Service Quality Dynamics of mHealth in A Developing Country

by

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ABSTRACT

mHealth, a new paradigm of an emerging information technology (IT) artifact, transforms health care delivery in the developing world by making it more accessible, affordable and available. Although mHealth is transforming health care in developing countries, there are growing concerns about the perceived service quality of such service systems and their overall effects on satisfaction, continuance intentions and quality of life. In developing countries, expanding access or low costs are not enough if one's confidence in the quality of health services is low. If mHealth cannot be trusted to guarantee a threshold level of quality, it will remain underutilized, be bypassed or be used as a measure of last resort. However, there are few studies which have developed models to measure the components and consequences of mHealth service quality. Thus, to fill this knowledge gap, this study developed a service quality model for mHealth by framing its association with satisfaction, continuance intentions and quality of life. To validate the model, the study used a quantitative-positivist approach as a research paradigm, cross-sectional design as a survey method, cluster sampling as a sampling technique and component-based structural equation modeling (SEM) as a data analysis technique. The findings of the study show that mHealth service quality is a third-order construct model with three primary dimensions and nine subdimensions which have a significant positive association with consequential latent variables. Theoretically, the study extends service quality research by reframing the concept as a reflective, hierarchical model and framing its impact on satisfaction, continuance intentions and quality of life in the context of mHealth in a developing country. Methodologically, the study validates that component-based SEM can be used to estimate the parameters of a higher-order construct and its association outcome variables in a nomological network. Practically, the study provides managers with a service quality model for conducting integrated analysis and design of service delivery systems. Overall, the study makes a significant contribution to achieve patronage for firms, better health outcomes for patients and above all, an improved quality of life for the community in developing countries.

Publications Associated with this Thesis

Publications in Journals

1. Akter, S., D'Ambra, J. & Ray, P. (2010). Service Quality of mHealth: Development and Validation of a Hierarchical Model using PLS. ***Electronic Markets***, 20(3), 209-227.

2. Akter, S., D'Ambra, J. & Ray, P. (2011). Trustworthiness in mHealth Information Services: An Assessment of a Hierarchical Model with Mediating and Moderating Effects using Partial Least Squares (PLS). ***Journal of the American Society for Information Science and Technology (JASIST)****, 62(1), 100-116.*

3. Akter, S., D'Ambra, J. & Ray, P. (2012). Continuance of mHealth Services at the Bottom of the Pyramid: The Roles of Service Quality and Trust. ***Electronic Markets***, 22 (3).

4. Akter, S., D'Ambra, J., Ray, P. & Hani, U. Modelling the Impact of mHealth Service Quality on Satisfaction, Continuance and Quality of Life. Second round at ***Behaviour & Information Technology (BIT)***, (Manuscript ID: TBIT-2011-0090).

5. Akter, S., D'Ambra, J., Ray, P. & Hani, U. Development and Validation of An Instrument to Measure User Perceived Service Quality in mHealth. Second Round at ***Information & Management (I&M)***, (Manuscript ID: INFMAN-S-11-00162).

Publications as Conference Proceedings

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2. Akter, S., D'Ambra, J. & Ray, P. (2011). Viewing Systems as Services: The Role of Service Quality. In Proceedings of 32nd ***International Conference on Information Systems (ICIS)***, Shanghai, China.

3. Akter, S., D'Ambra, J. & Ray, P. (2010). User Perceived Service Quality of mHealth Services in Developing Countries. In Proceedings of the 18th ***European Conference on Information Systems (ECIS)***, Pretoria, South Africa.

4. Akter, S., D'Ambra, J. & Ray, P. (2011). An Evaluation of PLS based complex models: The Roles of Power Analysis, Predictive Relevance and GoF index. In Proceedings of the 17th ***Americas Conference on Information Systems (AMCIS)***, Detroit, USA.

5. Tariq, A. & Akter, S. (2011). An Assessment of mHealth in Developing Countries using TTF Model. In the Proceedings of the 17th ***Americas Conference on Information Systems (AMCIS)***, Detroit, USA.

6. Li, J., Moore, N., Akter, S., Bleistein, S. and Ray, P. (2010). mHealth for Influenza Pandemic Surveillance in Developing Countries. In the Proceedings of the 43rd ***Hawaii International Conference on System Sciences (HICSS)***, January 5-8, Hawaii, United States.

Publication as a Book Chapter

1. Akter S. & Ray, P. (2010). mHealth – An Ultimate Platform to Serve the Unserved, ***IMIA Yearbook of Medical Informatics***, Schattauer, Germany, 2010.

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Chapter 1 Introduction[1]

1.1 Overview (Research Problem, Rationale and Objectives)

The world is becoming a service economy (Ostrom et al. 2010). Health care is one of the fastest growing sectors in this economy. The growth of this sector can be sustained through a critical evaluation of its impact on the success of firms, the well-being of societies and the quality of consumers' lives worldwide (Bitner & Brown 2008). Although health care is arguably the most important service with a pervasive impact on daily life, this sector is facing serious challenges (Berry & Bendapudi 2007). The health service system in the developing world is on a depressing path, with a deadly combination of limited access to care, uneven quality and high costs (Porter & Teisberg 2006). In this context, the introduction of information and communication technologies (ICT), especially the application of mobile communications, creates the potential to transform health care delivery by making this service more accessible, affordable and available. According to the World Health Organization report (2011, p. 1), "the use of mobile and wireless technologies to support the achievement of health objectives (mHealth) has the potential to transform the face of health service delivery across the globe".

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[1] *An abridged version of the entire dissertation is encapsulated in this chapter, which was published in the following journal:*

- Akter, S., D'Ambra, J. & Ray, P. (2010). Service Quality of mHealth Platforms: Development and Validation of a Hierarchical Model using PLS, ***Electronic Markets***, 20(3), 209-227.

Within the context of developing countries, mHealth has emerged as a viable solution to serve these pressing health care needs through its high-reach and low-cost solution. The adoption rate of mHealth is quite high in these regions in comparison with the developed world because moving to mHealth from nothing is easier than moving to mHealth from a strong tradition of an efficient and ubiquitous telephony system (Prahalad 2004; Kaplan 2006; Ivatury 2009; Mechael 2009). Besides, the mobile platform is relatively inexpensive, faster and simpler than the fixed phone platform which leads mobile phone-based health systems to experience huge growth in resource-poor environments (Kalil 2009; Vodafone Group 2012). A recent study shows that 51 mHealth programs are being operated in 26 developing countries around the world (Vital Wave Consulting 2009). These programs have been fuelled by the mobile phone ownership in these regions which has already reached four billion (WHO 2011). This dramatic penetration of mobile phones in low- and middle-income countries is playing a critical role in reducing the digital divide in health care (Ranck 2011; Earth Institute 2010). It is expected that mHealth will soon transform the face and context of health care service delivery in the developing world by improving overall patient care and the provision of personalized health services.

"mHealth", a new health care paradigm, is the application of mobile communications—such as, mobile phones and PDAs—to deliver right-time health services to customers (or patients) (Vital Wave Consulting 2009). This study focuses on a business-to-consumer (B2C) mHealth hotline service in developing countries, which is defined as a personalized and interactive health service over a mobile phone in order to provide ubiquitous and universal access to medical information services to any patient (Ivatury et al. 2009). In the health care sector in developing countries, mHealth is a transformative service system for shifting the care paradigm from crisis intervention to promoting wellness, prevention and self-management (Kaplan & Litewka 2008). As a transformative service, mHealth centers on "creating uplifting changes and improvements in the well-being of both individuals and communities" (Ostrom et al. 2010, p. 9).

Although mHealth creates positive changes, there are growing concerns about the user-perceived quality of such services due to the lack of reliability of the service platform, knowledge and competence of the provider, privacy and security of information services, and above all, their overall effects on service satisfaction, continuance intentions and quality of life (Ahluwalia & Varshney 2009; Angst & Agarwal 2009; Ivatury et al. 2009; Kaplan & Litewka 2008; Mechael 2009; Varshney 2005). In developing countries, expanding access or low costs are not enough if one's confidence in the quality of health care services is low (Andaleeb 2001). If the system cannot be trusted to guarantee a threshold level of quality, it will remain underutilized, be bypassed or be used as a measure of last resort (Andaleeb 2001; Dagger et al. 2007). Overall, the importance of quality perceptions in the mHealth environment has been evidenced in numerous studies (e.g., Ahluwalia & Varshney 2009; Kahn et al. 2010; Kaplan & Litewka 2008; Mechael 2009; Norris et al. 2008; Varshney 2005; Vital Wave Consulting 2009) because of its strong effects on service satisfaction, future use intentions and quality of life (Choi et al. 2007; Dagger & Sweeney 2006; Kaplan & Litewka 2008). Therefore, the quality issues represent the most critical challenges in identifying and replicating the best mHealth practices around the world (WHO 2011).

This study defines service quality (SQ) as consumers' (or patients') judgment about the overall excellence or superiority of the mHealth service (Zeithaml 1987). The role of consumers (or patients) in evaluating the nature of quality becomes a critical competitive consideration due to its enormous impact on outcome constructs (Chiou et al. 2006; Donabedian 1992; Jun et al. 1998; O'Connor et al. 2000). As such, perceived service quality and its association with satisfaction, continuance intentions and quality of health life becomes a critical dimension to determine the success or failure of the mHealth service system (Dagger et al. 2007; Dagger & Sweeney 2006). However, research using models to analyze these relationships is scant in this domain (Ostrom et al. 2010). A review of the literature reveals that most of the research in this domain (i.e., mHealth) still remains largely anecdotal, fragmented and atheoretical (Chatterjee et al. 2009; Kahn et al. 2010).

Therefore, ***the main objective*** of this study is to develop a consumers' perception-based service quality model that can reliably and validly measure the performance of mHealth services and its effects on satisfaction, continuance intentions and quality of health life in the context of developing countries. ***The specific objectives*** are firstly, to explore service quality dimensions in the mHealth context; and secondly, to measure the impact of overall mHealth service quality on satisfaction, continuance intentions and quality of health life.

1.2 Research Questions

A growing number of countries in the developing world have adopted mHealth services to address health care needs (WHO 2011). mHealth is being used to provide versatile health care solutions, such as, education and awareness, remote data collection, remote monitoring, communication and training, disease and outbreak tracking, and diagnostic and treatment support (Earth Institute 2010; Vital Wave Consulting 2009). Although these programs are experiencing higher adoption due to their widespread access and cost-effective solutions to basic health care needs, they require immediate assessment to ensure their viability in terms of service quality (Ahluwalia & Varshney 2009; Angst & Agarwal 2009; Earth Institute 2010; Ivatury et al 2009; Kaplan & Litewka 2008; Mechael 2009; Norris et al. 2008; Varshney 2005; Vital Wave Consulting 2009; WHO 2011). There is ample evidence that conceptualization and measurement of service quality in health care have a significant impact on behavioral, financial and social outcomes (Andaleeb 2001; Dagger et al. 2007; Dagger & Sweeney 2006). An adequate level of service quality can provide greater fulfilment to patients through satisfaction, larger returns to providers through continued usage, and better societal returns to the community through quality of life (Andaleeb 2001; Dagger et al. 2007; Kahn et al. 2010). Although mHealth for developing countries has received considerable attention, there is a paucity of research focused on service quality dynamics in this setting. As such, research on mHealth service quality is necessary to facilitate its critical impact evaluation in order to move beyond discussions of the potential impact that it might have and anecdotal examples of how it is already being used (Curioso & Mechael 2010; Earth Institute 2010; Feder 2010; Ivatury et al. 2009; Mechael 2009; Vital Wave Consulting 2009; WHO 2011). Thus, to explore the dimensions of service quality in mHealth and to measure the impact of overall mHealth service quality on individual (i.e., satisfaction), economic (i.e., continuance intentions) and social (i.e., quality of life) outcomes, this study puts forward the following research questions:

RQ 1: What are the dimensions of service quality of mHealth in the context of developing countries?

RQ 2: Is there any influence of overall mHealth service quality on service satisfaction, intention to continue using and quality of health life in this context?

1.3 Research Scope and Theoretical Foundation

This study focuses on a popular B2C mHealth setting in Bangladesh, which is well known as mobile telemedicine or mobile health (hotline) services in developing countries, such as, MedicallHome in Mexico, HMRI in India and Healthline in Bangladesh (Ivatury et al. 2009; WHO 2011). In recent years, this service has become very popular in low- and middle-income countries (e.g., Bangladesh, India, Mexico, South Africa, etc.) and serves millions by delivering right-time primary health services at an affordable cost (Ivatury et al. 2009). Under this platform, a patient 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 then receive medical information, consultation, treatment, triage, diagnosis, referral and counseling from health professionals (registered physicians, nurses and paramedics) (Ivatury et al. 2009; WHO 2011).

The overall quality perception of an mHealth service is influenced by the quality of service delivery platform, quality of patient-physician interaction over that platform and quality of service benefits (Ahluwalia & Varshney 2009; Ivatury et al. 2009; Koivisto 2007; Norris et al. 2008; Varshney 2005). Therefore, conceptualization and measurement of service quality in mHealth is based on an interdisciplinary approach by exploring generic theories from marketing (e.g., Brady & Cronin 2001; Fassnacht & Koese 2006; Parasuraman et al. 1985, 1988, 2005; Sousa & Voss 2006), information systems (e.g., DeLone & McLean 2003; Nelson et al. 2005; Pitt et al. 1995, 1997; Wixom & Todd 2005) and health care literature (e.g., Andaleeb 2001; Dagger et al. 2007; Dagger & Sweeney 2006; Kahn et al. 2010). This study argues that reference disciplines and audiences are essential components for conducting research in an interdisciplinary field, such as, health service systems (Ostrom et al. 2010; Wilson & Lankton 2004). The central theme of this study is the *service quality concept* which was originally developed by marketing academics (Gronroos 1982, 1984; Parasuraman et al. 1985, 1988) and subsequently adopted in information systems research by Kettinger and Lee (1994, 1997, 2005), Pitt et al. (1995, 1997), Jiang et al. (2000, 2001, 2002), Watson (1998), DeLone and McLean (2003), Ma et al. (2005) and Jia et al. (2008). Therefore, this study is based on an interdisciplinary approach to model the dynamics of mHealth service quality in the context of developing countries.

1.4 Research Methodology

This study specifies that the nature of the theory is 'explaining and predicting' (Gregor 2006), the research philosophy is 'quantitative-positivist' (Straub et al. 2004), the research method is 'field study' (Jenkins 1985), the data collection technique is 'cross-sectional survey' (Pinsonneault & Kramer 1993), the sampling strategy is 'area wise cluster sampling' (Andaleeb 2001) and the data analysis technique is 'exploratory factor analysis' for the pilot study and 'PLS path modeling' for the main study. The study established rigor in the research design by supporting the application of each of these techniques using necessary logic and support from the literature.

1.4.1 Research Paradigm

This study reflects the positivist notion by formulating an empirically testable theory to establish 'law like generalizations' (Orlikowski & Baroudi 1991), such as, overall service quality in mHealth consists of three primary dimensions and nine subdimensions which have a significant impact on satisfaction, continuance intentions and quality of health life. Since this study is going to measure a causal network of relationships in service quality, a field study was conducted using cross-sectional survey design. This study confirms such research as a "proxy view" to capture the critical aspects of service systems through some surrogate measures (e.g., quantitative variables). It posits that perceptual, cognitive and attitudinal responses to service systems are the critical variables in explaining and predicting technology and its effects on the world (Orlikowski & Iacono 2001).

1.4.2 Sampling

Data were collected from Bangladesh, one of the leading mHealth service-providing developing nations, under a global mHealth assessment project from January to March 2010. The study used area wise cluster sampling to collect data from two urban areas (*Dhaka City* and *Khulna City)* and three rural areas (*Netrokona, Keranigonj* and *Kaligonj*). Areas were selected in such a manner that different socio-economic groups were represented. A total of 400 surveys were completed for the study, of which 110 surveys were completed for the pilot study in January 2010 and 290 surveys were completed for the main study in March 2010. The demographic profile of the respondents both in the pilot study and confirmatory study represents a diverse cross-section of the population.

1.4.3 Data Analysis

The study specified mHealth service quality as a third-order, hierarchical-reflective construct model which has a significant impact on satisfaction, continuance intentions and quality of life. This study conducted exploratory factor analysis with varimax rotation in the pilot study (Chapter 6) and confirmatory factor analysis with PLS in the main study (Chapter 8).

The study applied hierarchical modeling in the confirmatory study in order to capture a level of abstraction higher than these first-order constructs (Edwards 2001; Law et al. 1998; MacKenzie et al. 2005; Wetzels et al. 2009). The usefulness of such 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). Conceptual and empirical contributions of hierarchical models have been discussed in some CBSEM studies (Dagger et al. 2007; Fassnacht & Koese 2006); however, there is a paucity of research in component-based SEM (PLS) (Wetzels et al. 2009). Thus, this study adopted PLS path modeling in estimating a hierarchical service quality model because it leads to theoretical parsimony and model simplicity (Chin 2010; Edwards 2001; Law & Wong 1999; Wetzels et al. 2009). To the best of our knowledge, there is no study which has used PLS in validating a hierarchical service quality model.

1.5 Research Contribution

This study discusses its contributions in terms of theory, methodology and practice. Theoretically, the study extends service quality research by reframing the concept as a hierarchical-reflective construct and modeling its impact on satisfaction, intention to continue using and quality of life in the context of mHealth in a developing country. Methodologically, the study validates that component-based SEM or 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. Practically, the study provides managers with a service quality model for conducting integrated analysis and design of service delivery systems. Overall, the study makes a significant contribution to achieving patronage for firms, better health outcomes for patients and above all, an improved quality of life for the community in developing countries.

1.5.1 Contribution to Theory

This study extends existing service quality theory in the context of mHealth services by capturing users' perceptions about three primary dimensions (platform quality, interaction quality, outcome quality) and nine subdimensions (systems reliability, systems availability, systems efficiency, systems privacy, responsiveness, assurance, empathy, functional benefit and emotional benefit). In addition, it adds novelty to theory by modeling the association between service quality and two new outcome constructs (i.e., continuance intentions and quality of health life) which have not previously been investigated. Furthermore, the newness of the theory lies in its application in a new research setting (developing country) based on the logical evidence of user-perceived quality (Whetten 1989). Thus, the study believes that the proposed theoretical framework makes a significant contribution to knowledge as most of its constructs and their relationships have not been the subject of prior theorizing in the context of mHealth services.

