to close the gap by addressing the following hypotheses:-

H11: The relationship between users' satisfaction and continuous intention to use M-health is moderated by the monetary cost of the services.

3. METHODOLOGY

This study aims to look at the impact of a high-quality service system on diabetic patients' continued desire to utilise M-health in the UAE. For this purpose, a survey involving 292 respondents was adopted. In this research, there are three exogenous variables, which are the quality system, quality interaction and quality information; one mediator, which is the M-health users' satisfaction; one moderator, which is the monetary cost; and one endogenous variable, which is the continuous intention to use M-health.

Sampling and Data Collection

Data were gathered from the UAE patients who have diabetes type 2. To ensure the validity of our data, we used objective measurements during data collection to limit the bias that may arise



from heterogeneous measurements. Although using M-health can be influenced by the type of diabetes, the patients with diabetes T2D are mainly young adults. Hence, the scope of this study is young adults who suffer from T2D. United Health Group (2020) reported that the adult population (age 20-79) of the UAE is approximately 32%, amongst the world's highest. The use of mobile health technology is influenced by the age of the users [46]. Therefore, we targeted young adult patients aged 20 to 30 because they form the majority of the patients suffering from diabetes T2D. Systematic random sampling was adopted to select the respondents. In February 2020, a survey was distributed to 459 diabetes patients who used M-health in Abu Dhabi. We used three main social network websites namely WhatsApp, Facebook and Instagram. After two months, 309 of the disseminated questionnaires had been collected, giving in a response rate of 67%. However, 17 of the 309 surveys were incomplete, with missing values greater than 10%, and were thus removed from being analysed. For this purpose, 292 were found valid for statistical data analysis, distributed between 169 females and 113 males.

Data Analysis

This research utilises a component-based SEM or the PLS to analyse data because it is an appropriate tool to examine and establish the indirect effects of the variables with moderating and mediating constructs [74]. Unlike other software applications, PLS does not need any assumptions about the distribution of variables. Therefore, the method is suited for lower sample sizes [75]. In this research, service quality is deemed as a higher-order construct, comprising three dimensions of the first order and nine dimensions of the second order. The research uses a replicated indicator method to concurrently estimate all constructs instead of a single lower-order and higher-order dimension estimate. The study used PLS path modelling to analyse the model since it ensures parsimony, which is more theoretical and reduces model complexity. The study utilises PLS in particular because, first, it is consistent with the study's goal of developing and evaluating a theoretical model by predicting and describing it. Second, PLS can successfully address different limitations in hierarchical modelling in terms of distributional characteristics (multivariate normality), sample size, measurement level, model complexity, factor indeterminacy, and recognition. PLS is particularly well suited for complex constructs and when the phenomena of focus are new or scalable.

SmartPLS 3.0 was utilised to assess the high-order, reflective-formative model with frequent usage of specified variables in this study. For the inside estimation, we utilise a path weighting scheme in this situation [76]. The standard errors of the estimations were calculated using nonparametric bootstrapping [23], with 5000 repetitions [77]. The repeated indicator technique for reflective-formative models with a path weighting scheme gives the optimal parameters, as per Becker et al. [78].



Internal Consistency Reliability

The scales' convergent reliability, validity, and discriminant validity were investigated in this study. If item loadings are 0.60 or greater, convergent validity can be demonstrated (Becker et al., 2012). System efficiency, system dependability, system privacy, care, responsiveness, assurance, utilitarian, hedonic information, current information, satisfaction, switching price, and continuous intention to use are the 12 components that constitute this first-order model. Originally, all item loadings that surpassed the 0.7 cut-off value and were significant at $p = 0.001$ were computed. To confirm the reliability of all the measurement scales, the researchers estimated average variance extracted (AVE) and composite reliability (CR) Fornell et al., (Fornell & Larcker, 1981). These test results reveal the degree to which a concept and its indications are associated. All scales of CR and AVE are either equal to or surpass the 0.56 and 0.50 cut-off values, respectively (Fornell, Larcker, & Modeling, 1981). Table 2 shows that the minimum AVE for information quality is 0.651 and the minimum CR for collaboration is 0.791, both of which are beyond the required standards. As a result, the study found that all item loadings, CRs, and AVEs are more than their corresponding cut-off values, ensuring sufficient reliability and convergent validity (Fornell et al., 1981). Finally, the construct's AVE must be larger than the variance shared by the construct and other components in the model for discriminant validity. The square root of the AVEs is found in Table 2's diagonal values. Discriminant validity is demonstrated when these values surpass the interconstruct correlations. The AVEs' square root in the correlation matrix diagonal is computed in Table 1. This test signifies that the constructs do not share the same type of items and are conceptually distinct [79]. Overall, the measurement model was deemed satisfactory with the evidence of sufficient reliability ($AVE > 0.5$, $CR > 70$), convergent validity (loadings > 0.5), and discriminant validity ($\sqrt{AVE} > \text{correlations}$), as shown in Table 2.

