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Service Quality of mHealth: development and validation of a hierarchical model using PLS

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Abstract
Advancing research on service quality requires clarifying the theoretical conceptualizations and validating an integrated service quality model. The purpose of this study is to facilitate and elucidate practical issues and decisions related to the development of a hierarchical service quality model in mobile health (mHealth) services research. Conceptually, it extends theory by reframing service quality as a reflective, hierarchical construct and modeling its impact on satisfaction, intention to continue using and quality of life. Empirically, it confirms that PLS path modeling can be used to estimate the parameters of a higher order construct and its association with subsequent consequential latent variables in a nomological network. The findings of the study show that service quality is the third-order, reflective construct model with strong positive effects on satisfaction, continuance intentions and quality of life in the context of mHealth services. Finally, the study discusses the implications of hierarchical service quality modeling in electronic markets and highlights future research directions.

Keywords
pls, model, hierarchical, validation, development, mhealth, service, quality

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Abstract

Advancing research on service quality requires clarifying the theoretical conceptualization and empirical validation of an integrated service quality model. The purpose of this research is to facilitate and elucidate practical issues and decisions related to the development of a hierarchical service quality model in mobile health (mHealth) services research. Theoretically, it extends this line of research by reframing service quality as a reflective, hierarchical construct and modeling its impact on satisfaction, intention to continue using and quality of life. Methodologically, it confirms that PLS path modeling can be used to estimate the parameters of a higher order construct and its association with outcome constructs in a nomological network. Overall, our findings confirm that service quality is the third-order reflective hierarchical construct model with strong positive effects on satisfaction, continuance intentions and quality of life in the context of mHealth services. Finally, the study discusses the implications of hierarchical service quality modeling in electronic markets and highlights future research directions.
Introduction

Health challenges present arguably the most significant barrier to sustainable global development. The introduction of ICT in healthcare, especially the application of mobile communications, has transformed healthcare delivery around the world by making it more accessible and affordable across electronic markets (Akter et al. 2010; Ivatury et al 2009; Mechael 2009, UN foundation & Vodafone foundation 2009). However, there are growing concerns about the perceived quality of such services due to lack of reliability and efficiency of the service delivery platform, knowledge and competence of the provider, privacy and security of information and above all, their effects on satisfaction, intention to continue using (ICU) and quality of life (QOL) (Ahuwalia & Varshney 2009; Akter et al. 2010; Angst & Agarwal 2009; Ivatury et al 2009; Kaplan & Litwka 2008; Mechael 2009; UN foundation & Vodafone foundation 2009; Varshney 2005). We define service quality of mobile health services (mHealth) as the user’s judgment about the overall excellence or superiority of the service (Zeithaml 1987). It is noteworthy that perceptions of poor quality of care may dissuade patients from using the mHealth platform because health concerns are among the most salient of human concerns (Andaleeb 2001). Thus, expanding access or lowering costs is not enough if one’s confidence in the quality of health services over this platform is low (Andaleeb 2001). If mHealth cannot be trusted to guarantee a threshold level of quality, it will remain underutilized, be bypassed, or used as a measure of last resort. Overall, the importance of quality perceptions in mHealth environment has been evidenced in numerous studies (Ahuwalia & Varshney 2009; Ivatury et al 2009; Kaplan & Litwka 2008; Mechael 2009; Norris et al. 2008; UN foundation & Vodafone foundation 2009; Varshney 2005) because of its strong effects on user satisfaction (Bailey & Pearson 1983; Baroudi and Orlikowski 1988), ICU (Bhattacherjee 2001; DeLone & McLean 2003) and QOL (Choi et al. 2007; Dagger & Sweeney 2006; Kaplan & Litwka 2008). However, there is a paucity of research in electronic markets which have developed metrics to analyze this relationship (Chatterjee et al. 2009; Choi et al. 2007). A review of the literature reveals that it has been under-researched and still most of the literature remains largely fragmented and anecdotal (Chatterjee et al. 2009). Thus, this study aims to develop a service quality model in the context of mHealth services by framing its association with satisfaction, ICU and QOL.

This study specifies service quality in mHealth as a hierarchical model. The usefulness of hierarchical modeling is quite evident both in covariance based Structural equation modeling (CBSEM) and component based structural equation modeling or partial least squares (PLS) (Chin 2010). Generally, it is used in modeling a level of abstraction higher than that first order constructs under hierarchical reflective or formative framework (Chin &
models have been discussed in some CBSEM studies (Dagger et al. 2008; Fassnact & Koese 2006); however,
there is a paucity of studies in component based SEM (PLS) (Wetzels et al. 2009). Thus, this study adopts PLS
path modeling in estimating a hierarchical service quality model (Chin 2010; Lohmoller 1989; Noonan and Wold
1983; Petter et al. 2007; Wetzels 2009; Wold 1985) because it leads to theoretical parsimony and model
knowledge, there is no study which has used PLS in assessing a hierarchical service quality model.

Overall, our main objective is, first, to develop a hierarchical service quality model in the context of mHealth
services by framing its association with satisfaction, ICU and QOL. And second, to show that PLS path modeling
can be used to estimate the parameters of a higher order model in a nomological network. One general research
question drove this study: how do hierarchical service quality perceptions at the individual level influence
satisfaction, quality of life and continuance intentions of mHealth services? In an effort to answer this question,
the paper is organized as follows: next section focuses on the literature review & the theoretical background.
Then, we conceptualize the research model and propose our hypotheses. The subsequent section describes
research methodology and empirical findings. Finally, the study discusses the implications of the research in
terms of theoretical and practical contributions, and provides the concluding remarks with limitations and future
research directions.

**Literature Review**

**mHealth services**

We define ‘mobile health’ as a subset of e-Health and using mobile devices to deliver health services to the
customers in electronic markets (Mechael 2008). It describes the application of mobile telecommunication and
multimedia technologies in mobile and wireless health care delivery systems (Istepanian & Lacal 2003). In broad,
it involves using wireless technologies to transmit and enable various data contents and services which are easily
accessible by health workers through mobile devices such as mobile phones, smart phones, PDAs, laptops and
Tablet PCs (UN foundation & Vodafone foundation 2009). However, this definition has targeted only health
workers as the sole users of mobile health services; but in case of mobile telemedicine services, the users are both
patients and health workers, such as, Healthline in Bangladesh, HMRI in India, Teledoctor in Pakistan, MedicallHome in Mexico, Fonemed in USA, NHS Direct in UK, project REMOTE in Europe and Project Masiluleke in South Africa. Focusing on such platforms, this study defines mHealth as a personalized and interactive health service platform whose main goal is to provide ubiquitous and universal access to medical advice and information to any customers through mobile device in electronic health markets (Akter et al. 2010; Akter & Ray 2010).

Service quality challenges of mHealth Services

This study is based on a popular B2C mHealth setting in developing countries, which is well known as ‘mobile telemedicine services’ or, ‘mobile health hotline services’ in electronic health markets (see Figure 1). In recent years, it has become very popular in the developing world (e.g., India, Bangladesh, Mexico, South Africa etc.) and serving millions by delivering right time medical information services at an affordable cost (Ivatury et al. 2009).