1.5.2 Contribution to Methodology

The study explains the methodological gestalt of hierarchical modeling using PLS in order to demonstrate why this study is a leap forward. It is one of the earliest attempts to conceptualize and validate a hierarchical model using PLS in the context of service quality research. Using the approach of repeated indicators (Lohmoller 1989; Wold 1982) in estimating the higher-order latent variable, the study confirms adequate measurement and structural properties for the research model (Chin 2010; Hair et al. 2011; Wetzels et al. 2009). The application of PLS makes it possible to extend the theoretical contribution of the study by developing and validating a third-order, reflective service quality model. The study also confirms that higher-order constructs can be framed with outcome constructs in a structural model to prove nomological validity. The study also illuminates the robustness of analysis by illustrating how to quantify mediating and moderating variables, and the effects of control variables in a hierarchical model. This is a situation where PLS outperforms covariance-based SEM (CBSEM) in estimating a third-order, hierarchical model by successfully averting various constraints of CBSEM in terms of distributional properties (multivariate normality), measurement level, sample size, model complexity, model identification and factor indeterminacy.

1.5.3 Contribution to Practice

The implications of this research are highly relevant to mHealth service providers, health care management and society in general. The findings suggest that users evaluate the service quality of mHealth at an overall level, a dimensional level (platform quality, interaction quality and outcome quality) and at a subdimensional level (systems reliability, systems efficiency, systems availability, systems privacy, responsiveness, assurance, empathy, functional benefit and emotional benefit). For providers of mHealth services, this finding improves the understanding of how customers evaluate mHealth service quality. In particular, the findings suggest that providers of mHealth should focus on improving the quality of the services they provide across the three primary dimensions which can be achieved through nine subdimensions. The model also offers managers an understanding of how individual service quality dimension and overall service quality interact in the formation of satisfaction (SAT), quality of life (QOL) and intention to continue using (ICU). The findings support the importance of overall service quality (SQ) as a significant decision-making variable in predicting individual outcome (i.e., satisfaction (SAT)), economic outcome (i.e., ICU) and social outcome (i.e., QOL). Thus, the findings on SQ-SAT-ICU offer managers an understanding of economic sustainability, and the findings on SQ-SAT-QOL help managers to track the level of societal welfare caused by mHealth implementation in developing countries.

1.6 Research Limitations

This study has some limitations. Firstly, the research was conducted within the specific domain of an mHealth service in a specific country. As a result, the applicability of findings more broadly or to other specific forms of mHealth service in a new setting is uncertain. Secondly, this research was based on multiple cross-sectional studies so the study contains typical limitations associated with this kind of research methodology. Thirdly, the sample only represents consumers from a developing country (i.e., Bangladesh), thereby there is a limitation regarding the generalizability of findings to other consumers in developed countries.

1.7 Future Research

This study has paved the way for future research to extend into cross-cultural settings by incorporating respondents from both developed and developing countries. Future studies can also identify and test additional boundary conditions to present an even richer understanding of mHealth service quality and continuance behavior. Studies can also be extended to incorporate a dyadic approach in which perceptions of service providers and consumers will be taken into account. Subsequent studies can assess the impact of service quality on other consequential latent variables. Methodologically, it would be useful for future studies to evaluate hierarchical modeling by comparing both covariance-based SEM and component-based SEM (or PLS).

1.8 Structure of the Thesis

This dissertation consists of nine chapters, starting with this introductory chapter which provides a snapshot of the entire study. A brief overview of the remaining chapters of this dissertation is depicted in Table 1.1 and discussed in the following sections:

Table 1.1 Structure of the thesis

Chapters	Contents
Chapter 1 Introduction	▪ Problem definition, rationale and objectives ▪ Research questions ▪ Scope and theory ▪ Methodology and contribution ▪ Structure of the thesis
Chapter 2 Literature Review (Context)	▪ mHealth services ▪ mHealth in developing countries ▪ mHealth (hotline) services
Chapter 3 Literature Review (Theory)	▪ Generic service quality theory ▪ Service quality in information systems ▪ Relationship among service quality, satisfaction, continuance intentions and quality of life
Chapter 4 Conceptual Model and Hypotheses Development	▪ Discussion of conceptual model ▪ Discussion of key constructs ▪ Discussion of hypotheses
Chapters 5, 6, 7 Methodology (1) (2) (3)	▪ Research paradigm ▪ Instrument development and validation process ▪ Data analysis technique
Chapter 8 Analysis and Results	▪ Construct and measurement ▪ Reliability and validity ▪ Tests of hypotheses ▪ Overall findings
Chapter 9 Discussion and Conclusions	▪ Discussion of results ▪ Theoretical contribution ▪ Managerial implications ▪ Limitations ▪ Future research directions ▪ Conclusions

1.8.1 Chapter 2: Literature Review (Context)

Chapter 2 discusses the nature of the mHealth service and its role in developing countries with its critical challenges. As such, firstly, the chapter provides an overview of service in terms of service definition, service characteristics and service categories. Secondly, the chapter provides an overview of mHealth service in terms of definitions, characteristics and service types. Thirdly, the chapter explores different types of mHealth services in developing countries. Finally, the chapter discusses the research setting of the study, that is, an mHealth (hotline) service in the context of a developing country.

1.8.2 Chapter 3: Literature Review (Theory)

Chapter 3 explores different service quality theories and synthesizes the gaps and findings for developing an mHealth service quality model. Firstly, the chapter defines quality, service quality and perceived service quality. Secondly, the chapter explores generic service quality theories and identifies their findings and gaps to determine the nature of the service quality concept. Thirdly, the chapter discovers service quality theories in information systems and their relevance to the mHealth context. Fourthly, the chapter explores service quality theories both in traditional health services and mHealth services and critically analyzes their dimensions, relevance and research limitations. Finally, the chapter discusses the association between service quality and outcome constructs (e.g., satisfaction, continuance intentions and quality of health life) with their gaps in the mHealth environment.

1.8.3 Chapter 4: Conceptual Model and Hypotheses Development

This chapter discusses the nature of the proposed mHealth service quality model and presents the relevant hypotheses based on causality among constructs. Epistemologically, the model development process embraces a positivist-quantitative research paradigm and ontologically, the model extends knowledge by developing a hierarchical, multidimensional service quality model to measure mHealth which is a new paradigm in health service. Specifically, the conceptual model depicts the components and consequences of service quality in the context of B2C mHealth (hotline) services in developing countries. The model elucidates an overview of associations in terms of a cognitive-affective-conative framework. The model simplifies the service quality dominant decision-making process for the mHealth platform (e.g., B2C mHealth care) with an effect on individual (i.e., satisfaction), economic (i.e., continuance intentions) and social (i.e., quality of life) outcomes.

1.8.4 Chapter 5: Research Paradigm

Chapter 5 links the nature of the research model with epistemological beliefs and research methods. To pursue this objective, the chapter specifies that the nature of the theory is 'explaining and predicting', the research philosophy is 'quantitative positivist', the research method is 'field study', the data collection technique is 'cross-sectional survey', the sampling strategy is 'area wise cluster sampling' and the data analysis technique is based on 'PLS path modeling'. The study establishes rigor in the research design by supporting the application of each of these techniques using necessary logic and support from the literature.

1.8.5 Chapter 6: Instrument Development and Validation

Chapter 6 argues that there is a paucity of reliable and valid instruments for adequately capturing the dimensions of mHealth service quality. The chapter also argues that poor theoretical development, inadequate conceptualization of constructs and a lack of valid operationalization of measures have aggravated the pursuit of scale development process in this context. Thus, the main purpose of this chapter is to develop and validate a multidimensional service quality scale in mHealth and to investigate its ability to predict critical service outcomes in a nomological network.

1.8.6 Chapter 7: Estimating A Hierarchical Model Using PLS

This chapter specifies the data analysis technique of the study in estimating the research model. The study applies PLS path modeling or component-based SEM in estimating the third-order, reflective, service quality model. The study argues that PLS leads to more theoretical parsimony and less model complexity for estimating a higher-order model. Therefore, the objectives of this chapter are to specify the nature of the research model, justify the logic for applying PLS path modeling or component-based SEM, demonstrate how to operationalize PLS for estimating the hierarchical model and discuss the parameters for evaluating a PLS-based complex hierarchical model.

1.8.7 Chapter 8: Analysis and Results

This chapter presents the overall results of the study by estimating the measurement model and structural model. The results also present the impact of key mediator, moderator and control variables on the research model. Overall, this chapter discusses firstly, the first-order measurement model in terms of convergent and discriminant validity; secondly, the findings of the higher-order measurement model in terms of reliability and validity; thirdly, the findings of the structural model with the results of hypotheses testing; fourthly, the roles of mediator and moderator in the research model; fifthly, the roles of control variables in the research model; and finally, the results of power analysis, predictive relevance and the goodness of fit (GoF) index in validating overall empirical findings.

1.8.8 Chapter 9: Discussion and Conclusions

This chapter aims to elucidate the implications of the empirical findings, theoretical significance, methodological advancement and practical contribution of the study. The chapter also discusses limitations and future research directions of the study with concluding remarks. Overall, the chapter focuses on the following sections: a review of the research objectives; summary of empirical findings based on research questions; contribution to theory, methodology and practice; research constraints; and future research avenues.

1.9 Definition of Key Terms

In this section, the study defines key terms used in the dissertation:

- *Service:* The application of specialized competences (knowledge and skills) through deeds, processes and performances for the benefit of another entity or the entity itself (Vargo & Lusch 2004).

- *mHealth hotline service:* A personalized and interactive health service over a mobile phone in order to provide ubiquitous and universal access to medical information services to any patient (Ivatury et al. 2009).

- *Developing countries*: The nations which often have abundant natural resources but lack the capital, entrepreneurial and technical skills required to develop them. The average income per head and the standard of living in these countries is therefore far below that of the industrial nations (World Bank 2004).

- *Consumers or users or patients*: The ultimate users of services. However, the term also refers to the buyer or decision maker as well as the ultimate consumer (Kotler & Keller 2006).

- *Service quality or perceived service quality*: A consumer's (or patient's) judgment of, or impression about, an entity's overall excellence or superiority (Dagger et al. 2007).

- *Customer satisfaction or service satisfaction*: This study defines satisfaction as a consumer's overall evaluation of his/her experiences with the mHealth service (Spreng et al. 1996)

- *Intention to continue using (ICU) or continuance intentions*: This study defines intention to continue using as a usage stage when mHealth use transcends conscious behavior and becomes part of normal routine activity (Bhattacherjee 2001)

- *Quality of life (QOL) in health*: This study defines QOL as a consumer's (or patient's) sense of overall well-being in health care (Dagger & Sweeney 2006).

- *Hierarchical construct or model*: A construct with more than one dimension where each dimension captures some portion of the overall latent variable (Edwards 2001; Jarvis et al. 2003; Petter et al. 2007).

- *Reflective construct*: Indicators are the manifestation of a construct, and the direction of causality is from construct to indicators (Jarvis et al. 2003; Petter et al. 2007).

- *Reflective model*: A structural model comprised of all reflective constructs *(*Jarvis et al. 2003; Petter et al. 2007*)*.

- *PLS path modeling or component-based SEM:* Partial least squares (PLS) is a component-based approach for testing structural equation models (Chin 1998a).

1.10 Summary

The objective of Chapter 1 was to provide an overview of the present study. The chapter initially discussed the research problem, rationale and objectives, which was followed by the specification of the research questions in the context of mHealth in developing countries. The chapter then presented the research methodology in terms of the research paradigm, research method, sampling, scaling and data analysis techniques. The chapter also highlighted the contributions of the study in terms of theory, methodology and practice. Finally, the chapter presented the structure of the thesis by briefly outlining the nine chapters and defining the key terms used in the dissertation. The next two chapters review the literature and synthesize the findings and gaps in mHealth in developing countries (Chapter 2: Literature Review - Context) and service quality dynamics in mHealth (Chapter 3: Literature Review-Theory).

Chapter 2 Literature Review (Context)[2]

2.1 Overview

Health challenges present arguably the most significant barrier to sustainable development in the developing world. Research into this sector has predominantly focused on general health services with a scant focus on electronic platform-driven health care in developing countries. This study addresses this gap by considering mHealth services in these regions (Akter & Ray 2010). The extant literature demonstrates the potential of mHealth in transforming health care in resource-poor settings; however, service quality appears to be the most formidable challenge. Thus, the literature review covers both the contextual application of mHealth (Chapter 2) and service quality-related theoretical explorations (Chapter 3). The current chapter explores the nature and characteristics of services, health services and mHealth services. It also identifies mHealth as a transformative health service in developing countries and specifies the research setting of the study with critical challenges and gaps. The next chapter (Chapter 3) reviews the components and consequences of service quality theory and specific gaps in the context of mHealth services.

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[2] *Abridged versions of this chapter were published in the following book and conference:*

- Akter, S., & Ray, P. (2010). mHealth – An Ultimate Platform to Serve the Unserved, ***IMIA Yearbook of Medical Informatics***, Schattauer, Germany, 94-100.
- Akter, S., D'Ambra, J. & Ray, P. (2011). User Perceived Service Quality of mHealth Services in Developing Countries, In the Proceedings of the 18th ***European Conference on Information Systems (ECIS)***, Pretoria, South Africa.

This chapter is designed as follows: Section 2.2 discusses an overview of service in terms of service definition, service characteristics and service categories. Next, the chapter outlines the nature and characteristics of health services (Section 2.3) and mHealth services (Section 2.4). These discussions lead the chapter to explore mHealth in developing countries (Section 2.5) and to explore the research setting of the study with relevant gaps (Section 2.6). Finally, Section 2.7 provides a summary of the chapter.

2.2 The Nature and Characteristics of Services

2.2.1 Defining Services

Services are part and parcel of our life. Shostack (1977) views services as essentially intangible activities which fulfil certain wants. Many scholars (e.g., Bateson 1979; Kotler & Bloom 1984; Zeithaml et al. 1985) have supported this logic and based their service definition on 'intangibility'. Berry (1980, p. 24) defines a service as "a deed, a performance, an effort … and when a service is purchased, there is generally nothing tangible to show for it." This definition is very consistent with Kotler and Bloom's (1984) definition which also identifies a service as an activity or benefit under an exchange process that is based on intangibility and no ownership. Gronroos (1988, p. 10) in his initial definition proposes that "a service is not a thing but a series of activities or process, which moreover are produced and consumed simultaneously at least to some extent …" (p. 10). Recently, Gronroos (2000, p. 46) redefines services as "processes that consist of a set of activities which take place in interactions between a customer and people, goods and other physical resources, systems and/or infrastructures representing the service provider and possibly involving other customers, which aim at solving customers' problems".

Acknowledging the process viewpoint of service, Zeithaml et al. (1996) introduce perceived value orientation in services by identifying them as “deeds, processes or performances”. Overall, Lovelock et al. (2001) propose services as process-based economic activities that provide place, form, time, problem solving or experiential benefits to the user. In the same spirit, Fitzsimmons and Fitzsimmons (2006) define service as “a time-perishable, intangible experience performed for a customer acting in the role of a co-producer”. Rai and Sambamurthy (2006) echo the same concept by defining service as “a simultaneous or near-simultaneous exchange of production and consumption, transformation in the experience and value that customers receive from engagement with providers, and intangibility in that goods are not exchanged”. Sampson and Froehle (2006) also focus on the co-production and identify that “the customer provides significant inputs into the production process.” Overall, Kotler and Keller (2006) synthesize service as “any act or performance that one party can offer to another party that is essentially intangible and does not result in the ownership of anything”. They identify service as an economic activity which provides benefits to a customer by bringing a desired change in his or her status at a specific time and place.

However, Vargo and Lusch (2004) further update the extant notions by focusing on value rather than utility and defining service simply as “the application of specialized competences (knowledge and skills) through deeds, processes, and performances for the benefit of another entity or the entity itself”. More precisely, they identify a ‘‘service’’ as the application of resources for the benefit of another (Vargo & Lusch 2006). Supporting such a dictionary-like definition of a service, Alter (2008) states that “services are acts performed for others, including the provision of resources that others will use”. In the same spirit, IBM Research (2009) provides a simple definition of a service by defining it as "a provider-client interaction that creates and captures value". Early scholars emphasized the concept of 'intangibility' in defining services; however, present scholars identify a service as the application of 'resources' under a 'process' for the benefit of others. Overall, this study adopts the simplistic and unifying viewpoints of Vargo and Lusch (2004) and Alter (2008) which define service as a process to provide benefits to others using resources (e.g., skills, competences or better platforms).

2.2.2 Exploring the Nature of Services

The fundamental characteristics of services are based on *intangibility*, *inseparability*, *variability*, *perishability*, *customer participation* and *no ownership* (see Table 2.1). Research on services has always addressed these characteristics to identify their challenges and opportunities. As such, theories and models in services literature have always focused on these characteristics to extend knowledge.

'Intangibility' is the most basic nature of services which distinguishes them from goods (Shostack 1977). Although intangibility is an important nature of services, it is logical to think about intangibility on a continuum ranging from highly intangible to slightly intangible (Lovelock et al. 2011; Zeithaml & Bitner 2009). Consumers cannot make a full evaluation of service quality before purchase because of this nature. It indicates that the elements of service cannot be tasted, smelled, touched or seen (McColl-Kennedy 2003). As services are inherently intangible, it is very difficult for customers to evaluate service quality before consumption. Moreover, service providers are generally located in different locations. As a result, it is harder for customers to compare a particular service performance with other providers due to the lack of easily available reference points (Lovelock et al. 2011). Services also cannot be experimented with or sampled before involvement in the exchange process, which creates additional perceived risk for consumers in terms of functional or emotional benefit (Akter et al. 2010a; Dagger & Lawley 2003).