Table 1: Scale reliabilities

constructs	Code	Items	Loadi ng	CR	AVE
System efficiency	SQE1	It is easy to get service from M-health	0.767	0.84 7	0.649
	SQE2	It is flexible to meet a variety of needs in M-health	0.826		
	SQE3	The information of M-health platform are was well organised	0.822		
System privacy and Security	SQP1	My personal information is protected	0.833	0.89 6	0.683
	SQP2	M-health allows me to obtain query capabilities from localised trusted authorities	0.807		



	SQP3	System information is secured	0.848		
	SQP4	M-health offered me a meaningful guarantee not to share my information	0.818		
System reliability	SQR1	works smoothly.	0.801	0.839	0.565
	SQR2	performs reliably.	0.702		
	SQR3	dependable.	0.764		
	SQR4	available	0.737		
Utilitarian	IQU1	served its purpose very well	0.706	0.840	0.567
	IQU2	information is useful to me.	0.769		
	IQU3	Information is worthwhile	0.766		
	IQU4	information service is interested to me	0.771		
Hedonic	IQH1	The platform is helpful	0.814	0.874	0.699
	IQH2	I have trust in the growth of these services in the future	0.854		
	IQH3	It is helpful having information from M-health	0.822		
Current	IQT1	Provide most recent information	0.855	0.869	0.689
	IQT2	Provides most current information	0.795		
	IQT3	Always up to date	0.838		
Cooperation	QIC1	Willing to help me.	0.828	0.791	0.560
	QIC2	Eager to solve my glitches.	0.716		
	QIC3	Provide information with time responsiveness	0.695		
Confidence	QIF1	Make me confidence	0.859	0.898	0.746
	QIF2	I always feel safe with this platform	0.902		
	QIF3	M-health platform is competent	0.828		
Care	QIR1	Provide personnel and specific needs.	0.808	0.891	0.672
	QIR2	Provide personal attention	0.838		
	QIR3	They touch my heart	0.833		
	QIR4	Provides individual care.	0.800		
Satisfaction	US1	I am satisfied with the service system.	0.797	0.896	0.633
	US2	I am contented with M-health	0.761		
	US3	I am pleased to use M-health	0.796		
	US4	I am delighted using mealth	0.759		



	US5	I think service transaction is plausible.	0.849		
Monetary cost	SC1	I think M-health service equipment cost was not expensive.	0.839	0.848	0.650
	SC2	Access to M-health services was not expensive.	0.797		
	SC4	I am willing to pay for using M-health service	0.782		
Continuous Intention to Use	CU1	I intended to continue using M-health	0.824	0.864	0.679
	CU2	My intentions were to continue using M-health	0.770		
	CU3	I will promote this service to my friends	0.875		

Table 2: Discriminant Validity based on Fornell-Larcker criterion

	CU	IQ	SC	QI	SQ	US
CU	0.824					
IQ	0.453	0.723				
MC	0.467	0.367	0.806			
QI	0.592	0.533	0.520	0.669		
SQ	0.489	0.657	0.354	0.496	0.712	
US	0.509	0.418	0.398	0.359	0.401	0.795

The variance of inflation factors (VIF) values were evaluated to determine whether there was any possibility of multicollinearity amongst the study variables. The VIF values show the presence of collinearity level among independent variables, as per (F. Hair Jr, Sarstedt, Hopkins, & G. Kuppelwieser, 2014). They are predicated on VIF values of tolerance between 0.20 or lower and 5 or higher. The variance inflation factor (VIF) of all items ranges between 1.133 and 2.391, considerably below the usual cut-off value of 5-10, indicating that the data are genuine, according to a collinearity test.