Under this platform, a user can easily access this service both in a non-emergency (headache, cold, cough, etc.) and an emergency situation (accident, burn, severe stomach pain, etc.) by simply dialing some unique digits (e.g. 789 in Bangladesh) from his or her mobile phone and can receive medical information, consultation, treatment, triage, diagnosis, referral and counseling from registered physicians (Ivatury et al. 2009). This mHealth platform maintains a panel of physicians on 24/7 at the physical front office (physician’s interface) which is simultaneously backed by a physical back office and a mobile network operator (for network management) to provide right time health services to the users. It has significantly facilitated information access, enhanced workflow, and promoted the evidence based practice to make informed and effective decisions directly at the point of care (Akter & Ray 2010; Andrade et al. 2003; Jen et al. 2007; Krause et al. 2007; Michalowski et al. 2003).
Although these services have gained huge popularity in developing countries; however, there are growing concerns about the quality of such services. In fact, quality perceptions have a strong influence on one’s inclination to avail health services or, to continue using such services in electronic markets. It has been identified as one of the critical challenges to identify and replicate the best practices around the world (Akter & Ray 2010). The extant literature on health care in the mobile electronic markets has identified that the major quality challenges are related to service delivery platform (Information systems & related technology), service delivery personnel (Interaction between physicians and patients) and service outcome (service benefit) (Akter et al. 2010; Ivatury et al. 2009; Varshney 2005). However, there are few studies which have adequately articulated the quality dimensions of mHealth in electronic markets (Chatterjee et al. 2009; Varshney 2005). Therefore, it is necessary to explore the existing service quality theories in order to develop a comprehensive quality model for mHealth services.

**An Overview of Service Quality**

This section argues that service quality of mHealth is an interdisciplinatory domain which is necessary to be explored through generic theories from information systems (IS), services marketing and healthcare literature (Akter et al. 2010). Thus, using a cross disciplinary approach, this section defines service quality and explores its natures in relevant domains.

According to Nelson et al. (2005), “*Quality has evolved into a core business concept with multidisciplinary applications and dramatic implications for business value in electronic markets.*” It has been defined either as excellence or, value or, conformance with specifications or, meeting expectations (Reeves & Bednar 1994). European Union’s Research & Development in Advanced Communications technologies in Europe (RACE) program (1994) defines quality of service as “*a set of user perceivable attributes of that which makes a service what it is. It is expressed in user-understandable language and manifests itself as a number of parameters, all of which have either subjective or objective values.*” In fact, all these notions of quality are interrelated and play crucial role to shape consumer’s perceptions (Nelson et al. 2005). In our study, we are focusing on perceived service quality of mobile healthcare which is absolutely focusing on users’ judgment about the overall excellence or superiority of mobile health service (Zeithaml 1987). Thus, we define service quality in this study as a
consumer’s judgment of, or impression about, mHealth platform’s overall excellence or superiority (Dagger et al. 2007).

A synthesis of quality parameters in generic service quality theories indicates that conceptualization and measurement of service quality should be users’ perceptions based (Parasuraman et al. 1985), context specific (Dagger et al. 2007), hierarchical (Dabholkar et al. 1996) and multi dimensional (Brady & Cronin 2001). Most of the research on traditional health service quality perceptions have initially focused on application of generic models which range from Grönroos’s (1984) two dimensional model (i.e., functional quality & technical quality) to Parasuraman et al.’s (1988) five dimensional (i.e., reliability, responsiveness, assurance, empathy and tangibles) SERVQUAL model. However, the complexity of service quality evaluations is evident in many failed attempts to replicate the existing model in new contexts (Brady & Cronin 2001). One of the major gaps of all generic theories is that no theory has focused on electronic health platform to capture customers’ quality perceptions.

The extant literature on service quality in IS indicates that a good number of researchers (e.g., Kettinger & Lee, 1994, 1995, 1999, 2005; Pitt et al., 1995, 1997; Watson et al. 1998, Jiang et al. 2000, 2001; 2002; Nelson et al. 2005, Wixom & Todd 2005, DeLone & McLean 2003) adapted quality dimensions in the IS context. For example, DeLone & McLean (2003) incorporated service quality as a separate predictor of IS success in order to meet the growing needs of service orientation in IT industry. Furthermore, in the context of web services, Parasuraman et al. (2005) developed the E-S-QUAL model capturing users’ perceptions of front office (interaction quality) and back office dimensions (systems quality). Likewise, Sousa & Voss (2006) recommended using all the front office and back office dimensions to measure user perceived service quality of any virtual platform. In the similar vein, Chae and kim (2002) presented a quality model for mobile electronic platform incorporating dimensions on connection quality, content quality, interaction quality and contextual information quality. In this context, Koivisto (2008) found that when any service is provided over mobile platform, the service quality is influenced by the mobile network, information systems and information itself. Overall, it is evident that service quality perception in electronic environment is influenced by all moments of contact (Shaw & Ivens 2002) and users perceive different quality measures depending on the type of system being evaluated (Jiang & Klein 1999). Researchers also confirmed that- no single model is absolutely better than other, so conceptualization and measurement of variables are often influenced by the context and objective of the study (DeLone & McLean 2003; Seddon 1992).
A review of the mobile healthcare literature revealed that there are few studies which have directly focused on service quality in this setting. For instance, while exploring pervasive healthcare, Varshney (2005) explored that coverage of mobile networks, reliability of wireless infrastructure, and general limitations of hand-held devices influence quality perceptions in this atmosphere. Ivatury et al (2009) conducted an exploratory study on mobile telemedicine services in some developing countries and found that service quality perceptions are influenced by information systems, interaction between doctors and patients and overall service outcome. In a recent study, Akter et al. (2010) presented a conceptual model for mHealth quality integrating platform quality, interaction quality and outcome quality as the primary dimensions of service quality.

As an effect of service quality, the extant literature has found both a direct association between service quality and satisfaction and an indirect relationship between service quality and ICU through satisfaction (Cronin and Taylor 1992; Dabholkar et al. 2000; Dagger et al. 2007; Gotlieb et al. 1994; Zviran & Erlich 2003). Studies confirmed that service quality leads to user satisfaction and increased user satisfaction leads to continuance intention (DeLone & McLean 2003; Seddon 1997). The similar relationship is also found between service quality, satisfaction and QOL (Dagger & Sweeney 2006; Choi et al. 2007). Although the relevance of IT to QOL has been acknowledged and recognized in the health care industry (Sirgy 2001), IS researchers have remained quiet on the relevance of this social outcome to the IT based service evaluation. This paucity has been highlighted by some scholars (e.g., Straub and Watson 2001) in IS who believed that it is one of the critical objectives of any technology to increase the quality of its users’ life.

**Research Model Development**

In order to develop a model to measure mHealth service quality, this study began by investigating commonly cited factors that influence service quality perception in the mobile healthcare as outlined in the previous section. Through this process, it identified three primary dimensions that reflect service quality perceptions in mobile healthcare, that is, **platform quality**, **interaction quality** and **outcome quality**. Throughout our theoretical exploration, service quality was frequently cited as a multidimensional, hierarchical and context specific construct; thus, we believed that several specific subdimensions would determine the initially identified primary dimensions. As a result, we conducted an exploratory qualitative study to explore the subdimensions and to confirm the contextual appropriateness of the primary dimensions identified in the literature.
We obtained qualitative data from three focus group discussions (FGD) and ten depth interviews (DI) conducted with mobile telemedicine customers in Bangladesh. A total of 24 participants, 8 per focus group, were involved in the FGD. Participants were ranged in age from 18 to 62 years and both genders had equal participation. Each session was conducted by two moderators which lasted about 90 minutes. In addition, ten DIs were conducted to explore users’ insights on our research agenda. In both cases, participants were recruited using convenient sampling in order to ensure productive findings and the richest data for model development (Dagger et al. 2007). In each case, respondents were asked the following questions to evaluate their mHealth experiences and to identify the service quality dimensions:

a. In your opinion, what makes mHealth platform different from other health service platforms?

b. What are the major strengths of mHealth platform?

c. Any positive or negative experience that you have had while receiving health services from mHealth platform?