Table 2.1 Service characteristics and their implications in service research

Service Characteristics	Challenges	Implications	References
Intangibility Service cannot be tasted, smelled, touched or seen.	Difficult to provide concrete evidence; difficult to evaluate service quality; risk and uncertainty in visualizing service benefits.	Ensuring service benefits; documenting performance; offering guarantee.	Berry (1980); Lovelock et al. (2011); Shostack (1977); Zeithaml (1985); Zeithaml & Bitner (2009).
Inseparability Services are produced and consumed simultaneously.	Limited production capacity; difficult to ensure consistency in provider's equipment, facility or overall systems.	Ensuring quality of interaction to ensure service benefits.	Berry (1980); Lovelock et al. (2011); Zeithaml (1985); Zeithaml & Bitner (2009).
Variability Services vary as per contexts.	Difficult to ensure consistency, reliability and service quality or harder to protect customers from service failures.	Determining quality standards to prevent service failures; implementing good service recovery procedures.	Berry (1980); Lovelock et al. (2011); Zeithaml (1985); Zeithaml & Bitner (2009).
Perishability Services cannot be stored.	Services cannot be stored; time pressure in service execution; difficult to manage service demands, waiting time, right-time service.	Fixing service systems to adjust capacity.	Berry (1980); Lovelock et al. (2011); Zeithaml (1985); Zeithaml & Bitner (2009).
Customer participation Services require co-production from customers.	Attitude and behavior of service providers and customers hugely influence overall service quality, satisfaction or future use intentions.	Ensuring standardization in service quality in service execution.	Berry (1980); Lovelock et al. (2011); Zeithaml (1985); Zeithaml & Bitner (2009).
No ownership The ownership of services cannot be transferred.	Nothing remains after consumption; difficult to provide equal service experience; less time to evaluate quality; post-purchase dissonance	Reducing dissonance by ensuring service benefits and customer satisfaction.	Kotler & Bloom (1984); Lovelock et al. (2011); McColl-Kennedy (2003); Zeithaml & Bitner (2009).

‘Inseparability’ refers to the simultaneous production and consumption of a service. It indicates that it is very difficult to separate the service from its provider (Berry 1980; Zeithaml 1985). It also indicates that customers are expected to cooperate and coproduce the service by interacting with the provider’s equipment, facility and systems (Vargo & Lusch 2006). The degree and nature of consumers’ involvement in the service process influences service performance and the quality of the encounter (Dagger & Lawley 2003). In other words, the quality of interaction between provider and customer influences the customer’s perception of service quality and satisfaction. This feature indicates that both service providers and consumers are required to play an active role in order to enhance productivity, experience and satisfaction. This also highlights the roles of dynamic ‘front stage’ and ‘back stage’ to provide better customer experience (Sousa & Voss 2006).

‘Variability’ implies that it is difficult to maintain consistency in service outcomes (Berry 1980; Lovelock et al. 2011; Zeithaml 1987; Zeithaml & Bitner 2009). Because of the use of people in service delivery, simultaneous production and consumption and other extraneous factors, wide variation is seen in service performance. As people are involved in the service process, providers and customers with differing backgrounds make it difficult to control service quality. As such, differences in attitudes, transaction speed and quality of performance influence service interaction and sometimes lead to service failures (McColl-Kennedy 2003). Variability also indicates that the difference in provider and customer orientations in terms of personality, manner and actions leads to variation in service perceptions and evaluations. Due to service variability, it is not always possible to generate identical service outcomes each time the service is executed. Thus, it is critical to reduce variability by adopting standardized procedures at all service touch points which can be done by adopting rigorous management of all service quality dimensions.

'Perishability' indicates that services perish (McColl-Kennedy 2003). Services are ephemeral and cannot be stocked. It also suggests that services cannot be returned once they have been purchased. It is important to manage demand levels by matching service capacity (Zeithaml & Bitner 2009). It is also critical to manage demand and supply at a particular time to satisfy service needs. Thus, in case of no demand, service is wasted and, in case of over demand, customers have to wait. Service providers face major challenges when there is variation in demand. Thus, a critical task is to manage demand levels according to available resources. In addition to these basic characteristics of services, the role of the customer in production and delivery influences service performance (Berry 1980). Since service is an exchange process, the quality of customers' input influences service outcomes (Zeithaml et al. 2004). To improve the quality of input, customers should be provided with proper knowledge about the service process using communication channels. For high involvement services, such as in health care, it is often important to train customers to provide quality input for a better service outcome (Dagger & Lawley 2003; Lovelock et al. 2011; Zeithaml & Bitner 2009). Furthermore, as the exchange process in service does not transfer any ownership to customers, customer experience makes a real difference in service perception. This characteristic indicates the challenge of effectively reducing 'customer dissonance' to manage a long-term relationship. Overall, the basic characteristics of services indicate that service evaluations are highly subjective and context-specific (Brady & Cronin 2001).

2.3 The Nature and Characteristics of Health Services

Health care is one of the fastest growing sectors in the services economy (Berry & Bendapudi 2007) because of the ageing population, mounting competitive pressures (Abramowitz et al. 1987), increasing consumerism, and emerging treatment and technologies (Ludwig et al. 1993; Dagger et al. 2007; O'Connor et al. 2000). Health care has a pervasive and intensive impact on the economies and the quality of daily life (Berry & Bendapudi 2007).

The service literature shows wide variation in exploring the nature of health services in terms of its characteristics, contexts, process and interaction (Lovelock et al. 2011; Zeithaml & Bitner 2009). Although service characteristics (e.g., intangibility, inseparability, perishability and variability) receive overwhelming attention in characterizing the nature of health services (Shostack 1977; Zeithaml 1981, 1983), some other factors (e.g., people-based, equipment-based) also play an important role in defining these services. Overall, the service classification scheme provides an important insight in understanding the nature of different services.

Table 2.2 synthesizes the service classification scheme proposed in the literature. This scheme offers a critical insight regarding the nature of health services and its strategic implications. For example, health care is predominantly categorized as a high contact service (Kotler 1981; Kotler & Keller 2006) which is provided by people (Lovelock & Yip 1996), dependent on experience properties (Zeithaml 1981; Zeithaml & Bitner 2009) and the value is added by interaction (Booms & Bitner 1981; Kotler & Keller 2006). Some scholars highlight that health services are dependent on a high degree of interaction (e.g., Schmenner 1986; Dagger et al. 2007) and a large number of consumers use these services (Andaleeb 2001, 2008; Silvestro et al. 1992). According to Berry and Bendapudi (2007, p. 113), “[h]ealth care services are both labor and skill intensive, contributing to considerable variability in performance from one clinician to another. The variability is not just in the service style and communication skills of clinicians but also in their technical skills”. The authors also note that health services share common characteristics with other services. For example, health services are ‘intangible’ as the core benefits depend on their performance, ‘inseparable’ as they are always centered on people and ‘perishable’ as the providers create value through timely medical solutions. Some scholars identified a health service as a ‘credence service’ as it is difficult to judge its performance even after consumption (e.g., Berry & Bendaupudi 2007; Dagger et al. 2007; Zeithaml 1981). Overall, these characteristics indicate that it is necessary to evaluate the performance of any health service using patients’ perceptions (Andaleeb 2001; Dagger et al. 2007). According to Sofaer and Firminger (2005, p. 516) “… [p]atient perceptions of quality are inherently meaningful and should be a primary focus of attention within the health care system … patient perceptions because they are powerful drivers of outcomes important to various other stakeholders”. The authors also note that it becomes important to conceptualize patient perceptions of health service quality and uncover what drives those perceptions.

As the study focuses on an innovative health care paradigm, the understanding of patients’ perceptions regarding the nature and characteristics of this service is critical because patients still have fairly inchoate and pliable notions about this service. Thus, before understanding the nature of mHealth service in the next section, Table 2.2 presents a service classification scheme based on the extant literature to distinguish the nature of health service from other services.

Table 2.2 Nature of health services in service classification scheme

Author	Proposed Classification	Comments on Health Service
Shostack (1977)	Tangibility vs. intangibility	Health care is a highly intangible service.
Sasser et al. (1978)	Pure good vs. pure service	Health care is a pure service.
Thomas (1978)	Primarily equipment-based: automated, monitored by unskilled operator, monitored by skilled operator	Traditional health services are people-based (skilled); however, mHealth services are technology-based.
Chase (1978)	Primarily people-based: unskilled labour, skilled labour, professional staff	Health services are delivered by professional staff.
Zeithaml (1981)	Search vs. experience vs. credence	Health services are based on credence properties, that is, it is harder to assess its quality even after consumption.
Kotler (1980)	High contact vs. low contact	Health services are high-contact services, therefore, consumer input influences service quality.
Lovelock (1983)	The nature of the service act (tangible vs. intangible); relationship with customers (continuous, discrete, membership, no formal relationships); customization and judgment in service delivery; nature of demand in relation to supply; methods of service delivery (single or multi-site, provider's or customer's premises)	Generally, health services are intangible and highly customized. mHealth or eHealth services are ubiquitous.
Schmenner (1986)	Degree of interaction and customization (high vs. low), degree of labour intensity (high vs. low)	Health services depend on higher degrees of interaction.
Silvestro et al. (1992)	Volume of customers: high volume, medium volume, low volume	Health services are consumed by a large number of customers.
Booms & Bitner (1981)	Self service, interpersonal service, remote services	For health services over electronic platform, front office and back office influence quality.
Lovelock & Yip (1996)	People processing services, possession processing services, information processing services	Health services are typically people processing services.
Berry & Bendapudi (2007)	Intangibility, inseparability, perishability, variability	Health services are labour and skill intensive.

2.4 The Nature and Characteristics of mHealth Services

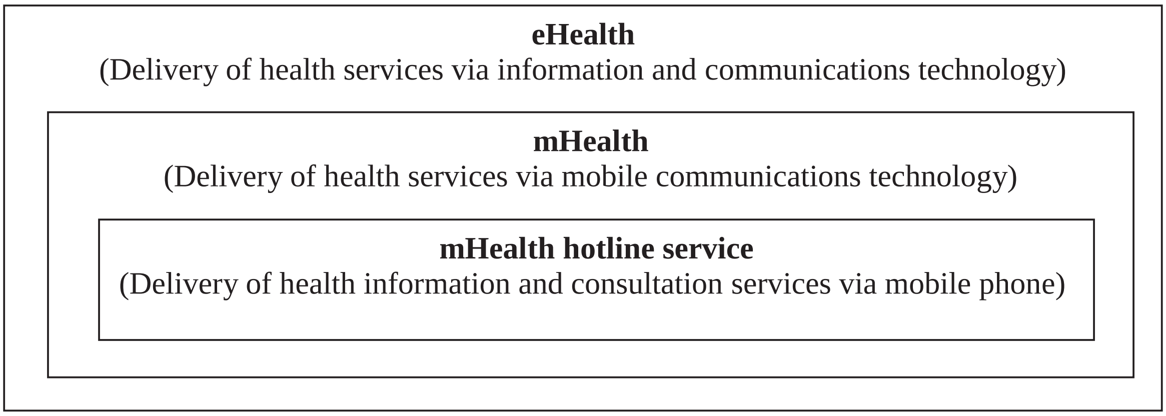
2.4.1 Defining mHealth Services

mHealth has been broadly understood as health service delivery over a mobile or wireless platform (Istepanian 2004). This early definition of mHealth has been extending since its inception due to the massive uptake of mobile communications, dramatic growth in the use of mobile handsets and greater penetration of mobile services throughout the world (Akter & Ray 2010). The extant literature defines mHealth as a subset of eHealth which delivers health services over a mobile platform (Mechael 2009). Whereas eHealth is defined as the embryonic convergence of wide-reaching technologies like the Internet, computer telephony/interactive voice response, wireless communications, direct access to health care providers, care management, education and wellness (DeLuca & Enmark 2000), mHealth is defined as using mobile communications—such as PDAs and mobile phones—for health services and information (see Figure 2.1). Broadly, mHealth is defined as the use of portable devices with the capability to create, store, retrieve and transmit data in real time between end-users for the purpose of improving patient safety and quality of care (Vital Wave Consulting 2008). These definitions of mHealth have predominantly emphasized 'wireless communication' to provide health care solutions (Vital Wave Consulting 2008). Highlighting the importance of wireless communication devices to support public health and clinical practice, Kahn et al. (2010) define mHealth as the use of portable electronic devices for mobile voice and data communication over a cellular or other wireless network of base stations to provide health information.

It is worth noting that there is a clear difference between mHealth and telemedicine. According to a recent report by WHO and Vodafone (2012, p. 7), mHealth is “a sub-set of eHealth relating to the application of mobile communications and network technologies for healthcare, to optimise the efficiencies of health organisations’ internal processes and enhance the delivery of healthcare” whereas **telemedicine is** “a sub-set of telehealth relating to the use of telecommunications supported by ICT to link clinicians to patients for diagnosis and treatment”. In the context of mHealth, the delivery of health services is provided at anytime and any place over a mobile platform using cellular networks (e.g., mobile phone) whereas in the case of telemedicine, the health services are predominantly provided over general telephones from a fixed location and at a fixed time. As such, WHO (2011, p. 34) points out that mHealth employs “the communication or consultation between health professionals and patients using the voice, text, data, imaging, or video functions of a mobile device”. Ivatury et al. (2009) clearly differentiated mHealth from telemedicine programs by arguing that telemedicine requires patients to visit a fixed place where the patients are connected to health care providers via video and/or voice. Thus, it is evident that mHealth is different from telemedicine as: (1) it provides medical service and information to individual patients only by mobile phone; (2) it delivers information to patients through interpersonal interaction (i.e, voice) and/or short messaging service (SMS) (i.e., data) over a mobile phone; (3) it provides any-time and anywhere services over mobile phone with the patient not needing to be present at a specific location at a specific time.

Figure 2.1 Interrelationship among eHealth, mHealth and mHealth hotline services

(Ivatury et al. 2009)



IIuyemi (cf., Vital Wave Consulting 2009) extends the mHealth definition by focusing on "any wireless technologies (e.g., Bluetooth, GSM, GPRS/3G, wiFi, WiMAX) to transmit various health-related data contents and services through mobile devices such as mobile phones, smart phones, PDAs, laptops and Tablet PCs." However, this definition has targeted only health workers as the sole users of mobile health services, but there are some popular mHealth services around the world which include both patients and health workers as users, such as mHealth hotline services or mobile telemedicine services in India (HMRI), Mexico (MedicallHome), Pakistan (Teledoctor) and Bangladesh (Healthline) (Ivatury et al. 2009). Thus, focusing on mobile health hotline services, this study defines mHealth as a personalized and interactive health service where the main goal is to provide ubiquitous and universal access to medical advice and information to any user at any time over mobile phone (Ivatury et al. 2009). Overall, an assessment of various definitions (see Table 2.3) synthesizes that mHealth is all about delivering health services and information over a mobile platform.

Although the extant literature identifies mHealth as a subset of eHealth, some scholars specify that mHealth is a separate development (Akter & Ray 2010; Mechael 2009). They suggest that a mobile platform is the newest mass media based on some unique attributes (e.g., ubiquity, instant connectivity, convenience, personalization and timeliness) which can be leveraged to empower patients and health care service delivery. Some also refer to it as a pervasive health care paradigm to provide right-time health services to anyone by removing locational, time and other restraints while increasing both the coverage and quality of health care (Varshney 2005). In a recent study, Earth Institute (2010) identifies mHealth as a new health care paradigm which is transforming health systems by increasing access, reducing costs, providing more timely and accessible information, and promoting consumer-centered health care and well-being. In another recent study, WHO (2011) defines mHealth as the use of mobile phone and its different functionalities (e.g., voice, SMS, GPRS, GPS, Bluetooth and other emerging technologies) for providing various health care solutions.

Overall, the development of this ubiquitous health care platform is largely considered as a paradigm shift to improve health care around the developing world. It is widely believed that mHealth alone has all the potential to automate and speed up health care delivery processes, reduce costs, facilitate service delivery, relate more closely to patients and offer them more convenience and appeal through this new service (Kahn et al. 2010; Earth Institute 2010; Vital Wave Consulting 2009; WHO 2011).

Table 2.3 An evaluation of mHealth definitions

Study	Definitions	Focus
Istepanian et al. (2004)	mHealth refers to the emerging mobile communications and network technologies for health care.	Any wireless technology-based health services
Varshney (2005)	It as a pervasive health care paradigm to provide right-time health services to anyone by removing locational, time and other restraints while increasing both the coverage and quality of health care.	Using wireless technology to provide pervasive health care solutions
Bardram et al. (2007)	It refers to the application of embedded wireless devices to track health-related parameters.	Health services using wireless devices
Mechael (2009)	It is a subset of eHealth using mobile devices to deliver health services to patients.	Health services based on mobile phones and PDAs
Vital Wave Consulting (2008)	mHealth typically refers to the use of portable devices with the capability to create, store, retrieve and transmit data in real time between end-users for the purpose of improving patient safety and quality of care.	Health services based on mobile devices
Vital Wave Consulting (2009)	It is defined as using mobile communications—such as PDAs and mobile phones—for health services and information.	Mobile phone-based health care solutions
IIuyemi (cf., 2009)	Any wireless technologies (e.g., Bluetooth, GSM, GPRS/3G, wiFi, WiMAX) to transmit various health-related data contents and services through mobile devices such as mobile phones, smart phones, PDAs, laptops and tablet PCs.	Any wireless technology-based health care solutions
Kahn et al. (2010)	mHealth is the use of portable electronic devices for mobile voice and data communication over a cellular or other wireless network of base stations to provide health information.	Wireless devices to support public health and clinical practice
Akter & Ray (2010); Akter et al. (2010a, 2010b)	It is a personalized and interactive service which provides ubiquitous and universal access to medical advice and information to any users at any time over a mobile platform.	Mobile phone-based telemedicine (or hotline) services
WHO (2011)	It involves the use and capitalization on a mobile phone’s core utility of voice and SMS as well as more complex functionalities and applications including general packet radio service (GPRS), third and fourth generation mobile telecommunications (3G and 4G systems), global positioning system (GPS) and Bluetooth technology.	A unifying definition to cover all types of mHealth services

2.4.2 Characteristics of mHealth Services

mHealth has the potential to provide numerous health care solutions. The unique characteristics of mobile devices (i.e., mobile phones) compared with other platforms have made them attractive to the health sector to provide instant service to patients (illiterate or literate) at any time and anywhere (Demiris & Hensel 2008) (see Table 2.4).