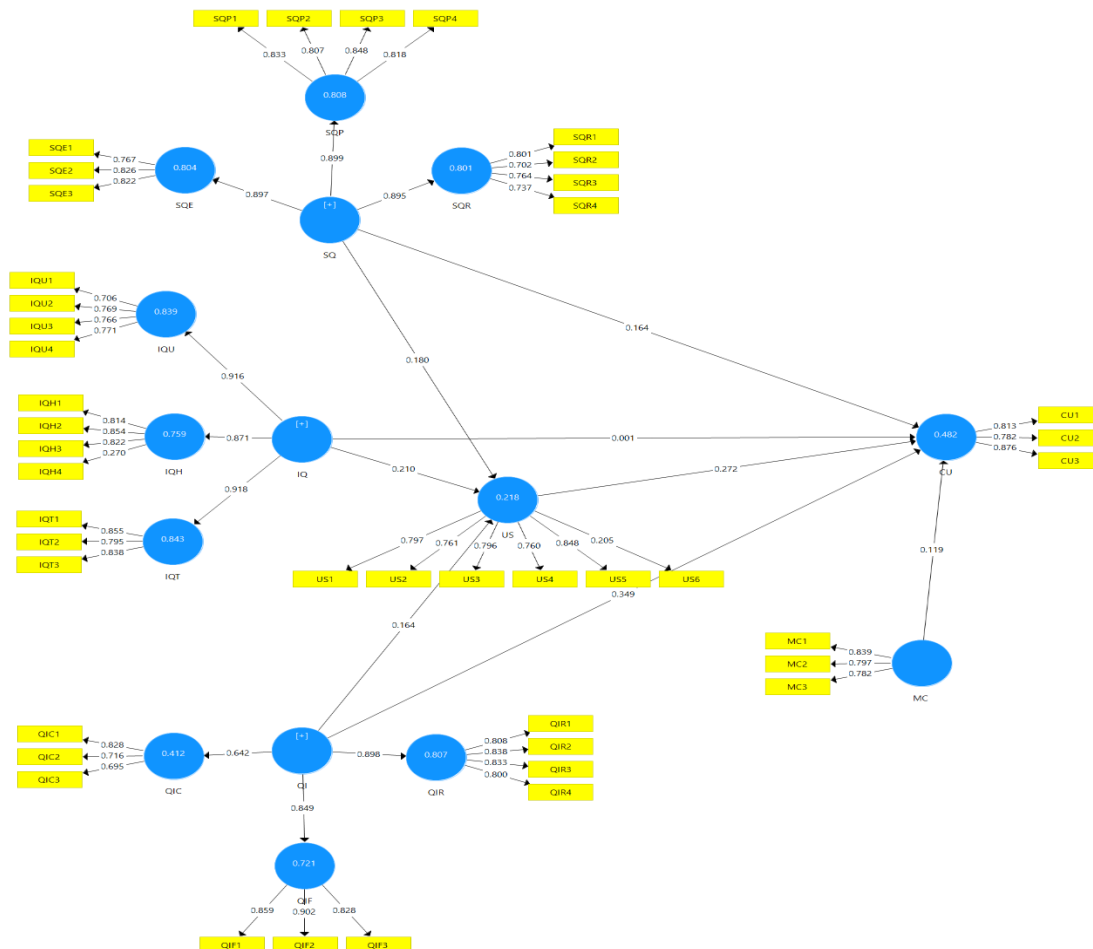


Fig 1: Measurement Model Results after Elimination

Structural Model Path Assessment

The connection between the independent variables of the SSQ, including (system quality SQ, interaction quality ITQ, and information quality IFQ) and the dependent variable of Continuous intention to Use (CU), was evaluated in this study. In Fig. 1 and Table 3, the results of a standardised beta of 0.394 (ITQ → CU), 0.167 and (SQ → CU) are significant. However, the results of a standardised beta of 0.007 (IFQ → CU) are not significant. Thus, the results confirmed that the service system quality of M-health through Interaction quality and system quality has a positive effect on continuous intention to use M-health, supporting H1 and H3. However, IFQ was not significantly associated with the continuous intention to use M-health, which rejects H5. The study estimated the relationship between the independent variables of SSQ, including (system quality SQ, Information Quality IFQ and Interaction Quality ITQ), and mediating variable of Users satisfaction (US). In Fig. 1, the findings yield a standardised beta of 0.183 (SQ → US), 0.216 (ITQ → CU), and 0.153 (IFQ → US) are significant and supporting



H2, H4 and H6. Finally, the standardised beta of 0.304 (US → CU) shows a positive significant relationship between the users' satisfaction (US) and users' continuous intention to use M-health, which supports H7.

Table 3. Path Coefficients

Path	Path Coefficient	S.E	t-Value	p-Value
ITQ → US	0.216	0.085	2.527	0.012
ITQ → CU	0.394	0.071	5.537	0.000
SQ → CU	0.167	0.073	2.280	0.023
SQ → US	0.183	0.083	2.215	0.027
IFQ → CU	0.007	0.091	0.075	0.940
IFQ → US	0.153	0.072	2.140	0.032
US → CU	0.304	0.064	4.769	0.000

Mediation Effect

This paper also measures indirect effect or mediating effect value on (SQ → US → UC), (ITQ → US → UC) and (ITF → US → UC). The findings align with the firm mediating effects of US in (SQ → UC), (ITQ → UC) and (ITF → UC) link as the z-value exceeds 1.96 (p 0.05) [80]. These findings support H8, H9 and H10.

The VAF (Variance Accounted For) value is used in this research to examine the magnitude of the indirect impact, which is the ratio of the indirect effect to the overall effect. According to the findings, US accounts for roughly 21% of the entire influence SQ have towards UC. The US also describes about 38% of the total effect of ITQ on UC. In addition, the US explains 21% of the total effect of QI on UC. As a result, the US has been identified as important