The answers were recorded, synthesized and sorted into different categories to identify the core dimensions, subdimensions and their association with satisfaction, quality of life and continuance intentions. Users expressed their opinion on different service-level attributes (e.g., “I can access mHealth platform whenever I want” or, “The physician shows sincere interest to solve my problems,” or, “It is worthwhile having service from this platform”) under multiple dimensions. Throughout this process, we found support for three primary dimensions (i.e., platform quality, interaction quality and outcome quality) and nine subdimensions (system reliability, system availability, system efficiency, system privacy, responsiveness, assurance, empathy, functional benefit and emotional benefit) proposed in the research model (Figure 2). Though we developed our subdimensions under each primary dimension based on the themes identified in the qualitative study, we consulted the extant literature in the following sections to support our findings.

**Platform Quality:**

**Platform quality** reflects user’s perceptions regarding technical level of communication (Delone & McLean 1992, 2003; Petter & McLean 2009). In our qualitative findings, four core themes were found to constitute customers’ perceptions of platform quality in mHealth; these were termed as system reliability, system availability, system efficiency and system privacy. The first theme, system reliability, indicates the degree to
which mHealth platform is dependable over time (DeLone & McLean 2003; Nelson et al. 2005; Parasuraman et al. 2005). It measures service promise and service dependability as exemplified by the following comments: “It performs smoothly”, “It is dependable”. The second theme, *system availability*, defines the degree to which the mHealth platform is available ‘anytime’ and ‘anywhere’ basis (Akter et al. 2010; Chae & Kim 2002; Parasuraman et al. 2005). It was frequently referred as a unique and crucial indicator of platform quality in mHealth as suggested by the following comments, “I can access to mHealth platform whenever I want”, “I can receive medical service right away.” The third theme, *system efficiency*, defines the degree to which mHealth platform can be adapted to a variety of user needs and changing conditions (DeLone & McLean 2003; Nelson et al. 2005; Parasuraman et al. 2005). In fact, it reflects the adaptability of the platform as reflected by the comments “It can flexibly adjust to meet my variety of needs.” The final theme, *system privacy*, refers to the degree to which mHealth platform provides the security of protecting health information services provided by patients (Parasuraman et al. 2005; Varshney 2005). In electronic healthcare, ‘privacy’ has always been cited as an important parameter to gain reliance on the service platform, as reflected by the comments “It protects my personal information.” We believe that these four themes are the salient indicators of platform quality in the context of our study, in which health services are provided over mobile platform.

*Interaction Quality:*

Interaction quality indicates the quality of interaction and the dyadic interplay between a service provider and a user over mobile platform (Brady and Cronin 2001; Dagger et al. 2007; Grönroos 1984). It is defined as a ‘*a period of time during which a consumer directly interacts with a service*’ (Bitner 1990). Three core themes underpinned customers’ perceptions of interaction quality: responsiveness, assurance and outcome. The first theme, *responsiveness*, refers to the willingness of the service provider to help users and deliver prompt service (Akter et al. 2010; DeLone & McLean 2003; Parasuraman et al. 1988). Participants in our qualitative interview referred this factor as willingness and promptness of the provider to deliver mHealth service, as indicated by the comments, “Physicians provide prompt service to solve my problems.” The second theme, *assurance*, measures knowledge and courtesy of the provider (Akter et al. 2010; DeLone & McLean 2003; Parasuraman et al. 1988). It is an important dimension to inspire trust and confidence among users, as reflected by the comments, “I feel safe while consulting with physicians over mHealth platform” and “Physicians’ behaviour stimulate my confidence to deal with this healthcare platform.” The third theme of *empathy* reflects caring and individualized attention of the provider to the patients. It indicates the understandability of the user’s needs and ability to provide individualized
attention (Akter et al. 2010; DeLone & McLean 2003; Parasuraman et al. 1988). Comments such as “physicians understand my specific needs” or “physicians give me individual care” are evidence of the importance of empathy in the interaction quality.

Outcome quality:

This study proposes outcome quality as the final primary dimension of service quality. It refers to the outcome of the service process, or what a consumer receives as a result of his or her interactions with mHealth platform (Aharony and Strasser 1993; Grönroos 1984). According to Dagger et al. (2007) “outcome does not refer to ultimate result (e.g., cure) but rather to the outcomes experienced over a series of service encounters”. The extant literature has highlighted the importance of outcome quality in terms of several service benefits which may have varying importance on the user (Sheth et al. 1991). The direct relationship between service outcome (service benefit) and service quality is also cited in some healthcare studies (e.g., Dagger et al. 2007; Ruyter and Wetzels 1998). In this study, we have found two key themes of outcome quality, that is, functional benefit and emotional benefit (Fassnacht & Koese 2006). The first theme, functional benefit, refers to the degree to which the mHealth service serves its actual purpose. During the exploratory study, it was frequently discussed as an important parameter, as indicated by the comments, “It serves its purpose very well or, it is very useful”. Most studies in IS found that functional benefit (i.e., usefulness) plays a critical role in developing a positive attitude toward information technology implementation (Davis 1989). The second theme of emotional benefit refers to the degree to which mHealth service arouses positive feelings (Fassnacht & Koese 2006). Comment such as, “I feel hopeful having service from this platform, or, I feel confident using this service” highlight the importance of emotional benefit. This hedonic benefit has received much attention in recent years to stimulate users’ beliefs regarding service quality perception (Fassnacht & Koese 2006; Sweeney & Soutar 2001).

Thus, in conceptualizing a service quality model (see Figure 2) for mHealth services, we propose that users perceive quality at three primary dimensions (platform quality, interaction quality and outcome quality) and nine subdimensions (system reliability, system availability, system efficiency, system privacy, responsiveness, assurance, empathy, functional benefit and emotional benefit). We also propose that service quality dimensions have a significant impact on satisfaction (e.g., DeLone & McLean 2003; Wixom & Todd 2005) and satisfaction, in turn, positively influences quality of health life perception (e.g., Choi et al. 2007; Dagger et al. 2007) and the
intention to continue using mHealth services (Bhattacherjee 2001; DeLone & McLean 2003; Wixom & Todd 2005).