Table 2.4 An evaluation of communication channels

Features of platform	TV	Radio	Press	PC Internet	Mobile phone
Interactivity	None	None	None	High	High
Timeliness	None	Low	Average	None	High
Personalization	Low	None	Low	High	High
Context sensitivity	Low	Low	None	Low	High

Source: Adapted from Demiris & Hensel (2008)

These unique characteristics of mobile devices (i.e, mobile phones) provide values which are not available to traditional wired platforms, such as interactivity, timeliness, personalization and context sensitivity (Siau et al. 2001). Bauer et al. (2005) identified such attributes as “ideal for individualized and dialogue oriented communication” (p. 182). These attributes of m-services (e.g. mHealth) provide a competitive edge to customers in various ways (Wang et al. 2006). Firstly, a mobile service provides ubiquitous, universal and Unison accessibility (Watson et al. 2002). These attributes make it possible for a mobile phone to provide services on an ‘any-time’ and ‘anywhere’ basis (Varshney 2003). According to Sirkeci and Mannix (2010, p. 96) “individuals with their personal mobile devices can be reached virtually anywhere and everywhere". This is possible as the subscriber identity module (SIM) is embedded in all mobile phones that allows exact identification of the users (Bauer et al. 2005). Such technological opportunities help a wireless platform to provide ubiquitous service value (Pura 2002; Scharl et al. 2005; Gressgard & Stensaker 2006). Secondly, mobile phones are capable of providing personalized solutions because they carry users' identities. Through personalization, the information is customized for the receiver to add individualized value (Barnes & Scornavacca 2004). Using this attribute of the mobile phone, service providers address the specific needs of a person capitalizing context, personal characteristics and location (Barnes 2002, 2003; Barnes & Scornavacca 2004; Jelassi & Enders 2005; Sirkeci & Mannix 2010). Thirdly, a mobile service provides right-time information which is also known as immediacy (Barwise & Strong 2002). In this regard, Pousttchi and Widemann (2010, p. 3) state that " one of the particularities of mobile technology is that consumer's location can be used to deliver relevant, targeted and timely information exploiting this physical context". Fourthly, the mobile phone provides context-specific information which is known as location-based services based on global positioning systems (GPS) and cell of origin technology (COO) (Dey 2001; Barnes 2003). These location-based services are identified as "killer applications" of mobile services (Kolmel 2003, cited in Bauer et al. 2005) in order to provide customized solutions (Barnes 2003; Yuan & Tsao 2003). Finally, the mobile phone provides interactive services which play a critical role in value co-creation through long-term and more intense interaction (Barnes 2003; Dourish 2004; Jelassi & Enders 2005). According to Kotler and Keller (2008, p. 477) "consumers and business people no longer need to be near a computer to send and receive information". This statement is supported by Bauer et al. (2005, p. 182) who state that the "mobile phone is a highly interactive medium that enables the recipient of a message to reply to it immediately. Interactive media exhibit a bidirectional mode of communication enabling the recipient to affect the communication process actively". Thus, mobile phones have superseded other media by taking the place of interactive and quick communication (Sirkeci & Mannix 2010). Table 2.5 synthesizes all the unique attributes of mobile services that facilitate the mobile business in an unprecedented manner.

Table 2.5 Unique attributes of mobile services

Attributes of mobile service	**Implications**	**References**
Accessibility	Mobile service provides ubiquitous, universal and Unison accessibility for any-time anywhere solutions.	Bauer et al. (2005); Scharl et al. (2005); Sirkeci & Mannix (2010); Watson et al. (2002); Varshney (2003); Pura (2002)
Personalized solutions	Individualized solutions to address the specific needs of a specific person based on profile, interests and hobbies.	Barnes (2002); Barnes & Scornavacca (2004); Jelassi & Enders (2005); Sirkeci & Mannix (2010).
Immediacy	Right-time services focusing on relevant, targeted and timely information.	Barwise & Strong (2002); Barnes & Scornavacca (2004); Pousttchi & Widemann (2010)
Location-based information	Context-specific information services global positioning systems (GPS) and cell of origin technology (COO).	Dey (2001); Barnes (2003); Yuan & Tsao (2003)
Interactivity	Service value co-creation through long-term and more intense two-way interaction.	Barnes (2003); Dourish (2004); Jelassi & Enders (2005); Kotler & Keller (2008); Sirkeci & Mannix (2010)
Mobility (Temporal-spatial-contextual needs)	Mobile service serves the needs for temporal, spatial and contextual mobility.	Kakihara & Sorensen (2001); Chatterjee et al. (2009)

In addition to the abovementioned characteristics, the extant literature highlights the role of the mobile phone in serving three different types of mobility (Table 2.5): temporal, spatial and contextual (Kakihara & Sorensen 2001; Chatterjee et al. 2009). The authors defined concept mobility as "humans' independency from geographical constraints," performing communication using interactive processes (Kakihara & Sorensen 2001, p. 1). The study also specified three different types of mobility in which the mobile phone can play a critical role. For example, firstly, the mobile phone serves “human geographical movement or nomadicity” under spatial mobility (Kakihara & Sorensen 2001, p. 2). In this case, mobile phone-based health information systems allow physicians or patients access to medical information irrespective of the physical location (Chatterjee et al. 2009; Lyytinen & Yoo 2002). Secondly, temporal mobility refers to the “temporal order of the workplace” (Kakihara & Sorensen 2001, p. 3) and reflects both the “pace of work” and time (cf. Chatterjee et al. 2009). For example, in the health care context, both patients and physicians experience such mobility to a greater degree, which requires both of these groups to rely on mobile technologies to participate in diagnosis-treatment and execute medical emergencies. This particular mobility enables a mobile device to access medical information and services anywhere at any-time to address time-critical needs (Chatterjee et al. 2009). Finally, contextual mobility refers to the context of human action which is based on the belief that performance of an action is shaped by the elements of a particular context (Kakihara & Sorensen 2001). This mobility addresses the questions “in what way” and “in what particular circumstances” (Kakihara & Sorensen 2001, p. 4). Thus, the needs of contextual mobility can be addressed by a mobile phone by reshaping interactions on a continuous basis. For example, a patient in a remote community can access mobile phone-based health hotline services irrespective of the distance, time and location. Overall, mobile phone-based services have transformed our lives due to their accessibility, personalized solutions, location-based information, interactivity and mobility. According to Scornavacca (2006, p. 3), “[d]riven by the penetration of mobile phones and related devices, mobile applications became especially valued in an age where time is precious and the weight attached to convenience is high”.

Inspired by the tremendous growth and impact of mobile phone-based services in developing countries, global health policy-makers and providers are embracing mHealth as a new weapon to fight against the global health crisis by connecting the unconnected (Vital Wave Consulting 2008). Throughout the mHealth initiatives around the world, it is quite evident that mobile communications have the potential to radically transform health care services "even in some of the most remote and resource poor environments" (Vital Wave Consulting 2009). And it is well accepted that this health service system provides new patterns for health care by making resources available to health care professionals and users with an efficient, secure, ubiquitous and robust infrastructure coupled with right-time assessment and management of health care with preventive programs (Istepanian et al. 2004). With massive penetration of mobile phone networks globally and the availability of low-cost smart phones, the majority of the global population (more than five billion) who never had access to fixed-line telephones or computer networks now use mobile platforms for communication: this ubiquity of mobile phones is a central element in the promise of mobile technologies for health (Akter & Ray 2010). According to Patrick et al. (2008, p. 178), "[a]dvances in the technologies that underlie mobile phones are enabling them to become better, faster, and less expensive … the technologies that underlie mobile phones are becoming more powerful and cheaper, and evidence is beginning to emerge about the value of mobile phones for the delivery of healthcare services and the promotion of personal health". Overall, mHealth stands out as a dynamic health service platform because of its cost-effectiveness, convenience, scalability and broad reach.

2.4.3 Types of mHealth Services

mHealth is a dynamic health care paradigm whose applications are constantly expanding. The extant literature elucidates mHealth solutions in some major areas including diagnostic and treatment support services, health education and awareness, data collection and disease surveillance services, health information systems and point of care services, and emergency medical services (Earth Institute 2010; Vital Wave Consulting 2009). This section briefly synthesizes mHealth solutions in the abovementioned areas. Table 2.6 presents a snapshot of such services and their corresponding challenges.

In the '*diagnostic and treatment support service*', the mobile phone is used by health professionals as a point of care platform to save patients' travel time and costs and, therefore, to increase access to basic health care. Specifically, mHealth solutions in this area provide right-time diagnosis and treatment advice to remote health care workers and patients through health professionals or a health information database. Major applications of mHealth under this category include mHealth telemedicine or mHealth hotline services, SMS applications to remind patients to take drugs and attend appointments, infectious disease drug adherence and chronic disease management services (Earth Institute 2010). The mHealth telemedicine or mHealth hotline model is now serving more than 10 million customers with reliable and supportive medical advice (Ivatury et al. 2009).

Table 2.6 Types of mHealth services and IS challenges

Types	Examples	IS Challenges
Diagnostic and treatment support service	Medical consultation services using voice Chronic disease management using SMS (e.g., blood sugar report for diagnosing diabetes) Infectious disease management using SMS and hotline	Systems quality (e.g., availability, accessibility, privacy); interaction quality (e.g., responsiveness, reliability); information quality (e.g., accuracy, comprehensiveness)
Health education and awareness service	Use of SMS to distribute health information Use of games and quizzes to educate and make patients aware	Reliability of information Context and cultural challenges Language and literacy challenges Security challenges as mobile devices are shared
Data collection and disease surveillance service	Use of SMS, voice and electronic forms Use of SMS to remind patients for drug adherence	Privacy and security of data Rights to data and usage Data management and sharing
Health information systems (HIS) and point of care service	Mobile phone-based HIS to share data at all levels Using mobile devices at point of care to collect, report and share information at all levels	Resistance to technology; cost and infrastructure; local ICT needs and its integration; interoperability of information systems
Emergency medical service	Emergency medical response using FrontlineSMS Disease and epidemic outbreaks tracking using using FrontlineSMS Disaster management and recovery using SMS	Capacity of mobile networks; nature and sensitivity of emergencies; user-friendly devices

Sources: Adapted from Ivatury et al. (2009), Earth Institute (2010)

In the *‘health education and awareness service’*, mobile phone-based short sessage service (SMS) is widely used to provide outreach services for a range of health issues (Holtz & Whitten 2009). SMS is an efficient, scalable and cost-effective method to provide health information on treatment, diagnosis, disease management and the availability of health services. This particular mHealth application has proven very useful for rural areas and hard-to-reach target populations (e.g., HIV/TB patients). This method includes alerts, interactive tools, games or quizzes to provide critical information on health issues. For instance, SMS campaigns which provide information on reproductive health, communicable disease (TB/HIV) and health care facilities have been quite popular in developing countries (Earth Institute 2010).

In the *'data collection and disease surveillance service'*, a mobile phone-based data collection process using SMS, voice and electronic forms is replacing the traditional paper and pen method in order to reduce errors, time and costs (Anantraman et al. 2002; Blaya et al. 2009; Buck et al. 2005; Forster et al. 1991). It is crucial to ensure data accuracy in order to assess the existing policies and programs and present new ones. In this case, a mobile phone (or PDA)-based data collection process is convenient, cost-effective and reliable because data can be collected, updated and accessed in real time (Galliher et al. 2008; Safaie et al. 2006; Yu et al. 2009). Such an mHealth application presents an exciting opportunity to integrate data on diagnosis, treatment and surveillance. In developing countries, data collection under an mHealth program has proven to be very fruitful for people in remote communities who rarely visit health care settings. One study in Fiji showed that mobile phone-based data collection reduced 93.26% of the time for data entry, validation and cleaning and 62% of users perceived that the method was faster (Yu et al. 2009). In addition to data collection, the *'disease surveillance service'* is one of the significant applications of mHealth for diagnosing and treating patients in external settings. It is an important application in resource-poor settings where health care facilities are limited; for instance, remote monitoring ensured 90% medication compliance in Thailand where TB patients were provided with mobile phones so that community health workers could remind them to take their medicines. In addition, remote monitoring of chronic patients dramatically increases survival rates. Both in developed and developing countries, this particular mHealth service has improved health outcomes for patients with chronic and communicable diseases.

In ‘*health information systems and point of care service’*, mHealth can play a crucial role in improving access to information. Using mobile devices at the point of care, health professionals and community health workers (CHWs) can provide better medical solutions in terms of accuracy of diagnosis and treatment. Real-time data collection, reporting and use of information via mobile technology can enable decision support systems to improve the quality of care. CHWs can also link current patient information with historical information to reach a better decision. A study of 463 health professionals in Colombia showed that more than 60% of the physicians owned mobile phones and were interested in using this communication device for education and information (Valenzuela et al. 2009). In another study, Prgomet et al. (2009) found that PDAs had a positive impact on patient care and work facilitation in a hospital. Studies also confirmed the benefits of mobile phones for coordination and consultation among health care workers and between health care workers and patients to provide timely health care delivery (Mechael 2006, 2009; Scott et al. 2005). However, to leverage the full potential of the mobile platform for medical solutions, the platform’s perceived ease of use, usefulness, portability, task structure and task-technology fit should be considered (Tariq & Akter 2011) because such characteristics influence users’ overall satisfaction, value and future behavioral intentions (Chatterjee et al. 2009). Some scholars have expressed their concern with regard to data security and privacy of mobile phone-based health information systems (Patrick et al. 2008).

For the *'emergency medical service'*, mHealth applications have proven to be very useful for accessing emergency medical response to track outbreaks and manage natural disasters. Mobile phones have been useful in coordinating emergency support and improving response times to emergencies (Earth Institute 2010). Studies confirmed the applications of mobile SMS (short message service) and MMS (multimedia message service) to facilitate emergency consultation at low cost (Hsieh et al. 2004; Syed et al. 2007; Tsai et al. 2004; Yamada et al. 2003). In addition, the mobile phone is being used to track disease and epidemic outbreaks in India, Peru and Rwanda (Vital Wave Consulting 2009). The adoption of mobile systems for tracking outbreaks has significantly lowered costs and improved the data quality of the previous systems based on paper and pen, radio and satellite communication (Li et al. 2010). Studies also confirm the use of mobile technology to manage rescue missions and to provide food, health and shelter during natural disasters such as Hurricane Katrina, the earthquake in Haiti and the Indian Ocean tsunami (e.g., Akter & Ray 2010; Mechael 2009).

2.5 mHealth Services in Developing Countries

"Services are failing because ... they are inaccessible and prohibitively expensive. But even when accessible, they are often dysfunctional, extremely low in technical quality, and unresponsive to the needs of a diverse clientele."

The above quote by the World Bank (2004) indicates the depressing condition of health services in developing countries. Table 2.7 outlines the dire situation of primary health care in developing countries in comparison with developed countries (Ivatury et al. 2009). In addition to this, the UN report (2008) on MDGs (Millennium Development Goals) presents a formidable picture showing that there were an estimated 2.5 million newly-infected HIV users in 2007 and that communicable diseases (tuberculosis, malaria, etc.) continue to claim lives due to lack of knowledge or access to medication. According to WHO (2006), '57 countries have critical shortages in health care workers, with a total deficit of 2.4 million health professionals worldwide'.

Table 2.7 Primary health care indicators in developed and developing countries

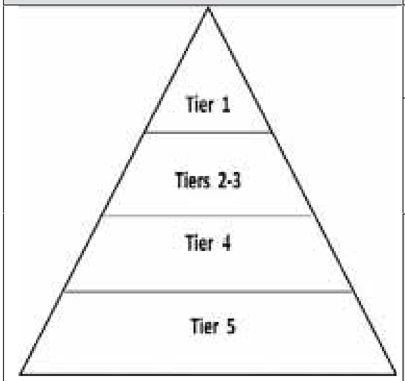
Countries	Infant mortality rate (Per 1000) (2006)	Maternal mortality (Per 100,000) (2005)	Years of life lost due to communicable disease (%) (2002)	Births attended by skilled health personnel (%)	Hospital beds (per 10,000)	Total health workers (per 10,000)
India	57	450	58	47 (2006)	9 (2003)	14 (2003)
Mexico	22	63	27	83 (2005)	11 (2002)	28 (2001)
Pakistan	78	320	70	54 (2006)	12 (2005)	12 (2003)
Bangladesh	52	570	60	20 (2006)	3 (2001)	5 (2001)
USA	5	8	10	100 (2004)	32 (2005)	125 (1999)
UK	7	11	9	99 (1998)	39 (2004)	75 (2001)

Source: Adapted from Ivatury et al. (2009)

Within this context, mHealth has emerged as a viable solution to serve the pressing health care needs through its high-reach and low-cost mechanism by making health care more accessible, affordable and effective across the developing world (Vital Wave Consulting 2008). According to Curioso and Mechael (2010, p. 264), "[p]articularly in developing countries, mHealth offers a great opportunity to strengthen and transform weak health systems and combat everything from maternal and child illness and mortality to chronic and infectious diseases". mHealth is seen as an enabler of change in the health care sector. For many years, the mobile phone was not considered a powerful tool to reduce the digital divide in health, but the dramatic penetration rate of mobile phones in low- and middle-income countries over the last decade has increased the potential of mHealth services (Mechael 2008). There are now more than 5.3 billion mobile subscribers in the world, of whom 3.5 billion who come from the developing world can easily access mobile health services (Ranck 2011). According to WHO (2011), “[t]he majority of Member States (83%) reported offering at least one type of mHealth service. However, many countries offered four to six programs. The four most frequently reported mHealth initiatives were: health call centres (59%), emergency toll-free telephone services (55%), managing emergencies and disasters (54%), and mobile telemedicine (49%)”.

In terms of wealth distribution and income generation, the world can be framed in the form of an economic pyramid, in which the top represents two billion people with high levels of income (i.e., developed countries) and the bottom of the pyramid (or developing countries) represents more than four billion people who live on less than $2 per day (Prahalad 2004; Prahalad & Hammond 2002; Prahalad & Hart 2002) (see Table 2.8). A recent study shows that the total bottom of the pyramid (BOP) spending on health care and ICT is $158.4 billion and $51.4 billion respectively (Hammond et al. 2007). Thus, serving these low- and middle-income countries with digital health services and recognizing these people as value-conscious consumers have created a whole new world of opportunity (Prahalad 2004). To capitalize this untapped opportunity in the developing regions, ICT-driven health care innovation has taken place to pursue sustainable growth while playing a catalytic role in serving the health care needs of the world’s poorest populations. Consequently, B2C mHealth has emerged as a viable solution to serve the pressing health care needs through its high-reach and low-cost mechanism. It has made health care more accessible, affordable and effective across the developing world (Vital Wave Consulting 2008).

Table 2.8 Income, technology and health-related statistics for developing countries

Global Economic Pyramid	Purchasing power ($)	Population (million)	Nature of ICT markets	Mobile phone penetration (million)	Health care (per 10,000)
	> 20000	75-100	High income markets	1800	Hospital beds = 35, health workers = 100 (approx.)
	1500 > 20000	1500-1750			
	1500	> 4000	Low income markets or BOP markets	3500	Hospital beds = 7, health workers = 15 (approx.)

Sources: Prahalad (2004), Vital Wave Consulting (2009)

Table 2.8 also shows that for every 10,000 people in the developing world, there are only seven hospital beds and 15 health professionals, but the majority of these populations own mobile phones which indicates that this tiny interactive platform has higher access than other media and is capable of serving the unserved health needs of the users (Vital Wave Consulting 2009). Therefore, it is critical to leverage the growing connectivity of this communication platform to meet and overcome these formidable health challenges (Ranck 2011).