mediator in assessing the impacts of overall service quality on consumers' continued intention to use M-health. The model's overall variance explained in terms of R² was 0.219 for the US and 0.474 for the CU, both of which were significant as per the effect size established for R² by (Cohen, 1988). These findings support the influence of total service system quality on perceived satisfaction and continued intentions, guaranteeing the study model's homological validity.



Moderate Effect

The moderate effect of switching the M-health cost on the association between users' satisfaction and M-health continuous use was estimated through a two-stage approach using SmartPLS. As shown in Table 4, the value of (0.086) suggested that switching cost positively strengthened the relationship between users' satisfaction (US) and continuance intention to use (CU). This figure showed that a one-unit standard deviation rise in switching costs is expected to improve the connection between the US and the CU by 0.086 (8.6%). Furthermore, the significance of the moderating effect was confirmed using the SmartPLS bootstrapping tool. It revealed the moderating effect of significant at the 0.05 level of confidence (t-value = 2.011 and p-value = 0.044). As a result, these figures demonstrate the importance of MC's moderating influence on the relationship between the US and CU.

Table 4: Significance of Moderating Effect of MC over US & CU

Path	Path coefficient	t-value	p-value
Moderating Effect→ CU	0.086	2.011	0.044
US → CU	0.251	3.748	0.000
MC → CU	0.141	2.293	0.022

As portrayed in Figure 2, the slopes illustrated that when users' perception about switching costs is low, both users' satisfaction and continuous use are lower. In contrast, when users' perception of switching costs improved from low to high, the relationship between US and CU values also increased. This indicates that when the MC level is increased, the relationship between the US and the CU enhanced as well. Ultimately, these findings suggest that changing the cost moderates the connection between the US and the CU. As a result, the current study's H11 is approved. It can be concluded that the significant moderate effect of cost on the relationship between US and CU of M-health among diabetes patients in the UAE is due to the characteristics of the sample that was gathered from a group of non-working young people and dependent on others. Thus, the cost influences their behaviour to continuously use M-health, even though they are satisfied with the service.