![Research Model and Hypotheses](image)

**Figure 2. Research Model and Hypotheses**

We specify the proposed service quality model as the third-order reflective hierarchical model (see Table 1) in which indicators are manifestations of construct (Jarvis et al. 2003; Petter et al. 2007). The extant research on service quality perception (Brady & Cronin 2001; Fassnacht & Koese 2006; Parasuraman et al. 2005) and measurement model specifications (Edward & Bagozzi 2000; Jarvis et al. 2003; Petter et al. 2007; Wetzel et al. 2009) have always embraced such hierarchical view. One of the significant advantages of hierarchical modeling is that it allows for more theoretical parsimony and less model complexity (Edwards 2001; Law et al. 1998; MacKenzie et al. 2005). Also, we adopt the perspective of reflective modeling (Jarvis et al. 2003; Petter et al. 2007) because all the indicators in our model share a common theme and dropping an indicator should not alter conceptual domain of the construct (see Table 1). Besides, the correlation between any two indicators is expected to be highly positive (Bollen and Lennox 1991) and internal consistency is important for such reflective constructs (Petter et al. 2007). Furthermore, such reflective measures are expected to be unidimensional, and if so, individual measures can be removed to improve construct validity without affecting content validity.
This study applies PLS path modeling to conceptualize the third-order reflective hierarchical service quality model through the repeated use of manifest variables (Chin & Gopal 1995; Chin 2010; Lohmöller 1989; Noonan and Tenenhaus et al. 2005; Wetzels et al. 2009; Wold 1993). In this case, the manifest variables will be used three times: for the first-order latent variable (e.g., system reliability), for the second-order latent variable (e.g., platform quality) and for the third-order latent variable (service quality) (See Table 1). Since latent variable scores are determinate in PLS path modeling, so manifest variables for lower order latent variables (e.g., system reliability) can repeatedly be used for higher order latent variables (platform quality or, overall service quality) (Chin 1998, 2010; Tenenhaus et al. 2005; Wetzels et al. 2009). According to Wetzels et al. (2009), “This approach also allows us to derive the (indirect) effects of lower-order constructs, or dimensions, on outcomes of the higher-order construct.”
Table 1: Framing the third-order reflective hierarchical Service quality model using PLS

<table>
<thead>
<tr>
<th>Construction of the model</th>
<th>Service quality as a Hierarchical Reflective Model</th>
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<tbody>
<tr>
<td>Figure 3.1 shows first order, reflective latent variables (LVs) (system reliability, system efficiency, system availability and system privacy) of platform quality, which are related to their respective manifest variables (MVs).</td>
<td><img src="image1" alt="Figure 3.1: First order latent variables of Platform Quality" /></td>
</tr>
<tr>
<td>Figure 3.2 shows that platform quality as a second order reflective variable, which is constructed by relating it to the block of the underlying first order latent variables. For instance, platform quality is constructed by using 10 MVs (3+3+2+2) of 4 first LVs. Likewise, interaction quality and outcome quality have been constructed as second order reflective LVs.</td>
<td><img src="image2" alt="Figure 3.2: Platform Quality as a second order reflective construct" /></td>
</tr>
<tr>
<td>Figure 3.3 shows service quality as a third order reflective variable, which is constructed by using all the manifest variables (25 MVs) of the 3 second order LVs. For instance, service quality is constructed by Platform quality (10 MVs), interaction quality (9 MVs) and outcome quality (6 MVs) Thus, service quality is reflected by 25 (10 + 9 + 6) MVs.</td>
<td><img src="image3" alt="Figure 3.3: Service Quality as a third-order hierarchical reflective construct" /></td>
</tr>
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</table>
Hypotheses Development

To embed the hierarchical service quality model in a nomological network, we have framed it with outcome constructs, such as, service satisfaction, ICU and QOL. We define satisfaction as the users' affect with (or, feelings about) prior mHealth services use (Bhattacherjee 2001; Spreng et al. 1996), ICU as the behavioral patterns reflecting continued use of mHealth services (Limayem et al. 2007) and QOL as the degree of fulfilment of one’s healthcare needs and wishes through mHealth services (Dagger & Sweeney 2006).

Service quality and satisfaction

The impact of service quality on patient satisfaction is a dominant concern in the health services (Andaleeb 2001; Dagger et al. 2007). Studies in marketing confirmed that service quality, as a cognitive evaluation, precedes the more emotive satisfaction construct (e.g., Brady and Robertson 2001; Cronin and Taylor 1992; Dabholkar et al. 2000; Gotlieb et al. 1994). IS researchers (e.g., Bailey & Pearson 1983; Baroudi and Orlikowski 1988) used a quality based approach for measuring user satisfaction and suggests that it is an indispensable indicator to measure IS performance. Likewise, the healthcare literature suggests that service quality measures have always been linked to satisfaction in order to maximize performance and to minimize failures (Andaleeb 2001; Taylor & Baker 1994). In healthcare, service quality is increasingly used as an instrumental tool to satisfy users, identify target groups, clarify objectives, define measures of performance, and develop performance information systems (Andaleeb 2001). Thus, we strongly believe that user satisfaction should be an integral component in evaluating the standard of health services provided over mobile platform.

H1: Service quality has a significant positive impact on service satisfaction in mHealth environment.

Service quality, satisfaction and intention to continue using

Both service quality and service satisfaction have profound impact on continuance intentions (Bhattacherjee 2001; Limayem et al. 2007; Venkatesh and Davis 2000). According to Dabholkar et al. (2000) “customer satisfaction will have a mediating role on behavioral intentions rather than an effect independent of service quality.” Prior studies have found that there is a direct impact of quality on intentions to use and also an indirect impact on intentions to use through satisfaction (DeLone & McLean 2003; Wixom & Todd 2005). Here we are using 'intention to continue use' instead of 'intention to use' as it is necessary for an IS to be truly able to measure net benefit (DeLone & McLean 2003). Continuance intention is defined as a behavioral patterns
reflecting continued use of a particular IS (Limayem et al. 2007). It is also defined as a usage stage when IS use transcends conscious behavior and becomes part of normal routine activity (Bhattacherjee 2001). It refers to a usage behavior, commonly labeled as post-implementation (Saga and Zmud 1994) or post-adoption (Jasperson et al. 2005) which are equally important to attaining information technology implementation. Some researchers (e.g., Bhattacherjee 2001; Limayem et al. 2007) say that long-term viability of an IS and its eventual success depend on its continued use rather than [its] first-time use. In the context of IS, perceived quality and satisfaction tend to reinforce a user’s intention to continue using the system (Limayem et al. 2007). Also, in health services, quality perceptions and satisfaction have a strong influence on one’s inclination to continue using such services (Andaleeb 2001). Most organizations are interested to know about this relationship because it indicates its overall financial performance (Dagger & Sweeney 2006). Thus we hypothesize that:

**H2:** Service quality has a significant positive impact on the intention to continue using mHealth services.

**H3:** Service satisfaction has a significant positive impact on the intention to continue using mHealth services.

**Service quality, satisfaction and quality of life**

In health service context, prior studies found that there is a link between service quality, satisfaction and quality of life perceptions (Choi et al. 2007; Dagger & Sweeney 2006). Since satisfaction contributes to and enhances well-being, it is related to QOL (Choi et al. 2007; Dagger & Sweeney 2006). IS researchers have identified this association by modeling the impact of service quality and satisfaction on social levels (DeLone & McLean 2003; Myers et al. 1997). QOL refers to the degree of fulfillment of one’s needs, goals and wishes (Campbell et al. 1976; Diener 1984). Given the healthcare context of the present study and the significance of healthcare as a vital component in QOL, we define QOL as a sense of overall well being in health (Dagger & Sweeney 2006). It is also recognized as the social outcome of mHealth services which has positive association with continuance intentions. Hence, we posit that:

**H4:** Service quality has a significant positive impact on the quality of health life perception.

**H5:** Service satisfaction has a significant positive impact on the quality of health life perception.

**H6:** Quality of health life perception has a significant positive impact on the intention to continue using mHealth services.
Research Methodology

Research Paradigm

The hierarchical service quality model proposed in this study conforms Gregor’s (2006) ‘explaining & predicting’ paradigm which is in line with positivistic mindset. The model explains something that is new and interesting, poorly or imperfectly understood beforehand and discovers the regularities that will allow adequate prediction of the service quality model in electronic markets (Gregor 2006). Orlikowski and Iacono (2001) confirm such IT research as “proxy view” to capture the critical aspects of information technology through some surrogates measures (e.g., quantitative variables). Since this study is going to measure a causal network of relations in service quality, so a field study was conducted in a natural setting using human subjects. Under a field study, it adopted cross sectional survey design to elicit specific information from any given sample of population elements only once (Malhotra 2004). In terms of survey interaction, this study applied location intercept and in-home survey techniques jointly because these methods provide maximum response rates in comparison with postal mail, telephone and online survey in a developing country context (Andaleeb 2001; Malhotra 2004).