The dramatic penetration of mobile phones in developing countries over the last decade has increased the potential of mHealth services around the world (Mechael 2009; Prahalad 2004). At present, more than 70% of the population in developing countries has access to a mobile phone which is driven largely by the rapid penetration of mobile technology in these regions (Ranck 2011). This “majority world” is becoming increasingly interconnected and can easily be served by current and emerging mHealth services. In this context, Barrett (2008), Chairman of Intel, comments that this technology-mediated service can reduce the gap between the haves and havenots and reduce the potential for further isolation, desperation and instability in countries and groups of our population who deserve a better fate.

A growing number of countries around the developing world are using mobile technology to address health needs because of its dynamic applications and time-befitting services which include treatment support services, health education and awareness, data collection and remote monitoring services, health information systems and point of care services, and emergency medical services (Akter & Ray 2010). A recent study of the United Nations Foundation and Vodafone Foundation (Vital Wave Consulting 2009) shows that 51 mHealth programs are operating in 26 developing countries around the world. These programs are gaining momentum and necessitate immediate impact evaluation studies to advance knowledge in this field. Different types of mHealth services are in practice: these include text (SMS) and video content and voice (medical call centres) services. In Table 2.9, this study presents a brief summary of mHealth applications in developing countries in the light of the five types of mHealth services already identified in the previous section.

Table 2.9 mHealth services around the developing world

Type	Project Name	Applications	Solution areas	Countries
Diagnostic and treatment support service	Grameen Healthline	Voice	Primary health care	Bangladesh
	HMRI	Voice	Primary health care	India
	Teledoctor	Voice	Primary health care	Pakistan
	RICE	Voice	Primary health care	Vietnam
	M-DOK	SMS	Primary health care	Philippines
	MedicallHome	Voice	Primary health care	Mexico
Health education and awareness service	Freedom HIV/AIDS	Mobile games	HIV/AIDS	India
	Learning about Living	Interactive e-learning	HIV/AIDS	Nigeria
	Project Masiluleke	SMS/Voice	HIV/AIDS	South Africa
	Text to Change	SMS	HIV/AIDS	Uganda
Data collection	EpiSurveyor	Health survey	HIV/AIDS	Kenya, Uganda, Zambia (+ 20 countries in Sub-Saharan Africa)
	Epihandy	Health survey	HIV/AIDS	Uganda, Zambia
	Cell-PREVEN	SMS/Voice	Primary health care	Peru
	CHITs	SMS	Primary health care	Philippines
	The Dokoza system	SMS	HIV/AIDS, TB	South Africa
	IHISM	SMS	HIV/AIDS	Botswana
	Phones for Health	Health survey	HIV/AIDS	Rwanda
	Nokia data gathering	Health survey	Disease incidence data	Brazil
Disease surveillance service	The Cell-Life project	SMS	HIV/AIDS	South Africa
	Medinet	SMS/Voice	Diabetes, heart disease	Trinidad & Tobago
	MCST	Access to data	HIV/AIDS	India
	Phoned pill reminder	Voice	TB	Thailand
	SIMpill	SMS/Voice	TB	Thailand
	Virtual Health pet	SMS	HIV/AIDS	Brazil
	Mashavu	Health survey	Primary health care	Tanzania
Health information systems and point of care	ENACQKT	Mobile instruction	Professional development of nurses	The Caribbean
	Mobile HIV support	Access to data	Information support to health workers	Uganda
	Nursing promotion	Mobile instruction	Virtual nursing program	Guatemala
	UHIN	Access to data	Health care planning, resource allocation	Uganda
Emergency medical service	Frontline SMS	SMS	Any outbreak tracking	Worldwide
	UHIN	Health survey	HIV/AIDS	Uganda
	AESSIMS	SMS/Voice	Japanese encephalitis	India
	Alerta DISAMAR	SMS/Voice	Disease incidence data	Peru
	Health Watch	Health survey	Disease incidence data	India
	GATHER	Health survey	HIV/AIDS	Uganda

Sources: Earth Institute (2010), Ivatury et al. (2009), Vital Wave Consulting (2009)

In developing countries, the most popular mHealth service is currently the *'diagnostic and treatment support service'* (Earth Institute 2010; WHO 2011) which allows patients access to a health service for medical advice and consultation at any time over a mobile phone. According to Ivatury et al. (2009), "[h]ealth hotlines are medical call centers that provide health-related information, advice, referrals, and sometimes prescriptions to individual callers over a phone line. Callers are connected to health professionals (nurses, paramedics or physicians) who usually follow standard protocols to assess medical situations and provide information and advice". They also report that four health hotlines, that is, Healthline in Bangladesh, HMRI in India, Teledoctor in Pakistan and Medicallhome in Mexico, are serving more than 10 million people in developing countries. These services are transforming the health care situation in developing countries by serving unserved people who had inadequate access to medical care at an affordable cost (see Exhibit 2.1). However, the major challenges of this service are its quality in terms of platform, patient-physician interaction, service benefits and patient satisfaction (Chatterjee et al. 2009).

Under the *'health education and awareness service'*, mHealth is being used for preventing HIV/AIDS, other sexually-transmitted diseases, TB, diabetes and heart disease in South Africa, Tanzania, Uganda, India and Philippines (Earth Institute 2010). Specifically, mHealth has been applied for smoking cessation (Lazev et al. 2004); health care provision and disease management support (Krishna 2009); text messages to patients for healthy eating and regular exercise (Winchester 2009); managing HIV conditions in Tanzania (Roura et al. 2009); text messages to patients on diabetes, H1N1 influenza, maternal health and human reproduction in India (Dolan 2010); and text messages for prenatal support in Thailand (Jareethum et al. 2008). In Uganda, a local mobile phone company in collaboration with AIC (AIDS Information Centre) provides bulk SMS messages to clients to provide education on AIDS (Vital Wave Consulting 2009). The aim of the program is to raise awareness about AIDS through voluntary counseling and HIV testing (see Exhibit 2.2). Such services are also available in Nigeria in which the project named *'Learning about Living'* raises awareness on AIDS through text messaging. In Georgia, the awareness program was conducted using mobile video content and in India, it is done through mobile game services (Vital Wave Consulting 2009). However, the major barriers of this service revolve around service interaction (Tolly & Alexander 2010), contextual factors (Roura et al. 2009) and information systems (Chatterjee et al. 2009).

The *'data collection and disease surveillance service'* is another very popular application in developing countries (Exhibit 2.3). The extant literature on mobile technologies confirms the superior benefits of mobile devices (i.e., mobile phone, PDAs and hand-held computers) in comparison with traditional paper and pen methods in terms of accuracy (Anantraman et al. 2002; Blaya et al. 2009; Forster et al. 1991; Galliher et al. 2008), reduction in time (Blaya et al. 2006; Buck et al. 2005; Escandon et al. 2008; Safaie et al. 2006), human resources (Anantraman et al. 2002), cost (Blaya et al. 2009; Yu et al. 2009), improved data quality (Anantraman et al. 2002; Galliher et al. 2008), authentication and receipt of data, less bias from interviewers and flexibility of modification (Tegang et al. 2009). Although the literature provides consistent evidence of greater benefits of mobile data collection, there are variations in systems reliability, efficiency and flexibility in terms of context and complexity of applications.

Exhibit 2.1: Diagnostic and Treatment Support Service

"……..Afiya lives in the rural Sylhet region of Bangladesh. For two days, her youngest daughter Rubina has been complaining of fatigue and has felt warm to the touch. Taking the child to the nearest clinic would cost Afiya a day's lost wages, round-trip bus fare, and clinic fees of Taka 200 (US$3). Instead, Afiya and her husband use the family's mobile phone to dial '7-8-9,' the Healthline hotline service set up by TRCL, Ltd., a telemedicine firm, and GrameenPhone, the country's largest mobile network operator. The family quickly reaches Dr. Quadri at Healthline's call centre in Dhaka. After asking a few questions, Dr. Quadri tells her to give Rubina small regular doses of paracetamol, available at neighborhood shops. For the three minute call, Afiya pays only Taka 15 (US$0.21) from her family's GrameenPhone pre-paid talk-time balance."

In Bangladesh, this mHealth (hotline) platform receives 6,000 to 10,000 calls per day. A survey of users in Bangladesh reports that by using the service, most callers save travel time (98%) and money (91%), and experience shorter waiting times (97%) and reduced doctors' fees (83%). Of calls to Healthline, 55% are from rural areas and 77% of callers are women. Of rural callers, 81% are women of whom two-thirds are calling about their children's health. Most callers' income was below the poverty line (56%), and most were located in rural areas (63%). Of those in rural areas, 72% reported not having access to a modern health care provider within a 5-mile radius of their home.

Source: Ivatury et al. (2009)

Exhibit 2.2: Health Education and Awareness Service

Project 'Text to Change' in Uganda and Project Masiluleke in South Africa use SMS message campaigns to educate and make people aware of HIV/AIDS. Project 'Text to Change' (or TTC) conducted an SMS-based multiple choice quiz program on over 15,000 mobile subscribers in a rural village to provide knowledge about HIV/AIDS and to encourage people to undergo regular check-ups and counseling. Patients who subsequently visited the health centre through TTC were provided with free testing and counseling. The program increased patients' visits to the testing centre by 40%, that is, from 1,000 to 1,400 during a six-week period. On the other hand, Project Masiluleke uses 'please call me' (or PCM) SMS messages to educate and make people aware of HIV/AIDS. Under this program, mobile phone users can send such free PCM SMS to the health care platform for free testing and counseling.

Sources: Vital Wave Consulting (2009); Ivatury et al. (2009)

Exhibit 2.3: Data Collection Service

Mobile data collection continues to be the largest concentration of mobile applications for services. In this case, EpiSurveyor of DataDyne.org pioneered an open-source application that allows community health workers (CHWs) to exchange information using smart phones. CHWs can download an electronic patient information sheet from online, fill that in with a mobile phone and send it to the computer at a central clinic for analysis in real time. The ease of use and usefulness of EpiSurveyor enable clinical teams to have accurate health statistics. In tracking the outbreak of diseases, this application plays an instrumental role in analysing bulk data immediately. For example, in Zambia the program has been used to track the immunization program and elsewhere to monitor stocks of essential drugs in a region's health clinics. CHWs prefer this program because they can do all their tasks using their own mobile phones. In Sub-Saharan Africa, CHWs at the regional office of each country are using this application, which is supported by the mHealth Alliance, established by the UN Foundation-Vodafone Foundation technology partnership. This transition towards electronic data exemplifies a leapfrog technology for developing reliable and robust electronic health records.Since EpiSurveyor is built on open-source software, it allows the project to be cost-effective, collaborative, and suitable for quick revision and adaptation. However, its operation depends on using sophisticated smart phones (e.g., Blackberry) and a stable Internet connection which are still rare in the developing world. Thus, web-independent mHealth solutions based on low-cost smart phones would be more scalable and sustainable.

Source: Adapted from Blynn (2009)

Exhibit 2.4: Disease Surveillance Service

FrontlineSMS is a free open-source software package created for non-government organizations (NGOs) in the developing world. Using only a PC and a cell phone, FrontlineSMS creates an SMS-based communication hub that can be used anywhere with cellular network coverage without requiring an Internet connection. It has been used in this way in several different locations, notably at St. Gabriel's, a rural hospital in western Malawi. The hospital serves a population of 250,000 with only two physicians: FrontlineSMS allows the hospital to respond to requests for emergency medical care, track patients, record HIV and TB drug adherence, stay updated on patient status, mobilize remote communities for outreach testing, provide instant drug dosage/usage information, and connect HIV/AIDS support group members. The whole project was extremely inexpensive; the mobile phones were recycled, the laptop was donated and the ongoing cost (of SMS messages) is less than US$10 per week. Therefore, FrontlineSMS presents a strong model for an mHealth solution based on open-source software. The sustainability of this project lies in its flexibility, low-cost applications and web-independent solutions in resource-poor settings.

Source: Li et al. (2010)

Studies have also confirmed the use of mHealth for *disease surveillance services (*see Exhibit 2.4). These services are designed for monitoring infant mortality over 20,000 households in Tanzania (Shirima et al. 2007), monitoring child and maternal health in India (Anantraman 2002), gathering data on child nutrition in Malawi (Blaschke et al. 2009) and investigating acute respiratory illness in Kenya (Diero et al. 2006). A major challenge of remote data collection and monitoring is data interoperability (Akter & Ray 2010) due to the existence of multiple health information systems in one setting. Scholars (Earth Institute 2010) suggest moving towards an open and interoperable environment with defined data standards to get rid of such difficulty in resource-poor environments. In addition to the interoperability challenge, some other challenges in this context are privacy and security of data, poor information systems and malfunctioning networks (Bernabe-Oritz et al. 2008).

Under *'health information systems and point of care services'*, mobile phones are increasingly being used to provide data and make decisions. Due to portability and perceived ease of use, there is an apparent shift from computer to mobile phone-based data entry and reporting. Furthermore, with the advent of mobile technology, there has been integration in health information systems where data is shared by both community health workers (CHWs) and clinicians. Mobile phone-based electronic medical records (EMR) are one of the primary applications to commence on mobile health information systems in order to record health history and establish a continuous relationship between patients and physicians. Mobile EMR is believed to be one of the building blocks to mHealth success assisting health professionals as a point of care support tool and to implement disease management programs. However, clinician resistance is identified as one of the major impediments of mobile health information systems implementation (Lu et al. 2005). In addition, cost (Lucas 2008, Fox-Rushby & Foord 1996, Kanter 2009), inadequate infrastructure (Kuntalp & Akar 2004), staff workload, understaffing, power shortages and network breakdowns (Mechael et al. 2010) surfaced when implementing such health information systems. Overall, mHealth platforms need to consider ease of use, portability, task-technology fit, overall quality, degree of satisfaction, behavioral intentions and quality of life in developing such systems (Chatterjee et al. 2009; Tariq & Akter 2011). However, there is a paucity of research in this particular domain which necessitates investigating the impact of mHealth in assessing work practices and outcomes (Kaplan 2006; Prgomet et al. 2009).

Exhibit 2.5: Emergency Medical Service

After the massive earthquake in Haiti, mobile phone networks were used for the rescue mission and to provide emergency medical services. As cell towers were operational, Haitians were able to send SMS/text messages to a special code '4636' to seek emergency relief. This short code was communicated over Haiti's radio stations which were largely active. Messages started flowing immediately. These messages were used by health professionals and emergency relief workers to respond more quickly and effectively and support victims with necessary food and medicine. Under most circumstances, this service helped to rescue trapped survivors from rubble who were assumed to have died from dehydration, exposure or untreated injuries. Using such mHealth solutions, the World Food Program (WFP) provided necessary relief to more than 100 million disaster-stricken people in 80 countries.

Source: Earth Institute (2010); Akter & Ray (2010)

The *'emergency medical service'* has already been proven as an exciting avenue for mHealth application (see Table 2.6). According to WHO (2011, p. 40) "[t]he use of mobile devices for emergencies was one of the most commonly reported mHealth initiatives across WHO regions. It was the most highly adopted mHealth initiative in the African Region (48%). The Regions of South-East Asia (75%) and the Americas (67%) also reported high levels of activity". VanRooyen et al. (1999) identified 15 possible applications of mHealth in emergency medical service which included real-time access to care, communication, disaster management, patient record keeping, patient transfer, transportation, public education and information, and mutual aid. In this case, subsequent studies have focused on utilizing the functions of the mobile phone ranging from the basic (e.g., voice, video, imaging, text, GPS, wireless application protocol) to the complex (e.g, wireless sensor networks) (Birati et al. 2008; Capampangan et al. 2009; Chandhanayingyong et al. 2007; Chew et al. 2006; Chien-Chih et al. 2009; De Leo et al. 2002; Hsu-Yang et al. 2005; Syed et al. 2007; Yang et al. 2008; Yang et al. 2009; Yamada et al. 2003).

mHealth solutions are also playing a critical role in disaster relief communications enabling relief workers to respond more quickly and effectively, and to support victims with necessary food and medicine. Although mHealth appears to be very promising in emergency medical services, the real challenges lie in identifying the nature of the emergency and the application of mobile technology in mitigating that emergency need (Earth Institute 2010). Also, challenges lie in developing an integrated support system which includes connecting IT systems with emergency support services (Mechael 2004, 2006). The future of implementing emergency medical services using mobile technology depends on overall platform quality (Demaerschalk et al. 2009; Handschu et al. 2003), such as, reliability and availability of mobile networks (Coyle &

Childs 2005; Jagtman 2009; Samarajiva & Waidyanatha 2009), and systems efficiency (Chandhanayingyong et al. 2007; De Leo et al. 2002; Syed et al. 2007; Yang et al. 2008). Since there are few studies investigating the direct impact of mHealth in emergency medical services, more studies are needed with robust evidence.