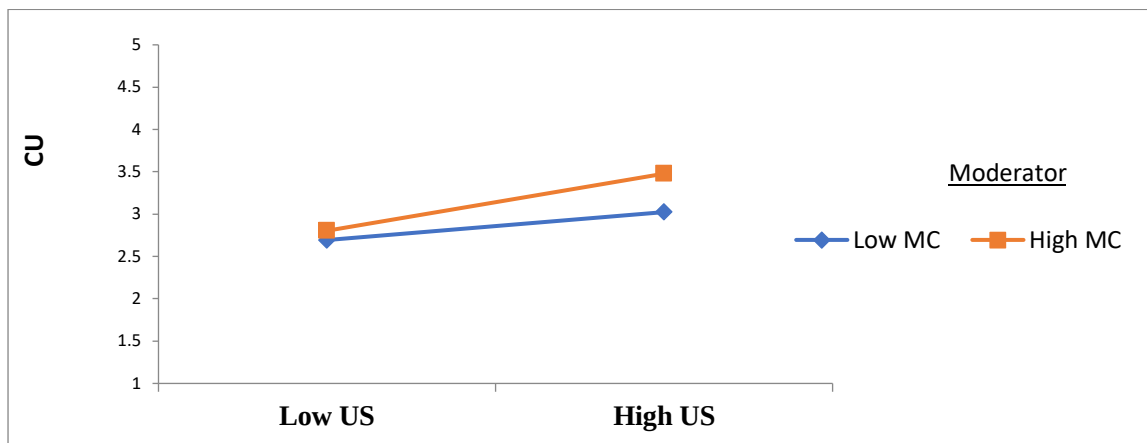


Figure 2: Two-Way Interaction Term

4. RESULT AND DISCUSSION

In this paper, service system quality was constructed, consisting of three main constructs and nine sub-constructs. The finding of this paper emphasises that quality is the departure point to solving the challenges of system service [11], [81] in diabetes M-health. This study also posed a perception of how to create a system's quality of service to overcome usage problems that encounter diabetes among young patients, affecting their satisfaction. SSQ was positively associated with all the primary dimensions. The 'quality interaction' was the most significant factor influencing users' continuous intention to use M-health and their satisfaction with 0.394 and 0.216, respectively. This result proposes that higher gains in total SSQ may be accomplished by improving the quality interaction between M-health doctors, staff, and patients. This can be achieved by cooperating with patients to reach their personal needs and solve the problems with confidence and care. Second, 'system quality' was signified as a significant predictor of the M-health service system, emphasising the system's availability and accessibility, allowing everyone to obtain health services at any time and from any location. This accessibility is essential in allowing the patient outcomes of M-health delivery systems in low-resource environments. However, the quality information was revealed to have no significant effect on the intention to use M-health. Perhaps the patients are more likely to use interaction to gain the needed information, which explains why interaction quality (ITQ) is a crucial factor that affects CU. However, there is a significant relationship between quality information and users' satisfaction. This indicates that the information provided by M-health should meet users' satisfaction by ensuring the currency of the information and improving the utilitarian and hedonic benefits. While the study prioritised the significance of overall SSQ dimensions in terms of the variance clarified, the study advises that all dimensions should be given equal consideration to properly embrace consistency in research into service systems.

Theoretical Contribution



This study provided insights on the effect of information success factors on user satisfaction and continuance intention to use M-health in the UAE. This research contributed to the body of knowledge by examining the mediating role of user satisfaction as well as the moderating effects of monetary cost in these relationships. Significant contributions of this study have been considered, and these are categorised into theoretical, methodological and practice.

Theoretical Contribution

This study's conclusions have a variety of theoretical implications. This study tested the modified De Lone and McLane (2003) information system success model with some adjustments to determine its applicability to the mobile healthcare system in the UAE. This was done by expanding information system success into the quality of M-health services by investigating device quality factors. While mobile health researchers are increasingly interested in this research area, many deficits remained, such as providing a solution for the low rate of patients who continuously use M-health. Most of the literature paid attention to the drivers of M-health adoption guided by several theories, for example, the Technology Acceptance Model (TAM) and UTAUT.