Sampling

Data was collected from Bangladesh, one of the leading mHealth service providing developing nations, under a global mHealth assessment project from January 07 to March 17, 2010. In the absence of lists for drawing a random sample, five hundred interviews were planned from two urban areas (Dhaka city & Khulna City) and three rural areas (Netrokona, Keranigonj and Kaligonj) using area wise cluster sampling. Areas were selected in a manner such that different socioeconomic groups were represented. From each area, first, thanas were selected randomly; then, streets /villages were selected from each thana; and finally, residential homes were selected from each street /villages. In order to obtain a probability sample, systematic random sampling was applied so that each sample unit /element had an equal chance of being selected. The population was defined as the customers who had experience of using mobile telemedicine services provided by Grameen Phone (the leading mHealth service provider in Bangladesh with 24 million subscribers) in the past 12 months. After a quick screening question on whether the respondent had used mHealth services in the past 12 months, interviewers proceeded with the survey questions. Both self completion and interviewer filled survey techniques were used in order to receive higher valid response. A total of 290 surveys were ultimately completed. Of the total number of surveys,
seven were considered problematic and excluded, because of excessive missing data, don’t know answers, or N/A answers, and response biases. Finally, 283 surveys were analyzed.

<table>
<thead>
<tr>
<th>Items</th>
<th>Categories</th>
<th>Statistic (%)</th>
<th>Items</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Male</td>
<td>50.2</td>
<td>Occupation</td>
<td>Student</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>49.8</td>
<td></td>
<td>Housewife</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Personal business</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Public Organization</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Private Organization</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Others</td>
</tr>
<tr>
<td>Age</td>
<td>18-25</td>
<td>47.7</td>
<td>Education</td>
<td>High School</td>
</tr>
<tr>
<td></td>
<td>26-33</td>
<td>26.5</td>
<td></td>
<td>Two years’ college</td>
</tr>
<tr>
<td></td>
<td>34-41</td>
<td>14.1</td>
<td></td>
<td>4Year’ university</td>
</tr>
<tr>
<td></td>
<td>42-49</td>
<td>6.4</td>
<td></td>
<td>Graduate</td>
</tr>
<tr>
<td></td>
<td>50+</td>
<td>5.3</td>
<td></td>
<td>Others</td>
</tr>
</tbody>
</table>

Of the respondents, 50.2 percent were male; 47.7 percent were between 18 and 25 years, 26.5 percent were between 26 and 33 years, 14.1 percent were between 34 and 41 years and remaining 11.7 percent were older than 42 years. Of the total number of respondents, 43.1 percent were students, 37.4 percent were involved with different services, 15.9 percent were housewives and remaining 3.5 percent had other involvements.

**Measurement Instruments**

The questionnaire consisted of previously published multi-item scales adapted from E-S-QUAL model (Parasuraman et al. 2005), SERVQUAL model (Parasuraman et al. 1988), IT quality model (Nelson et al. 2005) electronic services quality model (Fassnact and Koese 2006) and health service quality model (Dagger et al. 2007) with favorable psychometric properties. We developed the primary version of the questionnaire in English, and then translated the measures into the local language (Bangla). The local version was retranslated until a panel of experts agreed that the two versions were reasonably comparable (Andaleeb 2001). All of the items were measured in a structured format on a seven-point Likert-type scale, ranging from “strongly disagree” to “strongly agree.” Before the final study, we conducted a pretest over 10 samples to ensure that the question content, wording, sequence, format and layout, question difficulty, instructions and the range of the scales (5-point vs. 7-point) were appropriate. Upon response from the pretest, we made minor adjustments to refine the final version of the questionnaire.
Data Analysis Strategy

The research paradigm of the study is ‘quantitative positivist’ (Straub et al. 2004) and the research objective is ‘explaining and predicting’ (Gregor 2006), which require that ‘rigor’ needs to be established in research modeling, statistical design and methods. As such, it specifies service quality as a third-order, hierarchical reflective construct model in order to estimate the model parameters (Edwards 2001; Law et al. 1998; MacKenzie et al. 2005, Wetzels et al. 2009). As we discussed earlier, this model consists of constructs involving more than one dimension and indicators are manifestations of constructs. Therefore, to estimate the parameters for such model, this study decided to use component based SEM (PLS) in order to avoid the limitations of covariance based SEM with regard to distributional properties, measurement level, sample size, model complexity, identification and factor indeterminacy (Chin 2010; Fornell and Bookstein 1982, Wetzels et al. 2009). Also, PLS is more suitable for this study because theoretical objective is ‘explaining and prediction’, the model is relatively complex and the phenomenon under study is new or changing (Chin & Newsted 1999). As a result, this study adopted PLS path modeling to estimate the parameters of the third-order reflective hierarchical service quality model using repeated measures (Chin & Gopal. 1995; Chin 1998, 2010; Wetzels et al. 2009; Wold 1985). Under this mechanism, the manifest variables were used repeatedly for the first order latent variable (“primary” loadings), second order latent variable (“secondary” loadings) and finally for the third-order latent variable (“higher order” loadings) (See Table 3) and then structural parameters had been estimated for the overall model.

Table 3: Estimation of the third-order reflective hierarchical service quality model using PLS

<table>
<thead>
<tr>
<th>First Order model</th>
<th>Second order model</th>
<th>Third order model (Extension of second order model)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y_i = \Lambda_y \cdot \eta_j + \epsilon_i$</td>
<td>$\eta_j = \Gamma \cdot \xi_k + \zeta_j$</td>
<td>$\eta_j = \beta \cdot \eta_j + \Gamma \cdot \xi_k + \zeta_j$</td>
</tr>
<tr>
<td>$y_i =$ manifest variables (e.g., items of system reliability)</td>
<td>$\eta_j =$ first order factors (e.g., system reliability)</td>
<td>$\beta \eta_j =$ second order latent variables (e.g., platform quality, interaction quality and outcome quality) except the highest order</td>
</tr>
<tr>
<td>$\Lambda_y =$ loadings of first order latent variable</td>
<td>$\Gamma =$ loadings of second order latent variable</td>
<td>$\Gamma \xi_k =$ Third order latent variable (e.g., service quality)</td>
</tr>
<tr>
<td>$\eta_j =$ first order latent variable (e.g., System reliability)</td>
<td>$\xi_k =$ second order latent variable (e.g., platform quality)</td>
<td>$\zeta_j =$ error of first order factors</td>
</tr>
<tr>
<td>$\epsilon_i =$ measurement error</td>
<td>$\zeta_j =$ error of first order factors</td>
<td>$\xi_k =$ error of second order factors</td>
</tr>
</tbody>
</table>
Findings

Assessment of the Measurement Model
In order to assess the third-order reflective hierarchical service quality model, we used PLS Graph 3.0 (Chin 2001) to estimate the parameters in the outer and inner model. In this case, we applied PLS path modeling with a path weighting scheme for the inside approximation (Chin 1998; Tenenhaus et al. 2005; Wetzels et al. 2009). Then we applied nonparametric bootstrapping (Chin 1998; Efron and Tibshirani 1993; Tenenhaus et al. 2005) with 500 replications to obtain the standard errors of the estimates. In estimating the higher-order latent variables, we used the approach of repeated indicators suggested by Wold (cf. Lohmoller, 1989, pp 130-133).