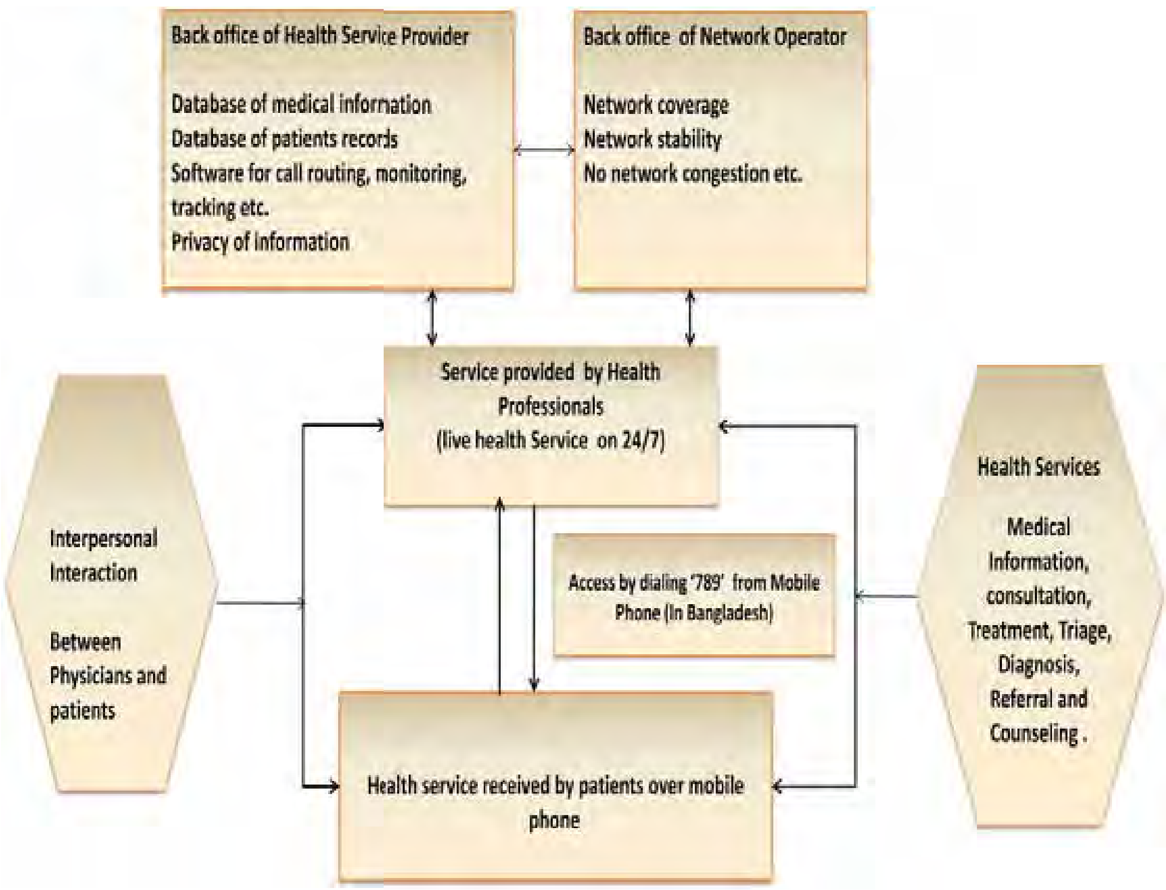
In the above sections, this study discusses the roles of mHealth in developing countries in terms of diagnostic and treatment support services, health education and awareness services, data collection services, disease surveillance services, health information systems and point of care services, and emergency medical services. A synthesis of the existing mHealth solutions reveals that service quality lies at the heart of all mHealth solutions to guarantee a high level of care for patients. According to Akter and Ray (2010, p. 79) “[i]t is also seen as the right of patients to receive quality health care, whether it is delivered face-to-face or by means of modern ICT technologies. Poor quality leads to complications and the need for additional care, which raises costs substantially”. However, there are few studies which have evaluated the quality and impact of this emerging health care paradigm in developing countries (Curioso & Mechael 2010). According to Kahn et al. (2010, p. 257), “[t]he positive potential for mHealth is huge … rigorous evaluation is essential. Evidence for the value of mHealth remains scarce, especially for the developing world”. Thus, to address this gap, this study intends to measure one of the most popular mHealth platforms, that is, mHealth (hotline) services in developing countries. The study has already categorized this particular mHealth platform as ‘diagnostic and treatment support services’. The following section explores the research setting of the study by focusing on mHealth (hotline) services.

2.6 Research Setting of the Study: mHealth (Hotline) Services

This study focuses on a specific mHealth service, that is, mHealth hotlines or mobile telemedicine services in developing countries. WHO (2011) reports this particular mHealth service as the most frequently reported (68%) and successfully implemented mHealth initiative in developing countries to provide diagnostic and treatment support. In Bangladesh, this service is only accessible by mobile phone and, thus, it is defined as a personalized and interactive health service over a mobile phone in order to provide ubiquitous and universal access to medical information services to any patient (Ivatury et al. 2009). Based on this definition, the basic characteristics of mHealth hotline services in Bangladesh are identified as: (1) providing medical service and information to individual patients only by mobile phone; (2) delivering information to patients through interpersonal interaction and SMS over a mobile phone; (3) primarily inbound services with a limited number of outbound calls and SMS to ensure follow-up or reminders; (4) any-time and anywhere services over mobile phone with the patient not needing to be present at a specific location at a specific time. Thus, this definition draws clear differences between *mobile (health) hotlines* and *other tele-health services* because in the case of an mHealth (hotline) service, users don't need to access the service at a particular location, such as a telemedicine centre, a health clinic or meeting with a health worker.

Under the mHealth hotline platform in Bangladesh (Figure 2.2), 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. Patients can receive medical information, consultation, treatment, triage, diagnosis, referral and counseling. Health professionals assess the medical situation and provide services based on standard protocols. These health hotlines are accessible to patients in remote sparsely-populated regions or low-income rural areas where there are few health care facilities or doctors. Such an mHealth platform maintains a panel of health professionals available 24/7 at the physical front office (physician's interface) which is simultaneously backed by a back office and a mobile network operator (for network management) to provide health information to users (see Figure 2.2). It has significantly facilitated information access, enhanced workflow and promoted evidence-based practice to make informed and effective decisions directly at the point of care (Andrade et al. 2003; Jen et al. 2007; Krause et al. 2004).

Figure 2.2 mHealth (hotline) service platform (adapted from Akter et al. 2010a)



This particular platform is transforming health care delivery in developing countries by providing right-time medical services in terms of medical information, consultation, triage, diagnosis, referral, treatment and counseling (see Table 2.10). The most popular mHealth hotlines or mobile telemedicine service providers are Healthline in Bangladesh, HMRI in India, Teledoctor in Pakistan and MedicallHome in Mexico. At present, these are serving millions of people in developing countries by providing right-time medical services. Citing an example from Bangladesh, WHO (2011, p. 20) states that, "[t]he hotline is managed by licensed physicians and has been designed to be accessible directly from mobile phones by dialing "789". Since November 2006, the service has received more than 3.5 million calls".

Table 2.10 mHealth hotline services in Bangladesh

Medical information	Availability and location of medical facilities, such as, specialized doctors, hospitals, clinics, laboratories or other facilities.
Triage	Assessing patients on standard protocols to determine whether they should be directed to emergency, administration or medical consultation services.
Consultation	Consulting on patients' conditions as a first touch point of care.
Diagnosis	Diagnosing health status after gathering and analysing health information.
Referral	Recommending patients for advanced treatment such as an in-person consultation with a physician at a clinic.
Treatment	Prescribing medications, prescribing care by another health provider or prescribing a plan of action for the patients based on consultation.
Counseling	Supportive and encouraging counseling to patients with specific mental or physical ailments.

In developing countries, this platform is providing low-cost medical services any time, anywhere via a mobile platform. Patients can also receive service from registered doctors rather than village quacks. This mHealth solution empowers patients with basic information on the availability and location of medical facilities and about prescription medicines. In the context of developing countries, people can save time, cost and, most importantly, can maintain privacy by consulting doctors over a mobile platform. Based on the above discussion, the study identifies the following key attributes of mHealth (hotline) services in developing countries (see Table 2.11).

Table 2.11 Characteristics of mHealth hotline services

Characteristics	**Operationalization**
Type	Diagnostic and treatment support
Services	Primary health care provided by registered health professionals
Cost	Affordable medical solutions for general population
Benefits	Database of health care facilities, professionals and standard drug information
Time	Any-time, anywhere health services over mobile phone
Process	Standardized medical solutions through quality training
Systems	Reliability of mobile networks and information services
Consumers	Patients, community health workers (CHWs) and rural clinicians
Privacy	Privacy is ensured through randomized call routing

2.6.1 Nature of mHealth (Hotline) Services

An mHealth (hotline) service involves delivering real-time *physical services* (medical consultation, medical information, triage, diagnosis, referral, treatment and counseling) over an *electronic channel* (i.e., mobile phone) (see Table 2.12). This study defines the mobile phone as the *electronic channel* or as the means of communication using advanced telecommunications, information and multimedia technologies through which a service is delivered to (or reaches) the customer (Sousa & Voss 2006). The study defines *physical service* as the customer's service experience provided with human intervention. Thus, the study frames mHealth (hotline) services as interactive services over a mobile electronic channel delivered with human intervention. In this particular instance, human intervention takes place in the front office (i.e., patient-physician interaction), whereas mobile technology-based health information systems operate in the back office (service delivery systems). Indeed, the virtual front office with physical service and the virtual back office with information systems are highly interactive and integrated to provide overall service benefits (Sousa & Voss 2006). Thus, the study specifies the mHealth hotline as a service system which delivers a personalized and interactive health service over a mobile phone, which aims to provide ubiquitous and universal access to medical advice and information to any patient at any time (Akter & Ray 2010). The uniqueness of this particular mHealth service system lies in delivering primary health care to anyone at any time and anywhere using the mobile channel (Ivatury et al. 2009). The range of services that patients receive includes medical information, consultation, triage, diagnosis, referral, treatment and counseling (see Table 2.12).

Table 2.12 Nature of mHealth hotline service

	Virtual Service	Physical Services
Electronic Channel (Mobile phone)	e-prescriptions or e-referral, e-DSS, etc.	Medical consultation, Medical information, triage consultation, diagnosis, referral, treatment, counseling
Physical Channel	Not applicable	Face-to-face service in general (services in hospitals).

2.6.2 Service Quality Challenges of mHealth (Hotline) Services

The nature of mHealth (hotline) services indicates that both front office and back office dimensions should be taken into account to ensure quality of this service system. Thus, to better manage the performance of this system, it is necessary to ensure quality both at front and back stage, that is, "how can the voice of the customer and voice of the process be matched for the best overall performance?" (ifm & IBM 2008, p. 5). The extant literature on the mHealth hotline (or mobile telemedicine) service identifies that quality challenges of this platform revolve around service delivery platforms (e.g., systems reliability, systems efficiency, systems availability, systems privacy), patient-physician interaction over this platform (i.e., responsiveness, assurance and empathy) and service benefits (Akter et al. 2010a; Ivatury et al. 2009). Studies also indicate the importance of investigating the impact of overall service quality perception on patient satisfaction, continuance intentions and quality of health life (Kahn et al. 2010; WHO 2011) in order to ensure its sustainability in developing countries.

Overall, researchers in mHealth service systems consider quality as the single most important determinant of their long-term success (Alter 2010; Akter et al. 2011c; Kahn et al. 2010). Despite the importance of quality, there is a paucity of research that explores service quality dynamics (i.e., components and consequences of service quality) in this domain (Jen et al. 2008). mHealth service systems in the developing world are clearly struggling to develop meaningful consumer-oriented quality assessment measures and their association with service outcomes. Thus, there is a growing need to reframe and refocus service quality in order to manage the critical outcomes of this service system (Alter 2010; Bardhan et al. 2010; Ostrom et al. 2010; Vargo & Lusch 2008).

2.6.3 Overall Research Gaps: mHealth in Developing Countries

mHealth is transforming health care in developing countries; however, there are few studies with adequate sample size and rigorous study design which have assessed the service quality of mHealth service systems (Earth Institute 2010; Mechael et al. 2006). According to WHO (2011, p. 76), "[t]here is a clear emergence of mHealth around the globe … There is little published evidence on the effectiveness of mHealth services quality …" Highlighting the importance of service quality assessment in this context, Ivautry et al (2009, p. 201) mentioned, "the emergence of mHealth hotlines as potentially valuable for expanding access to health care in developing countries. Further research must now be done to inform industry, policy-makers and donors. This should include careful analysis of the public health benefits, the effect on health outcome disparities, and the commercial benefits of health hotlines".

Indeed, most of the literature on mHealth research is anecdotal and fragmented (Chatterjee et al. 2009; Ivatury et al. 2009; Mechael et al. 2009; WHO 2011). The extant research is mainly limited to a large number of case studies; hence there is a clear absence of solid empirical evidence (Akter & Ray 2010). Thus, according to Kahn et al. (2010, p. 257) "… rigorous evaluation is essential evidence for the value of mHealth remains scarce, especially for the developing world". There is also a tendency to discuss mHealth as a whole, but the nature of different mHealth applications should be explicitly specified and studied with sufficient details (Earth Institute 2010). Indeed, there is a paucity of study on mHealth service quality dimensions and service outcomes (i.e., patient satisfaction, continuance intentions and quality of life), which appears to be a formidable challenge for this health care paradigm (Ivatury et al. 2009; Kahn et al. 2010; WHO 2011). Studies on quality dimensions are critical to extend knowledge on the sustainability and scalability of this emerging health care paradigm. Studies also suggest investigating the outcomes of the mHealth application to establish its competitive advantages over other health care paradigms (Earth Institute 2010). To better understand the context of a specific mHealth platform, the impact of demographic and situational factors should also be studied (Ivatury et al. 2009; Mechael 2009). Overall, the extant literature urges focusing on the consumer-centric service quality solutions of mHealth to ensure its organic growth as the sustainability of mHealth and empowerment of consumers are closely interlinked (Akter & Ray 2010).

2.7 Summary

The objective of this chapter was to revisit the nature, characteristics, roles, opportunities and challenges of mHealth in the context of developing countries. A review of the literature found that studies in this domain are largely anecdotal and fragmented. Service quality has received greater attention and has been identified as the major challenge for mHealth platforms in the developing world; however, there is no study which has empirically evaluated the dynamics of service quality in this domain. The present study has evidenced frequent research calls to explore the existing service quality theories in order to develop a comprehensive quality model for mHealth. Thus, the next chapter reviews service quality theories from an interdisciplinary perspective in order to identify the pertinent research gaps with regard to the components and consequences of service quality in mHealth.

Chapter 3 Literature Review (Theory)[3]

3.1 Overview

The objective of this chapter is to explore different service quality theories and find out the essence and gaps of those theories from an mHealth perspective. The review of the literature (context) in the previous chapter found that mHealth transforms health care delivery in developing countries; however, the major challenge lies in user (or patient)-perceived service quality. Specifically, the review found that service quality dynamics (i.e., components and consequences) play an instrumental role in influencing users' (or patients') overall perceptions of mHealth service performance. As such, this chapter concentrates on the service quality concept.

This chapter argues that the nature of service quality for a technology-mediated service is complex, thus, it is necessary to explore this concept using a cross-disciplinary approach, that is, generic theories from marketing, information systems research and health services literature.

This chapter is designed as follows: Section 3.2 defines quality, service quality and perceived service quality. Section 3.3 explores generic service quality theories and synthesizes their

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[3] *Abridged versions of this chapter were published in the following conference and journal:*

- Akter, S., Ray, P. & D'Ambra, J. (2011). Viewing Systems as Services: The Role of Service Quality. Proceedings of the 32nd ***International Conference on Information Systems (ICIS)***, Shanghai, China.
- Akter, S., D'Ambra, J. & Ray P. (2012). Continuance of mHealth Services at the Bottom of the Pyramid: The Roles of Service Quality and Trust. ***Electronic Markets***, 22 (3), (In Press).

findings to determine the nature of the basic service quality concept. Section 3.4 discusses service quality theories in information systems and their relevance to the mobile service context. Then, the chapter explores service quality theories in a traditional health service (Section 3.5) and an mHealth service (Section 3.6) to critically analyze their dimensions, relevance and limitations. Next, in Section 3.7, the chapter discusses the association between service quality and critical outcome constructs (i.e., satisfaction, continuance intentions and quality of health life) and identifies relevant gaps in the mHealth service context. All these discussions lead the chapter to synthesize the major and specific gaps of the study in the context of mHealth service quality in developing countries in Section 3.8. Finally, Section 3.9 provides a summary of the chapter.

3.2 Defining Service Quality

Quality is an important ingredient for any service. The Japanese viewpoint treats quality as 'zero defects' (Parasuraman et al. 1985) and some researchers (e.g., Crosby 1979) treat it as 'conformance to requirements'. In a comprehensive review, Reeves and Bednar (1994) identified four dominant views of quality: quality as *excellence*, quality as *value*, quality as *conformance with specifications* and quality as *meeting expectations*. According to Grönroos (2000), quality is a complicated and indistinct concept and there is no single universal definition of quality in the literature. In addition, due to its 'elusive' nature (Parasuraman et al. 1985; Smith 1999), research in this sector has still remained 'unresolved' (Caruana et al. 2000, p. 57). Indeed, it has remained a difficult concept to grasp (Brady & Cronin, 2001) and "far from conclusive" (Atbanassopoulos 2000, p. 191). The extant research has undertaken either a production-oriented or customer-oriented view of quality (Gummesson 1991). Whereas the production or manufacturing-based approach focused on objective or technical quality to measure standardized products (Crosby 1984; Kasper 1999; Oliver 1997), the customer-oriented approach focused on the perceptions of customers or quality in the eye of the customer (Andaleeb 2008; Brady & Cronin 2001; Dagger et al. 2007; Gronroos 1984; Parasuraman et al. 1988; Rust & Oliver 1994). Because of the complex nature of quality, the customer-oriented view has become the mainstream approach in defining quality in service research (Schneider & White 2004). Thus, in focusing on the customer-oriented view, the International Telecommunication Union (1994) defines it as "the collective efforts of service performance, which determines the degree of satisfaction to the end user." The European Union's R&D in Advanced Communications Technologies in Europe (RACE 1994) program 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". These definitions reflect that quality of service should be viewed from the users' point of view to measure the performance level of an entity.

In health services, Dagger et al. (2007) define quality "as a consumer's judgment of, or impression about, an entity's overall excellence or superiority" which is consistent with the generic definitions in services literature provided by Bitner and Hubbert (1994), Boulding et al. (1993), Cronin and Taylor (1992) and Parasuraman et al. (1985, 1988). Similarly, Andaleeb (2001, 2008) focuses on patient-perceived service quality which basically reflects O'Connor et al.'s (1994) viewpoint that, ''[i]t's the patient's perspective that increasingly is being viewed as a meaningful indicator of health services quality and may, in fact, represent the most important perspective'' (p. 32). Thus, the role of patients in defining the nature and level of service quality has been emphasized in health service literature in order to sustain any particular health care platform (Jun et al. 1998; Dagger et al. 2007; Donabedian 1992; O'Connor et al. 2000). According to Andaleeb (2001, p. 1361), "[i]f patient-centered evaluations are to be effectively used, especially in a technically complex sector such as health care that reflects credence-based services (i.e., services that are difficult to evaluate by the patient), it may be unreasonable to expect patients to provide quality ratings based on technical merits of the service. Instead, subjective criteria must be used, understood, and translated into objective performance parameters". As such, in mobile health care, there is a clear need to define the *"user centric"* context of service quality in order to present a single, homogeneous metric that captures overall users' perceptions (Ahuluwalia & Varshney 2009; Akter & Ray 2010). Seminal studies on service quality in mHealth (e.g., Akter et al. 2010a; Akter et al. 2011a; Akter et al. 2012) have already focused on ***patient-perceived service quality*** by defining it as *users' judgment about overall excellence or superiority of a mobile health service* (Zeithaml 1987).