However, attending the continuance intention to use M-health has not been assessed adequately. This left a literature gap on improving the continuance intention to use M-health and the factors that influence it. This study model was positioned on system service quality, contributing to the knowledge and bridging the gap that exists in the literature. It combined both technical competencies of the M-health and quality of practice along with the system features such as the service cost. This research also contributed to IS by validating and verifying a consistent M-health service model relying on three key frameworks, namely system quality, interaction quality and information quality and the nine sub-constructs (system efficiency, system reliability, system privacy, responsiveness, care, assurance, utilitarian benefit, hedonic benefit and current). Even though an increasing body of literature highlights the significance of quality dimensions on continuous usage, very few studies have actually been conducted on the topic. This study advances the literature on service quality systems in M-health by adopting IS success factors. Framed within the IS success factors suggested by [82], which include system quality, information quality, continuous intention to use and users' satisfaction, this study conceptualises quality into three dimensions, namely interaction quality, service quality and information quality as the determinants for user satisfaction and continuous intention to use.

In the healthcare sector, the generic service quality models were adopted by a majority of past studies to understand the perceived service quality attributes. The literature argued that there are differences between healthcare quality and M-health quality because M-health services have unique features, for example, mobility, ubiquity, immediacy, virtual consultation



accessibility, and personalised nature interactivity. The findings proved that quality dimensions positively correlate with user satisfaction and continuance intention to use M-health. In addition, user satisfaction was a strong predictor of the continuance intention to use the M-health system. Because satisfaction is a consequence of satisfying customers' expectations on the service, usefulness and ease of use of M-health applications, it is critical to guarantee that customer experiences are uniform to enhance their continuation.

The monetary cost's moderating effect on user satisfaction and continued intention to use M-health was investigated in this study, which added valuable knowledge to the literature. By including monetary cost as one of the constructs of system quality, this study considered both consumers/users and product perspectives to operationalise quality, hence providing a richer understanding of the concept of quality. In addition, M-health is recognised as an economical product rather than a public product, considering the users need to bear the cost of maintaining the mobile gadgets and realising the value of money when using M-health.

Thus, this study empirically supported the findings that monetary cost should be considered to operationalise the quality construct and analyse its effects on user satisfaction and continuance intention to use.

Mobile health (M-health) technology has been recognised as an effective development devise that improves healthcare service quality by extending health service to everyone. The Arab Emirates (UAE) has a long experience with delivering mobile healthcare services. In addition, UAE has more usage of mobile IS in the gulf region. The majority of past studies in M-health through IS success model are suffering due to the generalizability of this model to other forms of technology. This forms a challenge because it is limited to specific contexts. As a result, this research contributed to the existing information about new technology continuation intentions in Arab and Gulf countries in general and the UAE in particular.

Methodological Contribution

This study operationalised the service system quality (SSQ) from both the subjective and objective measurements approach. From the subjective view, SSQ is defined based on users' judgment and perception of the superiority of a service system, which aligns with the general concepts in the literature. The objective measurement of quality is represented by the targeted users and service price, which can be more sensitive to some users, especially those who are jobless or from a low-income category. This study used methodological gestalt of PLS hierarchical modelling. This hierarchical model was developed and validated by PLS in the context of M-health quality service.

The study has reported sufficient measurement and structural results for the research model to estimate the latent variable at higher order. PLS allows the theoretical contribution of the study to be expanded by designing and evaluating a realistic third-order model of service quality.



This study confirmed that higher-order systems could be presented in a structural model to show the methodological validity of the entire research model. This condition is where PLS exceeds SEM, which depends on covariance in the higher-order model calculation (CBSEM). A complex model is generally referred to as a wide range of latent variables with realised variables, such as a model for the standard of third-order service.