In order to check the properties of the measurement scales, we conducted confirmatory factor analysis (CFA) to assess reliability, convergent validity and discriminant validity (see Table 4). Initially, we calculated average variance extracted (AVE) (Chin 1998, 2010; Fornell and Larcker 1981) and the composite scale reliability (CR) (Chin 1998; Fornell and Larcker 1981) to assess reliability of all the measurement scales. Here, the CR and AVE of all scales are either equal to or exceed respectively 0.80 and 0.50 cut off values (Fornell and Larcker 1981). Here, the lowest AVE is 0.707 for the functional benefit and the lowest CR is 0.881 for the system availability; however, all those values compellingly exceed their respective cut off value. Then, we ensured convergent validity as all the PLS indicators load much higher on their hypothesized factor than on other factors (own loading are higher than cross loadings) (Chin 1998, 2010). In addition, in Table 5, we calculated the square root of the AVE that exceeds the intercorrelations of the construct with the other constructs in the model in order to ensure discriminant validity (Chin 1998, 2010; Fornell and Larcker 1981). Thus, the measurement model was considered satisfactory with the evidence of adequate reliability, convergent validity and discriminant validity and was employed for hypothesis testing and research model validation.
<table>
<thead>
<tr>
<th>Constructs</th>
<th>Items</th>
<th>Loadings</th>
<th>CR</th>
<th>AVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Reliability</td>
<td>SR1. This service platform works smoothly.</td>
<td>0.891</td>
<td>0.942</td>
<td>0.844</td>
</tr>
<tr>
<td>System Availability</td>
<td>SA1. This platform is always available.</td>
<td>0.876</td>
<td>0.881</td>
<td>0.788</td>
</tr>
<tr>
<td>System Efficiency</td>
<td>SE1. This service platform can be adapted to meet variety of needs.</td>
<td>0.937</td>
<td>0.960</td>
<td>0.889</td>
</tr>
<tr>
<td>System Privacy</td>
<td>SP1. This platform protects information about my personal problems.</td>
<td>0.977</td>
<td>0.976</td>
<td>0.954</td>
</tr>
<tr>
<td>Responsiveness</td>
<td>RE1. Physicians of mHealth platform provide prompt service.</td>
<td>0.927</td>
<td>0.944</td>
<td>0.849</td>
</tr>
<tr>
<td>Assurance</td>
<td>AS1. The behavior of physicians instills confidence in me.</td>
<td>0.899</td>
<td>0.913</td>
<td>0.777</td>
</tr>
<tr>
<td>Empathy</td>
<td>EM1. Physicians give me personal attention.</td>
<td>0.942</td>
<td>0.945</td>
<td>0.852</td>
</tr>
<tr>
<td>Functional Benefit</td>
<td>FB1. It serves my purpose very well.</td>
<td>0.834</td>
<td>0.879</td>
<td>0.707</td>
</tr>
<tr>
<td>Emotional Benefit</td>
<td>EB1. I feel hopeful as a result of having this service.</td>
<td>0.961</td>
<td>0.967</td>
<td>0.907</td>
</tr>
<tr>
<td>Service satisfaction</td>
<td>SAT1. I am satisfied with my use of mHealth service.</td>
<td>0.950</td>
<td>0.973</td>
<td>0.901</td>
</tr>
<tr>
<td>Intention to continue using</td>
<td>ICU1. I intend to continue using mHealth to get medical information services.</td>
<td>0.944</td>
<td>0.964</td>
<td>0.900</td>
</tr>
<tr>
<td>Quality of health life</td>
<td>QOL1. Getting services from this platform have enabled me to improve my overall health.</td>
<td>0.905</td>
<td>0.946</td>
<td>0.813</td>
</tr>
</tbody>
</table>

Table 4: Psychometric Properties for First Order Constructs
Table 5: Intercorrelations of the latent variables for the first order constructs

<table>
<thead>
<tr>
<th>Construct</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Reliability</td>
<td>0.918</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>System Availability</td>
<td>0.456</td>
<td>0.887</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>System Efficiency</td>
<td>0.461</td>
<td>0.433</td>
<td>0.942</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>System Privacy</td>
<td>0.278</td>
<td>0.330</td>
<td>0.451</td>
<td>0.977</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Responsiveness</td>
<td>0.549</td>
<td>0.396</td>
<td>0.583</td>
<td>0.310</td>
<td>0.921</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assurance</td>
<td>0.455</td>
<td>0.316</td>
<td>0.611</td>
<td>0.476</td>
<td>0.614</td>
<td>0.881</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Empathy</td>
<td>0.453</td>
<td>0.280</td>
<td>0.580</td>
<td>0.429</td>
<td>0.660</td>
<td>0.745</td>
<td>0.923</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Functional Benefit</td>
<td>0.523</td>
<td>0.365</td>
<td>0.630</td>
<td>0.438</td>
<td>0.639</td>
<td>0.789</td>
<td>0.736</td>
<td>0.840</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emotional Benefit</td>
<td>0.556</td>
<td>0.392</td>
<td>0.612</td>
<td>0.402</td>
<td>0.645</td>
<td>0.739</td>
<td>0.715</td>
<td>0.789</td>
<td>0.952</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction</td>
<td>0.559</td>
<td>0.351</td>
<td>0.533</td>
<td>0.381</td>
<td>0.591</td>
<td>0.723</td>
<td>0.661</td>
<td>0.730</td>
<td>0.714</td>
<td>0.949</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICU</td>
<td>0.461</td>
<td>0.300</td>
<td>0.499</td>
<td>0.355</td>
<td>0.544</td>
<td>0.616</td>
<td>0.587</td>
<td>0.691</td>
<td>0.678</td>
<td>0.728</td>
<td>0.949</td>
<td></td>
</tr>
<tr>
<td>QOL</td>
<td>0.495</td>
<td>0.362</td>
<td>0.540</td>
<td>0.413</td>
<td>0.555</td>
<td>0.655</td>
<td>0.665</td>
<td>0.679</td>
<td>0.659</td>
<td>0.746</td>
<td>0.738</td>
<td>0.902</td>
</tr>
</tbody>
</table>

*Square root of the AVE on the diagonal

Assessment of the Higher Order Model

In Figure 4, this study shows the parameters of service quality as a third-order reflective hierarchical construct model. The degree of explained variance of third-order service quality construct is reflected in its second order components, that is, platform quality (77%), Interaction Quality (89%), and outcome quality (87%). Accordingly, variance of second order constructs is reflected in its corresponding first order constructs. All the path coefficients from service quality to second order and third-order components are significant at P < 0.01 (Appendix-1). Also, in Table 6, the results show that the CRs & AVEs of the second or third-order model are equal to or greater than 0.80 and 0.50 respectively, which provides evidence of reliable higher order measures.