In defining and conceptualizing perceived service quality, Gronroos (1984) suggests using expectation as a reference point against which performance can be judged, but Parasuraman et al. (1985, 1988) define perceived service quality as the difference between expected and perceived service. Parasuraman et al.'s (1988) difference score definition became very popular; however, it faced serious criticisms from subsequent researchers (e.g., Babakus & Boller 1992) as expectation score adds little value to service quality measurement. Thus researchers (e.g., Brady & Cronin 2001; Dabholkar et al. 2000) focus only on "perception measures" in order to define and conceptualize perceived service quality as perception scores performed better than difference scores. In the same spirit, researchers in health service (e.g., Andaleeb 2001; Dagger et al. 2007; Dagger & Sweeney 2006) have embraced perception-only measures to define service quality.

The conceptual definition of service quality has always received an abstract focus by identifying the dimensions as a second-order factor model (Gronroos 1984; Parasuraman et al. 1988; Rust & Oliver 1994) or third-order factor model (Brady & Cronin 2001; Dabholkar et al. 1996; Dagger et al. 2007; Fassnacht & Koese 2006; Parasuraman et al. 2005). This dimensionality of the service quality concept suggests that service quality might have first-order, second-order or third-order dimensions which are reflected by a higher-order overall perceived service quality. It indicates that overall service quality has a reflection over dimensions and subdimensions. Highlighting the complexity of such hierarchical dimensions of the service quality concept, Dagger et al. (2007, p. 24) suggest that *"[m]odeling service quality in this way recognizes that the evaluation of service quality may be more complex than previously conceptualized"*. The extant literature has also emphasized that conceptualization of service quality should be context-specific (Babakus & Boller 1992; Carman 1990; Dabholkar et al. 1996; Dagger et al. 2007). Although studies have frequently highlighted the context-dependent nature of the service quality concept, relatively few studies have focused on such modeling. As such, there is evidence of many failed attempts to capture service quality by applying generic service quality models in new contexts (Dagger et al. 2007). Overall, synthesizing the above findings, the study defines service quality as a multidimensional, hierarchical and context-specific concept which should always be viewed from consumers' perspectives.

3.3 Generic Service Quality Theories

Traditionally, generic models (e.g., Gronroos 1982; Parasuraman et al. 1985; Rust & Oliver 1994) have played a predominant role in service quality literature and have been applied in different disciplines, such as, services marketing, information systems and health care. In fact, marketing literature, particularly services quality and customer satisfaction, has played a crucial role in establishing the foundation for traditional service quality theory (Brady & Cronin 2001). In the following sections, this study discusses the classic service quality theories for typical service settings:

Firstly, this study focuses on the Nordic model which was introduced by Gronroos (1982, 1984). This model suggests that perceptions of service quality should be measured under two dimensions (Gronroos 1982), that is, functional quality (how) and technical quality (what). The functional quality focuses on the delivery mechanism and captures customers' perceptions while services are delivered (Brady & Cronin 2001). And the technical quality focuses on service information and captures customers' reactions to it. Gronroos (1984) based his arguments on the disconfirmation paradigm and suggested that the service quality should be measured by comparing expected service with perceived service. Although this is one of the foundational theories and famous for its seminal conceptualization among researchers (e.g., Bitner 1990; Lassar et al. 2000; Oliver 1997; Rust & Oliver 1994), it has been seriously criticized for its limited dimensions. As a result, subsequent literature (e.g. Brady & Cronin 2001; Dabholkar et al 1996; Parasuraman et al. 2005) proposed service quality as a multilevel and multidimensional concept. Some researchers (e.g., Carman 1990; Dabholkar et al. 1996) questioned the absence of subdimensions and argued that it is necessary to integrate subdimensions to grasp the complexity of human perceptions.

Secondly, the study concentrates on the SERVQUAL model (Parasuraman et al. 1988). This model (see Table 3.1) is quite dominant in services literature (Ma et al. 2005; Jia et al. 2008) and applied widely in industry (Brown et al. 1993), such as, health care, public recreation centers, banking, etc., which sometimes indicates that scholars around the world are using SERVQUAL as a basis for their own industries (Parasuraman et al. 1990). It may be noted that the initial exploratory research of Parasuraman et al. (1985) came up with 10 dimensions for assessing any service by consumers and these are tangibles, reliability, responsiveness, communication, credibility, security, competence, courtesy, understanding and access. However, because of the overlapping nature of the initial dimensions, this model was later modified into five dimensions (*reliability*, *responsiveness*, *assurance*, *empathy* and *tangibles*) and named as the SERVQUAL model (see Table 3.1) (Parasuraman et al. 1988).

Table 3.1 Summary of the SERVQUAL model

Original 10 dimensions (Parasuraman et al. 1985)	SERVQUAL dimensions (Parasuraman et al. 1988)	Definitions
Reliability	*Reliability*	Ability to perform the promised service dependably and accurately.
Responsiveness	*Responsiveness*	Willingness to help customers and provide service.
Competence, Courtesy Credibility, Security	*Assurance*	Knowledge and courtesy of employees and with trust and confidence.
Access, Communication and Understanding Customer	*Empathy*	Customized and caring attention.
Tangibles	*Tangibles*	Appearance of physical facilities, equipment, personnel and communication materials.

Using SERVQUAL, researchers measure service quality by comparing service expectation with service perception under 22 Likert scale-based items. The perceived service quality score is calculated by subtracting the perception score from the expectation score across 22 pairs of items which could be used for individual diagnostic purposes as well as for an overall service quality measurement (Brown et al. 1993). However, despite its popularity and widespread application across the industry, the model has been seriously criticized for being designed as a generic measure across all contexts rather than a customized one (Babakus & Boller 1992; Carman 1990; Dabholkar et al. 1996). Customization may take place in the form of adding new items or changing the wording of the items as per the application (Carman 1990; Dabholkar et al. 2000; Dagger et al. 2007). Modified versions of the model dropped the expectation dimension entirely (e.g., Boulding et al. 1993; Cronin & Taylor 1992; DeSarbo et al. 1994; Parasuraman et al. 1991, 1994; Zeithaml et al. 1996) because the expected service is always higher than the perceived service (Brady & Cronin 2001) and it is hard to measure service expectation in the case of credence properties such as health services (Andaleeb 2008; Dagger et al. 2007). Furthermore, some researchers (e.g., Boulding et al. 1993) added dimensions to the expectation portion of the model and some others (Carman 2000; DeSarbo et al. 1994) applied conjoint analysis instead of the difference method to determine service quality perception. Methodologically, the model was questioned because of its item-total correlation (Carman 1990; Dabholkar 2000), unidimensionality (Mangold & Babakus 1990; Brady & Cronin 2001), construct validity (Peter & Churchill 1986; Ma et al. 2005), poor reliability of the difference score problem (Brown et al. 1993) and limited contextual application (Dagger et al. 2007; Finn & Lamb 1991). Subsequent studies (Dabholkar et al. 1996, 2000; Brady & Cronin 2001; Dagger et al. 2007; Teas 1993) mentioned that the disconfirmation model has conceptual, theoretical and measurement problems and suggested that alternative perceived quality models should be used. Therefore, Cronin and Taylor (1992, 1994) proposed that a direct measure of perceptions, such as SERVPERF, is a preferable means to avoid the discrepancy between expected and perceived service quality. They contend that SERVQUAL is too simplistic to measure this complex cognitive evaluation process by separately measuring the expected and perceived level of service quality and subtracting these scores. Critics both in marketing (e.g., Brown et al. 1993; Cronin & Taylor 1992, 1994; Teas 1993, 1994; Brady & Cronin 2001; Dagger et al. 2007) and in information systems (IS) (e.g., Kettinger & Lee 1997; Van Dyke et. al. 1997, 1999; Jia et al. 2008; Ma et al. 2005) point to conceptual and empirical difficulties with the original SERVQUAL instrument and suggest that alternatives to the original “gap scored” model be used. Despite the abovementioned weaknesses, the SERVQUAL model is still distinct from others in the overall assessment of interactive service because of its multiple dimensions for measuring service quality (Brady & Cronin 2001; DeLone & McLean 2003; Jia et al. 2008). However, since service quality perceptions represent latent variables and service takes place at multiple levels under multiple dimensions, the major concern is to come up with such a model which is *context-specific, hierarchical* and *multidimensional*.

Thirdly, according to Rust and Oliver (1994), overall perception of service quality is influenced by three factors: customer-employee interaction or functional quality (Gronroos 1982, 1984), service benefit or technical quality (Gronroos 1982, 1984) and service environment (Bitner 1992). The model highlights support for Gronroos's generic model (Bitner 1990; Lasser et al. 2000; Mohr & Bitner 1995; Oliver 1997; Rust & Oliver 1994) and service environment (Baker 1986; Bitner 1990; Spangenberg et al. 1996; Wakefield 1996) to measure service quality and solidify the positioning of this three-component model. Although the model was not tested empirically (Brady & Cronin 2001), similar models were applied in retail banking (McDougall & Levesque 1994) and health care samples (McAlexander et al. 1994; Dagger et al. 2007).

Fourthly, the study focuses on Dabholker et al.'s (1996) multilevel and multidimensional model to address the inconsistency of the factor structure of the SERVQUAL model and to capture the complexity of human perceptions. Although a good number of researchers (e.g., Carman 1990; Czepie et al. 1985; Dabholkar et al. 1996; McDougall & Levesque 1994; Mohr & Bitner 1995) have supported this model, they neither identified the subdimensions properly nor defined those adequately (Brady & Cronin 2001). Subsequently, Dabholkar et al. (2000) proposed some unique findings based on the *antecedents, consequences, mediators* and *measurement* of service quality for measuring physical service. The study supported "perception measures" rather than "difference measures" and "cross-sectional study" rather than "longitudinal study" to measure service quality.

Finally, the study focuses on another multilevel and multidimensional model introduced by Brady and Cronin (2001) which consists of three primary dimensions *(interaction quality, outcome quality* and *physical environment quality)* and nine subdimensions *(attitude, behavior, expertise, ambient conditions, design, social factors, waiting time, tangibles* and *valence)* based on users' perceptions to capture overall service quality. This study successfully synthesized the previous works of Gronroos (1982, 1984) and Rust and Oliver (1994) and proposed a hierarchical service quality model. One of the greatest limitations of the model was the effort to establish it as a unifying model across all service industries; however, the authors acknowledged its inadequate representation of the population and emphasized the need for context-specific modeling (Brady & Cronin 2001). Overall, the authors called for further research in hierarchical modeling to better capture service quality perception of a particular service.

3.3.1 Findings and Gaps

Although the extant literature has evidenced multiple dimensions of service quality, such as *two* (e.g., Gronroos 1982; Lehtinen & Lehtinen 1982; Mels et al. 1997), *three* (e.g., Brady & Cronin 2001; Rust & Oliver 1994), *five* (e.g., Parasuraman et al. 1988) and even *ten* (e.g., Parasuraman et al. 1985), there is no standard agreement as to the nature or content of dimensions in defining service quality (Brady & Cronin 2001; Dagger et al. 2007). However, it is generally agreed that service quality should be defined from the users' viewpoint and its conceptualization should result in multilevel, multidimensional constructs. After synthesizing all the quality parameters of all generic models, this study identifies that conceptualization and measurement of service quality should be based on *users' perceptions* (Parasuraman et al. 1985, 1988) and *specific contexts* (Babakus & Boller 1992; Carman 1990; Dabholkar et al. 1996), and that the dimensions of quality should be captured under an *hierarchical and multidimensional* manner (Brady & Cronin 2001; Dabholkar et al. 1996). These studies also found that "perception scores" performed better than "difference scores" in developing and validating the instrument for service quality in a cross-sectional context. One of the major gaps of all generic theories is that very few theories have focused on mobile electronic platform-based services to capture perceived service quality. Specifically, no instrument has been developed to measure health services over a mobile platform (Chatterjee et al. 2009; Ivatury et al. 2009; Mechael 2009; Varshney 2005; WHO 2011).

Table 3.2 Generic service quality theories

Generic theory	Scope of application	Dimensions and subdimensions	Findings
2 factor service quality model by Gronroos (1982, 1984)	A generic model of service quality applicable to any services.	Functional quality (delivery) and technical quality (information)	Perceived service quality depends on technical quality, functional quality and image.
SERVQUAL model by Parasuraman et al. (1985, 1988)	A generic model of service quality widely applied in health care.	Reliability, responsiveness, assurance, empathy and tangibles	Service quality is the gap between expected and perceived service under five dimensions.
3 factor service quality model by Rust & Oliver (1994)	A conceptual model, later applied in health care by subsequent researchers.	Service product (service outcome), service delivery and service environment	Perceived service is determined by three factors.
A comprehensive framework for service quality (Dabholkar et al. 2000)	A generic model of service quality applicable to any services.	Applied the SERVQUAL model, however, prominent for some ground-breaking findings.	An antecedent-based service quality model predicts better in cross-sectional study. Satisfaction works as mediator between overall quality and intention.
Multilevel and multidimensional model by Brady & Cronin (2001)	Any service which is based on interpersonal interaction applied in health care.	The customer-employee interaction (attitude, behavior, expertise), service environment (ambient conditions, design, social factors) and the information (waiting time, tangibles, valence)	Service quality perceptions are multilevel and multidimensional.

Overall findings:
1. Service quality models are user perception-based, context-specific, hierarchical and multidimensional.
2. Service quality models are based on a components-based framework (as overall service quality), perception measures and cross-sectional study.

Major Gap: Generic theories have not addressed the service quality of mobile electronic platform-mediated services.

Specific Gaps:
Gap 1: Components of service quality for mobile electronic platform are not incorporated in any theory.
Gap 2: No instrument has been developed to measure both systems (i.e., technical communication) and interaction (i.e., physical services) quality for technology-mediated service platform (e.g., mHealth).

3.4 Service Quality Theories in Information Systems (IS)

Service-oriented thinking is one of the fastest growing paradigms in information systems (IS) as the world becomes a service economy (Bardhan et al. 2010). Services account for 70% of gross domestic product (GDP) in developed economies (Ostrom et al. 2010) and more than 40% contribution in developing economies (Lovelock et al. 2011). This service-oriented growth is projected to remain constant in the foreseeable future. As such, IT organizations have started viewing systems as services in order to accelerate adoption of the new platform, build business models for new technology and drive new innovation (Alter et al. 2010). It is widely believed that this growth of the service-oriented paradigm yields many opportunities for IS researchers to investigate the complex interaction between human behavior and IT (Rai & Sambamurthy 2006). ‘Viewing a system as a service’ can help IT organizations to align their interests with the services economy by modeling service quality dynamics (Alter 2010; Maglio et al. 2009). As Pitt et al. (1995, p. 175) suggest, “[i]f IS researchers disregard service quality, they may gain an inaccurate reading of overall IS effectiveness. We propose that service quality should be included in the researcher's armory of measures of IS effectiveness”. This behavioral perspective helps the IS field to capture the critical dimensions of a technology-mediated service by focusing on both front stage and back stage (Akter et al. 2010; Sousa & Voss 2006).

Researchers in service systems consider quality as the single most important determinant of businesses’ long-term success (Alter 2010). Despite the importance of quality in service systems, there is a paucity of research that explores the antecedents to and consequence of service quality in this domain (Jia et al. 2008). Thus, there is a growing need to reframe and refocus service quality in IS in order to manage the critical outcomes of service systems (Alter 2010, Bardhan et al. 2010; Ostrom et al. 2010; Vargo & Lusch 2008). However, the service system approach is struggling to develop meaningful consumer-oriented quality assessment measures and their association with service outcomes. According to Bardhan et al. (2010, p. 6), "[t]he deployment of IS and technology by firms increasingly determines their competitiveness in the service economy. In this milieu, there is a corresponding need to apply robust research findings in the appropriate managerial and organizational contexts on services innovation, quality, architecture, and design and delivery, as well as the customer satisfaction and business value that results." It is noteworthy that growing IT services (mostly data) including Internet search, mobile ticketing, digital wallet or mobile health (or mHealth) are transforming organizations by enhancing service quality and innovation. As such, there is a research call to encourage both researchers and practitioners to focus on *quality* as a core concept within the IT discipline (Jia et al. 2008; Nelson et al. 2005; Pitt et al. 1995).

In order to recognize the critical role of service quality in IS, researchers (e.g., Jiang et al. 2000, 2002; Kettinger & Lee 1994, 1995, 1999; Ketler & Walstrom 1993; Pitt et al. 1995, 1997; Ma et al. 2005; Watson et al. 1998) have initially adopted SERVQUAL to measure IS service performance. But they faced huge challenges because of the reliability and validity of the generic SERVQUAL measures and lack of IT artifact in the IS context (Orlikowski & Iacono 2001; Van Dyke et al. 1997; 1999). Critics in IS, for example, Van Dyke et al. (1997), highlight that confusion of SERVQUAL's expectation component and its difference score measurement approach make the model perform poorly in establishing discriminant validity for the five dimensions. Although such studies have been important in explaining IT usage, they are relatively weak in capturing human–technology interactions and provide limited guidance for system designers (Nelson et al. 2005). Orlikowski and Iacono (2001) have highlighted that such IT research, which employs a "proxy view" of technology, has lost its connection to the field's core subject matter—the IT artifact itself. Besides, some researchers found that when applying the SERVQUAL model to e-services' collapse, most dimensions lose their reliability and validity (e.g., Gefen 2002). Overall, the extant literature on the SERVQUAL model in IS did not focus on *human–technology interaction (system quality), interpersonal interaction* and *outcome (or information) benefits* separately to measure overall IS service quality.

Addressing the abovementioned concerns, Nelson et al. (2005) presented a model which puts forward two basic dimensions of IS, that is, systems quality (service delivery platform) and information quality (output of an information system) in order to establish an IT artifact in the IS quality literature (Table 3.3). They identified altogether nine fundamental dimensions of which five are for systems quality and four are for information quality. They applied the model over data warehousing in health care to predict information quality and system quality separately. However, this research was conducted within the specific domain of data warehousing, so the authors expressed their concern about whether or not the findings could be applied more broadly or to other specific forms of technology. As such, the authors suggested a context-specific conceptualization of system and information quality to better define the IT quality model. Furthermore, their study was not based on ultimate users' perceptions to capture service quality dimensions in IS.