This study also demonstrated how mediating and moderating effects can be quantified in a hierarchical model. Mediation effects and moderating effects are essential to ensure accurate correlations between latent variables since complex conations are subject to contingencies. PLS path modelling is ideal for predicting mediating and moderating effects for complex models, including hierarchical models (with a full disintegration approach). The analysis provided a step-by-step demonstration of how the mediating and moderating effects can be integrated into the PLS model. The findings indicated that PLS measures the true results of mediation in a nomological network by taking into account measuring error that mitigates the estimated relationships and strengthens the theory's validity.

Power analyses may be utilised to estimate the probability of the structural model's latent variables being discovered in relationships with significant interrelations. The study demonstrated the robustness and applicability of PLS for real-world models complex applications. The study also confirmed that Smart PLS path modelling could be the "silver bullet" for estimating causal models in various empirical and theoretical data situations.

Practical Contribution

Various stakeholders will benefit from this study's practical contributions. The outcomes of this study can assist service providers in increasing M-health app acceptance and usage in healthcare facilities. It's critical that consumers be happy with their recent experience since this encourages them to utilise the system again. Efforts must be made to increase and improve the device's utility because users would only be satisfied if they find the device useful to meet their needs and requirements. Service providers must also provide quality information on the relevant and useful device to the users and access to information whenever users need it.

In addition, the quality of interaction can be improved by providing customers with sincere answers, sufficient confidence and good empathy. This is because the findings on the functional (utilitarian) and emotional (hedonic) services (for example, comfort, efficiency, positive support and so on) of the M-health platform help improve customer satisfaction. This study also found that the only way to achieve the desired level of service quality is to provide a good technical infrastructure (for example, a good information system and a stable wireless network). Therefore, service providers need to discuss the consistency of their network and the nature of the relationship between them and their customers. The research methodology facilitates service providers and healthcare management to understand how specific service



quality dimensions and overall service quality interact with users' satisfaction and desire to utilise the M-health system in the future. By keeping track of changes in choices, expectations, demand, and marketplace competition, service providers can captivate new consumers and maintain existing ones.

They must be mindful that their expectations and feelings may shift as a result of frequent usage of the medical gadget. Thus, they have to evaluate the existing features of the M-health apps and the kind of service quality preferred by the existing customers and identify ones that can attract new customers. In terms of cost savings and business growth, service providers should be familiar with knowing that the cost of attracting new customers is much higher than the cost of retaining an existing customer. Moreover, increasing customer demands and continuance intention to use is crucial to mobile application providers.

Both public and private healthcare institutions in the UAE should benefit from the current business opportunities provided by the M-healthcare system. This is performed by upgrading the quality of their services in terms of service efficiency and effectiveness since IS is now becoming the norm for any hospital that aspires to provide world-class healthcare. One of the particular importance is user satisfaction with the current M-health service experience. How far the service quality provided by the M-health care service gave satisfaction to the customers? If strategies can be developed to make the existing M-health attractive to more customers, the M-health service could be used continuously in all healthcare institutions in the UAE.

If a substantial number of users continue to use the M-health system after the early stages, it will be a great accomplishment. According to the findings, user satisfaction has a major mediating effect in forecasting the intention to use the M-health system in the future. These results indicate that “service quality” and “users’ satisfaction” should be regarded by the management of healthcare institutions as strategic priorities. This ensures healthcare quality improvement that meets patients’ loyalty and continuous usage of the M-health facilities. The M-health service quality model suggested in this study allows M-health service providers to achieve customers’ loyalty, as well as improve patients’ and community’s health.

Diabetes is a major issue worldwide, including in the UAE. Therefore, the model of this study is useful for policymakers and M-health platform developers because it assists them in improving their services, increasing users’ satisfaction and users’ continuance intention to use M-health through the development of a quality M-health service system. Since many young adults in the UAE are suffering from diabetes, this model provides a solution on how to persistently improve their health and respond to the needs of many patients effectively and efficiently. This model was tested from the users’ perspective, which may help the M-health developers to bridge the knowledge gap between services provided and customers’ real demand.



This model may help health institutions improve their outreach by customising M-health services and features according to users' preferences. For example, system quality perceptions can be enhanced by humanising technology functions. System efficiency, system reliability, system availability, and system privacy can easily be handled and recognised by users. Similarly, by improving customer understanding with honest and heartfelt responses, compassionate attitude, and satisfactory assurance, the quality of interaction can be improved. Information quality can also be improved through upgrading the current information system to meet users' preferences and solve their problems.