Table 6: Reliability of Higher order Constructs

<table>
<thead>
<tr>
<th>Model</th>
<th>Construct</th>
<th>CR</th>
<th>AVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Third</td>
<td>Service Quality</td>
<td>0.96</td>
<td>0.51</td>
</tr>
<tr>
<td>Second</td>
<td>Platform quality</td>
<td>0.91</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>Interaction quality</td>
<td>0.94</td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td>Outcome quality</td>
<td>0.92</td>
<td>0.72</td>
</tr>
</tbody>
</table>

Figure 4: Service Quality as a higher order reflective model
Assessment of the Structural Model

To assess the nomological validity, we developed a structural model in which service quality is modeled as an exogenous latent variable influencing service satisfaction, ICU and QOL (see Table 7). In Figure 5A, the results give a standardized beta of 0.780, 0.294 and 0.206 respectively from service quality to service satisfaction, service satisfaction to ICU and service quality to ICU. All these path coefficients are significant at $p < 0.01$ (Appendix-1). Thus, it is evident that service quality has a direct impact on satisfaction (60.9%) and ICU (62.9%), and an indirect impact on ICU through satisfaction. We also find support for H1, H2, and H3. Similarly, the results show that the path coefficients between service quality to QOL, service satisfaction to QOL and finally, QOL to ICU are significant at $p < 0.01$ (Appendix-1). These relationships confirm that there is a significant direct and indirect impact (through satisfaction) of service quality on QOL (62.2%). Thus, we find support for H4, H5 and H6. The overall variance explained by the model in terms of $R^2$ is 0.622 for QOL and 0.629 for ICU. According to Cohen (1988), these effects can be classified as large ($f^2 > 0.35$) as per the effect sizes defined for $R^2$.

Table 7: Hierarchical service quality model and its impact on outcome constructs with/without mediator

<table>
<thead>
<tr>
<th>Service Quality</th>
<th>Service Satisfaction</th>
<th>Quality of Life (QOL) in health</th>
<th>Intention to continue using (ICU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.409</td>
<td>0.700</td>
<td>0.437</td>
<td>0.154 (0.625)</td>
</tr>
<tr>
<td>0.206</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 5A: Main effects model of service quality with mediator (satisfaction)

<table>
<thead>
<tr>
<th>Service Quality</th>
<th>Intention to continue using (ICU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.254</td>
<td>0.175 (0.551)</td>
</tr>
</tbody>
</table>

Figure 5B: Direct effects model of service quality without mediator (satisfaction)

In addition, we also tested the mediating effect of service satisfaction in the relationship between service quality, QOL and ICU (Baron and Kenny 1986; Holmbeck 1997). In the Figure 5B, the results show that service quality, without mediator, still has a positive direct impact on ICU and QOL, which are significant at $p < 0.01$. However, the direct model (Figure 5B) has relatively lower prediction power than the main model (Figure 5A), that is, $R^2 = 0.551$ for QOL and $R^2 = 0.600$ for ICU. Now if we compare the direct effects model (Figure 5B) with the
parameters estimated in the main effects model (Figure 5A), our result shows that the inclusion of service satisfaction as a mediator increases the overall variance explained for QOL ($\Delta R^2 = 0.07$, $f^2 = 0.16$, $p < 0.01$) and ICU ($\Delta R^2 = 0.029$, $f^2 = 0.07$, $p < 0.01$). For QOL, the overall effect size ($f^2 = 0.16$) is between medium to large (0.15 to 0.35) and for ICU, the overall effect size is between small to moderate (0.02 to 0.15) which are significant at $p < 0.01$ (Cohen 1988). Thus, these results suggest that indirect association (main effects model) has a better prediction power for the overall model than that of direct association (direct effects model), which supports for using satisfaction as a mediator between service quality, QOL and ICU.

An Evaluation of the PLS model

Power analysis (1-\(\beta\))

We conducted power analysis (1-\(\beta\)) to validate the empirical findings of our PLS analysis. Power test is generally defined as the probability of rejecting a false null hypothesis ($H_0$), that is, the probability of obtaining a valid result (Cohen 1988). Therefore, Power (1 - \(\beta\)) refers to the probability of successfully rejecting null hypothesis (Barudi & Orlikowski 1989; Cohen 1992). We used G*Power 3.1.2 (Faul et al. 2009) to conduct the power test (post hoc) to estimate the validity of statistical parameters. As a convention for behavioral research a value of 0.80 is used for power (Baroudi and Orlikowski 1989; Cohen 1988, 1992). We found that the power for all the parameters in our research model exceeds 0.99 which compellingly exceeds the cut off value 0.80 (Barudi & Orlikowski 1989; Cohen 1992).

Global fit measure (GoF)

We conducted a global fit measure ($GoF = \sqrt{AVE \times \bar{R}^2}$), for PLS path modeling which is defined as the geometric mean of the average communality and average $R^2$ for all endogenous constructs (Tenenhaus et al. 2005). Following the guidelines of Chin (2010), we estimated the GoF values to ensure global validation of PLS models. In this study, we obtained a GoF value of 0.7567 for the complete model, which exceeds the cut-off value of 0.36 for large effect sizes of $R^2$ (Cohen 1988). It allows us to conclude that our model has better prediction power in comparison with the baseline values ($GoF_{small} = 0.1$, $GoF_{medium} = 0.25$, $GoF_{large} = 0.36$). Thus, our findings adequately validate the PLS model globally (Wetzels et al. 2009).
Discussion & Implications

Summary of findings

One general research question drove this study: how do hierarchical service quality perceptions at the individual level influence satisfaction, quality of health life and continuance intentions of mHealth services? In an effort to answer this question, this study provided an empirical illustration by developing the third-order reflective hierarchical service quality model using data from a popular mHealth setting. It confirmed that PLS path modeling can be used to assess a hierarchical model. Since PLS is considered better suited for explaining complex relationships (Chin 2010; Fornell and Bookstein, 1982), so the application of PLS path modeling to this scenario made it possible to extend the theoretical contributions of this study. It showed that service quality as a third-order construct was reflected by platform quality ($\beta = 0.870$), Interaction Quality ($\beta = 0.944$), and outcome quality ($\beta = 0.931$), which explained 77%, 89% and 87% of overall quality variance respectively. It implies that interaction quality had the greatest reflection of overall service quality, followed by outcome quality and platform quality. Though our results show differences in components in reflecting overall service quality; however, we note that the differences in magnitudes were small and all these three primary components were important to customers. It also signifies that telemedicine services should be delivered over a robust mobile platform, ensuring vibrant interaction and meaningful benefit to satisfy the desired healthcare needs of customers. Then, variance of second order constructs is estimated by their corresponding first order constructs. For example, platform quality was reflected by system reliability ($\beta = 0.772$), system availability ($\beta = 0.681$), system efficiency ($\beta = 0.845$) and system privacy ($\beta = 0.642$) in which system efficiency (71%) reflects the highest variance of platform quality. Accordingly, variance of interaction quality and outcome quality were estimated to confirm reflections of their corresponding subdimensions. We used the approach of repeated indicators (Wold 1985) in estimating the higher-order latent variables and confirmed adequate measurement & structural properties for our research model. In order to assess the nomological validity of the higher order service quality model, we predicted the strong impact of service quality on satisfaction ($R^2 = 0.609$), ICU ($R^2 = 0.629$), and QOL ($R^2 = 0.622$) in which satisfaction was recognized as a strong mediator.
Implications for Theory

This study extended existing service quality theory in the context of mobile health services by capturing users’ perception on three primary dimensions (platform quality, interaction quality, outcome quality) and nine subdimensions (system reliability, system availability, system efficiency, system privacy, responsiveness, assurance, empathy, functional benefit, emotional benefit). Besides, it added novelty in theory by modeling the association between service quality and two new outcome constructs (*ICU* and *QOL*), which have not been investigated before. Furthermore, the newness of the theory lies in its application in a new research setting (i.e., mHealth in a developing country) based on the logical evidence of user perceived quality. According to Whetten (1989) “the common element in advancing theory development by applying it in new settings……..that is, new applications should improve the tool, not merely reaffirm its utility”. Methodologically, the contribution lies in validating service quality theory for the first time as the third-order reflective hierarchical model using PLS, which clearly provides new insights and clarifications to component based structural equation modeling. This application of PLS reflects Wold’s view (1985, p. 589) that, “PLS comes to the fore in larger models, when the importance shifts from individual variables and parameters to packages of variables and aggregate parameters.” Thus, we believe that the proposed theoretical framework of this study can make significant contribution to knowledge because of its unique modeling, interesting conjectures and sophisticated validation paradigm in the context of services quality research.

Implications for Practice

The implications of this research are highly relevant to mHealth service providers, healthcare management and society in general. The findings suggest that customer evaluate service quality of mHealth at an overall level, a dimensional level (platform quality, interaction quality and outcome quality) and at subdimensional level (system reliability, system efficiency, system availability, system privacy, responsiveness, assurance, empathy, functional benefit and emotional benefit). For managers of mHealth services, this finding improves overall understanding of how customers evaluate mHealth service quality. In particular, it suggests that managers of mHealth platform should focus on improving the quality of the services they provide across the three primary dimensions, which can be achieved by nine subdimensions.
The proposed service quality model provides managers with a tool for conducting an integrated analysis and design of service delivery systems. It underscores that having only a good technological platform (e.g., information systems & good wireless network) is not enough to deliver the desired levels of service quality. Thus, managers need to address, in a coordinated manner, the quality of a platform, the quality of patient-provider interaction and above all, the quality of service benefit associated with the service platform. These findings provide a useful road map for making interventions in the service delivery systems targeting the improvement of a particular quality dimension at different levels. The findings highlight that quality issues arising in dimensions of mHealth platform have different natures, such as, platform quality deals with ‘human-technology interaction’, interaction quality deals with ‘interpersonal interaction’ and outcome quality deals with ‘service benefit’ derived from the service delivery systems.

The model offers managers an understanding of how individual service quality dimension and overall service quality interact in the formation of satisfaction, QOL and ICU. The findings of our study support the importance of service quality as a decision-making variable in predicting economic outcome (i.e., ICU) as well as social outcome (i.e., QOL). Continuance is one of the critical challenges to identify and replicate the best mHealth practices around the world (Akter et al. 2010). Therefore, our findings on ‘continuance’ and its antecedents will facilitate the scalability of this new paradigm of an emerging IT artifact. Managers can now consider mHealth implementation as a success if a significant number of users move beyond the initial adoption stage and use this service on a continued basis. In addition, through QOL assessment, managers can track the level of societal welfare caused by mHealth implementation, which is a new paradigm to ensure sustainability of mHealth business models in electronic markets. The findings of the study confirm the strong mediating role of ‘satisfaction’ in predicting ICU and QOL. These findings suggest that managers should consider ‘service quality’ and ‘satisfaction’ as important strategic objectives to ensure better quality of health life perception and positive continuance intention. Thus, the mHealth service quality model proposed in this study can help providers achieve patronage for firms, better health outcomes for patients and above all, an improved quality of life for the community.

Limitations and Future Research Directions

Several limitations are worth noting. First, this research was conducted within the specific domain of mHealth services and in one country. Though service quality research by its nature is context specific, replications in other
contexts would increase the confidence in the research model. Second, data was collected under a cross sectional design, so the study contains the typical limitations associated with this kind of research methodology. For example, the model represents its static nature of service evaluation and the findings are confined to a single point of time. To gain a deeper understanding, this study suggests longitudinal study to evaluate users’ perceptions over time. Future research could also explore the impact of contextual factors, such as, demographic variables (income, education, sex etc.) and situational constructs (usage frequency, cost etc.) on the research model. Additional research is needed to develop a refined understanding of the relationships proposed in the integrated model. Finally, it would be useful for future research to evaluate hierarchical modeling by comparing the performance between component based SEM (PLS) and Covariance based SEM under different research conditions.

Conclusion

The mHealth service quality model developed in this study can be used to assess, diagnose and enhance the quality of health services delivered to customers. Though proposed in the context of mHealth services, this model may be of interest to any service platform in the mobile electronic markets which deal with vast network of customers to provide right time ubiquitous services. The findings of the study are highly valuable to managers to capture customers’ service quality perceptions which have been evidenced as hierarchical, multidimensional and context specific. This knowledge can play a critical role in improving overall service quality and determining its positive effects on outcome constructs in electronic markets. It also provides an important step on the path to providing conceptual clarity and practical solutions to the service quality challenges of mHealth platforms around the world. We hope that this research will serve as a catalyst for action in electronic markets by encouraging both researchers and practitioners to embrace service quality as a core concept in implementing mHealth, a new paradigm of an emerging IT artifact.

Acknowledgement

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# Appendix

## A1. (Path Coefficients, STDER, T-Values)

<table>
<thead>
<tr>
<th>Hierarchical Model</th>
<th>Path coefficients</th>
<th>Standard error</th>
<th>T statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Platform quality</td>
<td>System Reliability</td>
<td>0.772</td>
<td>0.0388</td>
</tr>
<tr>
<td>Platform quality</td>
<td>System Availability</td>
<td>0.681</td>
<td>0.0379</td>
</tr>
<tr>
<td>Platform quality</td>
<td>System Efficiency</td>
<td>0.845</td>
<td>0.0190</td>
</tr>
<tr>
<td>Platform quality</td>
<td>System Privacy</td>
<td>0.642</td>
<td>0.0583</td>
</tr>
<tr>
<td>Interaction quality</td>
<td>Responsiveness</td>
<td>0.856</td>
<td>0.0271</td>
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<td>Interaction quality</td>
<td>Assurance</td>
<td>0.885</td>
<td>0.0196</td>
</tr>
<tr>
<td>Interaction quality</td>
<td>Empathy</td>
<td>0.912</td>
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<td>Outcome quality</td>
<td>Functional Benefit</td>
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<td>0.0108</td>
</tr>
<tr>
<td>Outcome quality</td>
<td>Emotional Benefit</td>
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</tr>
<tr>
<td>Service quality</td>
<td>Platform quality</td>
<td>0.931</td>
<td>0.0093</td>
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<table>
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<th>Structural Model</th>
<th>Path coefficients</th>
<th>Standard error</th>
<th>T statistic</th>
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<tr>
<td>Service quality</td>
<td>Satisfaction</td>
<td>0.780</td>
<td>0.0356</td>
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<tr>
<td>Service quality</td>
<td>Intention to continue using</td>
<td>0.206</td>
<td>0.0671</td>
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<tr>
<td>Service quality</td>
<td>Quality of life</td>
<td>0.409</td>
<td>0.0580</td>
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<td>Satisfaction</td>
<td>Intention to continue using</td>
<td>0.294</td>
<td>0.0646</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>Quality of life</td>
<td>0.427</td>
<td>0.0594</td>
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<tr>
<td>Quality of life</td>
<td>Intention to continue using</td>
<td>0.365</td>
<td>0.0689</td>
</tr>
</tbody>
</table>
References


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