Limitations of Study

This research, however, has multiple limitations. First, it was performed only among young T2D diabetic patients from Abu Dhabi. There are other patients suffering from other health conditions that use similar M-health platforms. As such, the study's findings may not apply to other patients or healthcare institutions in other parts of the UAE. Other patients or respondents may provide different results. Therefore, this study needs to be replicated in other types of patients and health establishments in the UAE before general conclusions are drawn.

Second, this research was limited to a single nation, the United Arab Emirates, limiting the findings' generalisation. Although service quality research is context-specific, replications in different settings will strengthen the study model's credibility. Service quality in different countries can increase model validations by creating a clear, replicated sample representing the real population. Therefore, future studies should be conducted in other Gulf countries or even in other parts of the world, which may provide the researchers with interesting and valuable insights.

Third, participants in this study personally reported their use of the M-health system. Due to numerous negative variables such as dishonest replies or respondents responding in a socially acceptable manner, or respondents may have their motive for participating in the study, self-reported studies are prone to bias. This method also gives no opportunity for the respondents to understand certain vague points in the questionnaire. Therefore, there is no assurance that respondents will provide accurate data.

Fourth, the use of an online survey may have prevented those patients with inadequate computer access or experience from participating in the survey. This online method can also lend itself to participants' honest responses without the researcher's presence and monitoring. However, since this study focuses on technology usage, an online survey enhances the sample's representativeness since only the qualified patients who use the technology would complete the survey questionnaire. However, there may be a problem of generalisability.

Fifth, there is a scarcity of long-term research that must be addressed. The data for this research was collected using a cross-sectional method, and the information gained depends on



respondents' perceptions at the time. This method does not allow for the consideration of user's perception changes during and after use of the system. This can result in a lagged effect in some of the relationships among the study constructs. Furthermore, M-health is a technological application that witnesses rapid changes. Therefore, seeing the impact of changes over a longer period of time would likely provide further insights regarding probable outcomes.

Finally, this study's limitation may be due to employing a seven-point Likert scale, where the respondents measured the degree of agreement and disagreement on the statements related to system quality, interaction quality, information quality, user satisfaction, monetary cost, and continuance intention to use. Respondents sometimes may use Likert scale to measure their perceptions on the questions automatically without careful attention and understanding the statements. In addition, the use of the mid-point scale provides the possibility of respondents making the easy choice in answering the questions. It would be difficult to assume that all the questions have been completely understood and answered correctly by the respondents.

Suggestions for Future Research

Despite these shortcomings, this research has offered valuable suggestions for creating and implementing a mobile health system in the United Arab Emirates. Based on the results, it is proposed that this study can be replicated in various healthcare institutions in the UAE to determine its predictive validity. In addition, the study can also be replicated to more Gulf nations to examine whether this model would be more effective in measuring information system (IS) success and continuance intention to use simultaneously. It would be of great interest to see how well the study results fit into other healthcare institutions in different settings and contexts.

The cross-sectional research design does not provide further insight into perception changes during and after using the M-health devices. Perhaps adopting a longitudinal study would allow the researcher to gain insights into how users of M-health and the relationships among constructs amend over time. The constructs in this study, system quality, interaction quality, information quality, user satisfaction and monetary cost, are dynamic and tend to change over time. Hence, examining their association with continuance intention to use M-health on data collected over a period of time may provide further insights regarding probable outcomes. The online questionnaire was the only tool used to gather data in this study by employing quantitative research methodologies. Perhaps qualitative approaches, such as extensive interviews to obtain verbal descriptions of features, instances, and the context, should be used in the future study. Compared to quantitative research, qualitative research generally involves a smaller number of instances explored in more depth. It would also give a better grasp of the interacting and complicated interactions between factors in certain settings. As a result, this technique may provide further insights into using the M-health system in the UAE.



and the desire to utilise it in the future. Furthermore, the limitations in using a quantitative survey questionnaire can be overcome by adopting a qualitative research design in future studies.

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