Table 3.3 Nelson et al.'s IT quality model (2005)

System Quality	***Indicators***	***Definitions***
Systems reliability	Service accuracy, availability and consistency.	The degree to which a system is dependable over time.
Systems efficiency	Ease of use, access and speed of response.	The degree to which a system provides easy and quick access.
Systems flexibility	Ability to meet different needs.	The degree to which a system can adapt to a variety of user needs.
Systems privacy	Information protection and sharing.	The degree to which the site is safe and protects user information.
Systems integration	Seamless service across live or automated voice or SMS.	The degree to which a system facilitates the combination of information from various sources to support decisions.
Information Quality	***Indicators***	***Definitions***
Accuracy	Correct, unambiguous, meaningful, believable and consistent.	The degree to which information is correct, unambiguous, meaningful, believable and consistent.
Completeness	Information adequacy.	The degree to which all possible states relevant to the user population are represented in the stored information.
Currency	Currency of information.	The degree to which information is up-to-date.
Format	Comprehensive and easy to understand.	The degree to which information is presented in a manner that is understandable and interpretable to the user and thus aids in decision making.

Similarly, DeLone and McLean (1992, 2003) developed the taxonomy of IS success theory based upon Mason's modification of Shannon and Weaver's model (Shannon & Weaver 1949) of communications. DeLone and McLean developed their initial taxonomy using established theories of communication adapted to IS (Petter & McLean 2009). In the revised model (2003), they incorporated *service quality* and merged individual impact and organizational impact into net benefits to address the needs of greater benefits. They also felt that it is necessary to measure user satisfaction and its impact on intention to use (an attitude) due to the changing nature of IS and their contexts. As a result, DeLone and McLean (2003) combined systems quality, information quality and service quality in their updated model to measure overall IS performance. They argued that IS organizations now play the dual role of ‘information provider’ and ‘service provider’ so "service quality" should be added as an important dimension (in addition to systems quality and information quality) to measure overall IS performance (DeLone & McLean 2003).

However, empirical validation of the modified IS success model has failed to present clear guidelines on specific quality parameters (Petter & McLean 2009) and, thus, suggested context-specific conceptualizations of quality dimensions. Moreover, there are at least two groups of stakeholders in any IS service − staff and users. Whereas staff’s perceptions are based on performance and learning experiences, users’ perceptions are based on how well their needs are satisfied. DeLone and McLean did not draw a boundary line between these two different perceptions in developing their success model (Jiang et al. 2001). In most cases, the IS success model including the service quality dimension has been used to measure staff’s perceptions, such as Sedera et al.’s (2004) replication of the IS success model on enterprise systems. Overall, there is a paucity of research that focuses on users’ perceptions to evaluate service quality (Petter & McLean et al. 2009).

Table 3.4 DeLone & McLean's IS success model (adapted from Petter & McLean 2009)

Construct	Indicators	Definitions
System Quality	Availability, adaptability, reliability, usability, response time	Performance of the IS in terms of reliability, convenience, ease of use, functionality and other system metrics
Information Quality	Completeness, ease of understanding, relevance, personalization, security	Characteristics of the output offered by the IS, such as accuracy, timeliness and completeness
Service Quality	Responsiveness, assurance and empathy	Support of users by the IS department, often measured by the responsiveness, reliability and empathy of the support organization
User Satisfaction	Repeat purchase, repeat visits, user surveys	Approval or likeability of an IS and its output
Intention to Use	Reuse, repeat purchase, etc.	Expected future consumption of an IS or its output
Use	Nature of use, navigation, number of site visits, number of transactions	Use consumption of an IS or its output described in terms of actual or self-reported usage
Net Benefits	Cost savings, time savings, etc.	The effect of an IS on an individual, group, organization, industry, society, etc., which is often measured in terms of organizational performance, perceived usefulness and effect on work practices

In the case of mobile information services, Chae et al. (2002) developed a quality model focusing on the characteristics of a generic mobile platform. They identified four primary quality dimensions and these were *connection quality*, *content quality*, *interaction quality* and *contextual quality*. In order to address these dimensions, they developed subdimensions, such as, stability and responsiveness to address *connection quality*; objectivity, believability and amount to address *content quality*; structure, navigation and presentation to address *interaction quality* and finally, timeliness and promptness to address *contextual quality*. In another study on mobile Internet acceptance, Cheong and Park (2005) developed two quality constructs, *the system quality* and *content quality*, in their research model based on DeLone and McLean's (2001) original success model. Subsequently, Tan et al. (2008) proposed multiple quality dimensions (*perceived usefulness, perceived ease of use, content, variety, feedback, experimentation* and *personalization)* as constructs to measure the overall quality of mobile entertainment and information service. However, these studies are very much context-specific and did not generalize the dimensions in all other settings. Koivisto (2007) commented that the abovementioned quality models in mobile IS ignored two important components, that is, the quality of a mobile device and mobile network. So he offered a model capturing the quality perception of *a mobile device, a mobile network* and *the information service* and he suggested that *"the overall quality is a combination of all three that together form the mobile service supply chain."* This model has focused on both product and service quality and formulated a quality model on *expectation* and *perception* dimensions. However, his study is based only on users' perceptions ignoring the *expectation score* because the nature of the study is a 'credence' type service, that is, users can measure perception only when they experience (e.g., health care) so expectation does not add any value in this case.

Service quality theories in a web-based electronic service strongly influence mobile service because in both cases, services are delivered over an electronic platform. Several powerful models have been developed to address the issues of service quality over this platform, such as, eQUAL (Barnes & Vidgen 2001), web quality (Aladwani & Palvia 2002), E-S-QUAL

(Parasuraman et al. 2005), eTailQ (Caruana & Ewing 2006; Long & Mellon 2004; Wolfinbarger & Gilly 2003), perceived service quality in the web (Yang et al. 2004), WebQual (Loiacono et al. 2007) and service quality in general portals (Liu et al. 2009). Barnes and Vidgen (2001) presented three dimensions to measure the quality of a web-based electronic platform *(information quality*, *interaction* and *service quality and usability)* which was followed by Janda et al.'s (2002) five quality dimensions, that is, *performance, access*, *security*, *sensation* and *information* and Collier and Bienstock's (2003) three quality dimensions, that is, *process quality*, *information quality* and *recovery quality* to measure the service quality of the electronic platform. However, all these models have been seriously criticized for not defining electronic services broadly, missing some core dimensions and generalizing the models across all electronic service settings (Fassnacht & Koese 2006).

In order to overcome the pitfalls of the earlier models, Parasuraman et al. (2005) developed the E-S-QUAL or electronic service quality model (see Table 3.5) to measure service quality of web-based electronic services. The uniqueness of the E-S-QUAL model lies in its capacity to capture perceptions on human–technology interaction for any web-based e-service platform (Sousa & Voss 2006). Similarly, Fassnacht and Koese (2006) introduced quite a broad model by focusing on online electronic networks. They proposed to measure service quality through *environment quality*, *delivery quality* and *information quality.* However, this model did not address the unique characteristics of the mobile platform (e.g., network quality, interaction quality, etc.) and it was again restricted to measuring service quality of all web-related services.

Table 3.5 E-S-QUAL model (adapted from Parasuraman et al. 2005)

Dimensions	Subdimensions	Definition
Core dimension	Efficiency	Ease of use and speed of response time
	Systems availability	Technical function capacity
	Fulfilment	Fulfilment of promises
	Privacy	Security and protection of customer information
Service recovery	Responsiveness	Problems' handling efficiency in service failure
	Compensation	Degree of compensation in service failure
	Contact	Interactive assistance through online or telephone

Most web-based electronic service quality studies are primarily based on front office (i.e., quality of interaction between the end-user and the virtual platform) although service quality failures are frequently related to back office operations (i.e., information systems). Since overall customer satisfaction is strongly influenced by service quality at all moments of contact (Shaw & Ivens 2002), some researchers (e.g., Sousa & Voss 2006) integrated both front office and back office operations in evaluating service quality. In this case, Sousa and Voss (2006) proposed a powerful service quality model focusing on s*ystems quality*, *interpersonal quality* and *interaction quality* to measure any service which contains both electronic (e.g., mobile channel) and physical components (service provided by persons). Therefore, they proposed the dimensions of the E-S-QUAL model (Parasuraman et al. 2005) to measure *systems quality* and the SERVQUAL model (Parasuraman 1985, 1988) to measure *interpersonal interaction quality* for any service over an electronic platform (see Table 3.6). However, Sousa and Voss's (2006) conceptual model was not empirically tested and, again, it was proposed as a generic model for all electronic services ignoring the contextual influence of service quality settings.

Table 3.6 Service quality for virtual channels (adapted from Sousa & Voss 2006)

Dimensions	Subdimensions	Theories
Systems Quality	Efficiency	E-S-QUAL Model (Parasuraman et al. 2005)
	Systems availability	
	Fulfilment	
	Privacy	
Interaction Quality	Responsiveness	SERVQUAL Model (Parasuraman et al. 1988); cf. (DeLone & McLean 2003)
	Assurance	
	Empathy	

3.4.1 Findings and Gaps

Synthesis of the literature in IS and electronic services brings some overlapping dimensions of service quality in the IS context to measure users' perceptions (see Table 3.7). Most studies focus on *systems quality* to measure performance of the overall service delivery platform, *interaction quality* to measure user interactions with providers and *information* or *outcome quality* to measure the quality of overall service benefits. In addition, DeLone and McLean (2003) emphasized the role of *contexts* in conceptualizing and measuring any model. In this regard, they confirmed Seddon's (1992) opinion that no single model is absolutely better than another, so conceptualization and measurement of variables are often influenced by the *context and objective* of the study. Also, Jiang and Klein (1999) found that users prefer different quality measures, depending on the type of system being measured.

Table 3.7 Service quality theories in IS environment

Disciplines	Theory	Dimensions	Findings
Information Systems	SERVQUAL+ (Kettinger & Lee (1994, 1997, 2005)	Reliability, responsiveness, assurance and empathy	Services quality varies under desired level, adequate level and minimum level.
	SERVQUAL in IS (Jiang et al. 2000; Pitt et al. 1995, 1997)	Reliability, responsiveness, assurance, empathy	SERVQUAL model can effectively be used to measure IS service quality or success.
	IT Quality Model (Nelson et al. 2005)	System quality and information quality	Quality dimensions have been determined with IT artifact in mind.
	IS Success Model (DeLone & McLean 2003)	Service qualityhas been proposed as a separate dimension in addition to system quality and information quality	This theory is based on three primary dimensions of quality to measure service performance of IS.
	Quality dimensions in IS (Wixom & Todd 2005)	IT quality is framed as system quality and information quality	Quality, satisfaction and future use intentions are related.
Internet-based Electronic Services	E-S-QUAL (Parasuraman et al. 2005)	*Core dimension:* systems efficiency, systems availability, fulfilment and privacy. *Recovery dimensions:* responsiveness, compensation and contact	A general service quality model for Internet users with online shopping.
	Service quality of virtual platform (Sousa & Voss 2006)	Virtual quality (systems efficiency, systems availability, systems reliability and privacy): interaction quality is measured by SERVQUAL model and integration quality (channel service configuration & integrated interaction)	In addition to front office (interaction quality), quality of virtual back office (systems quality) is important to evaluate service quality
Mobile Information Service	(Chae et al. 2002)	Connection, content, interaction and contextual quality	In this case, researchers focus on quality of mobile network, interaction and information quality to measure any service through mobile platform.
	(Tan & Chou 2008)	Perceived usefulness, perceived ease of use, content, variety, feedback, experimentation and personalization	Conceptualized quality of mobile information services under mobile Internet settings.

Major Gap: There is no theory which measured system quality (quality of the service delivery systems), interpersonal interaction quality and outcome quality at same time for a technology-mediated service platform. Also, the overall impact of service quality on satisfaction, intention to continue using and quality of life has not been assessed yet.

Specific Gaps:
Gap 1: Dimensions and subdimensions of the user-centric service quality model over mobile platform have not been determined.
Gap 2: No scale has been developed which is applicable across all mobile platform-based service settings.
Gap 3: No empirical study based on random sampling has been conducted yet in such services.

3.5 Service Quality Theories in Health Services

Most of the research on health service quality perceptions has initially focused on the application of generic models, either Gronross's (1982, 1984) two-dimensional model (i.e., functional quality and technical quality) or Parasuraman et al.'s (1985, 1988) five-dimensional SERVQUAL model (i.e., *reliability*, *responsiveness*, *assurance*, *empathy* and *tangibles*). However, the complexity of service quality evaluations is evident in the many failed attempts to replicate the existing theory in new contexts (Dagger et al. 2007).

3.5.1 SERVQUAL Theory in Health Services Context

The widely applied SERVQUAL model (Parasuraman et al. 1988), for example, has been criticized for its five dimensions across diverse service contexts (Buttle 1996). Therefore, the application of the five-dimensional SERVQUAL model has come up with varying results in different health care settings, such as the original *five factor structure* which is supported by Wisniewski and Wisniewski (2005) and Rohini and Mahadevappa (2006); *six dimensions* which have been identified by Headley and Miller (1993) in a primary care clinic; *seven factor solutions* by Lytle and Mokwa (1992) in a health care fertility clinic; *seven factors* by Reidenbach and Sandifer-Smallwood (1990) in an emergency health care setting; *nine dimensions* by Carman (1990) in a multi-encounter hospital setting; and *12 dimensions* by Licata et al. (1995) in a health care setting. More recently, *outcome quality* has garnered greater attention and has been recognized as a pivotal aspect of quality in addition to the SERVQUAL dimensions (Carman 2000; Dagger et al. 2007; Doran & Smith 2004; Fassnacht & Koese 2006). This dimension refers to the benefits that the patients desire from the service, such as information or advice (Dagger et al. 2007). Some researchers (e.g., Andaleeb 2001, 2008) applied

SERVQUAL theory in developing country contexts and found some interesting findings. For instance, Andaleeb (2001) conducted his study in a developing country and found five dimensions, that is, *responsiveness, assurance, communication, discipline* and *baksheesh (bribing)* which affect the perceived service quality of hospital services. Akter et al. (2008) confirmed these dimensions when they applied the same scale to suburban public hospitals in Bangladesh. Similarly, Doran and Smith (2004) extended the SERVQUAL model by identifying the pivotal dimension (i.e., outcome quality), core dimensions (i.e., reliability, responsiveness, assurance and empathy) and peripheral dimension (i.e., tangibles). In a recent study, Andaleeb (2008) proposed *assurance, tangibles, empathy, responsiveness, communication, input adequacy* and *facilitation payments* as dimensions of service quality for health services provided to children in developing countries.

Overall, the findings on SERVQUAL application in a health care context reflect that conceptualization and measurement of service quality is context-specific, multidimensional and hierarchical (Brady & Cronin 2001; Dabholkar et al. 2000; Dagger et al. 2007; Gronroos 1984; Parasuraman et al. 1988). These findings also suggest that service quality has several predominant primary dimensions that reflect the corresponding subdimensions.

3.5.2 Other Service Quality Theories in Health Care

In health care literature, several conceptual frameworks for evaluating service quality have received frequent attention. Among those studies, Donabedian (1966, 1980, 1992) presented his findings by drawing a difference between *technical* and *interpersonal processes' quality*. In this framework, *technical care* focuses on the application of medical science and technology to health care, while *interpersonal care* focuses on managing the interaction between the service provider and consumer. In the same spirit, Brook and Williams (1975) presented a model similar to that proposed by Donabedian (1966, 1980, 1992) in which *technical care* reflects how well service processes are applied and *interactive care* explores the nature of interaction between the service provider and user. Accordingly, Ware et al. (1978, 1983) also identified the *interaction quality* and the *technical quality* of care. Likewise, Wiggers et al. (1990) investigated the importance of *technical competence* and *interpersonal skills* when evaluating the quality of care. Based on the above concepts, Zineldin (2006) extended his framework by five quality dimensions which basically incorporate object or technical quality, quality processes or functional quality, quality infrastructure, quality interaction and quality atmosphere. Similarly, Choi et al. (2005) introduced a four-dimensional service quality model to measure physical health care settings in Korea, which includes convenience of care, staff concern, physician concern and tangibles. This theory extends the functional and technical quality of care paradigm (e.g., Donabedian 1992) by introducing environmental and administrative quality. More recently, Dagger et al. (2007) proposed a *multidimensional hierarchical model* to measure health service quality and to predict satisfaction in general health care settings. They identified four primary dimensions *(interpersonal, technical, environment* and *administrative)* and nine subdimensions *(interaction, relationship, information, expertise, atmosphere, tangibles, timeliness, operation* and *support)* to develop their model.

3.5.3 Findings and Gaps

After synthesizing the above literature in health care, it becomes evident that service quality models in health care should focus on *users' perception* and *context-specific* conceptualization

(Andaleeb 2001, 2008; Berry & Bendapudi 2007). Moreover, abstractions for service quality must be done at *several levels* (Carman 1990) which should result in *hierarchical modeling* (Brady & Cronin 2001; Dabholkar et al. 2000; Dagger et al. 2007). A comparison of the health care dimensions in the service quality literature indicates considerable overlap, that is, quality of service delivery process, quality of interaction, quality of outcome and quality of atmosphere.

3.6 Service Quality Perceptions in mHealth Care

A review of the mHealth service literature reveals that there were no studies which directly measured the service quality in mHealth settings (Akter & Ray 2010; WHO 2011). However, the extant literature on such issues has identified some predominant factors which might influence service quality. For instance, Koivisto (2007) found that when any data service is provided over a mobile network, then service quality is influenced by the *mobile device, the mobile network, information systems* and *information* itself. Varshney (2005) mentioned that challenges regarding service quality arise from *information systems, networks* and *medical perspectives.* In addition, some other researchers (e.g., Chae et al. 2002; Ivatury et al. 2009; Mechael 2009; Varshney 2005) mentioned some general challenges (e.g., *connection quality*, *screen size*, *graphics*, *touch* and *feel*) that need to be overcome with regard to mobile data services in health care settings. Seminal studies on mHealth services which identified factors that influence service quality are considered in the following sections.

3.6.1 Major Studies in mHealth Environment

According to Varshney and Vetter (2000), *"the current and emerging wireless technologies could improve the overall health service for users in both cities and rural areas, reduce the stress and strain on healthcare providers while enhancing their productivity, retention, and quality of life, and reduce the overall cost of healthcare services in the long-term"*. In this regard, Varshney (2005) mentioned that coverage of wireless and mobile networks, reliability of wireless infrastructure and general limitations of hand-held devices strongly influence the service quality of such ubiquitous health services. Specifically, the author highlighted issues regarding *systems*, *interaction* and *managerial perspectives* which influence perceptions of service quality. In the case of *information systems*, the author has mentioned factors including the ability of the platform to answer and route calls to doctors, call tracking and monitoring capacity of the platform, database of medical facilities to provide right-time information, privacy and security of the system, scalability of the platform to serve users, and dependability and quality of access to the platform. In addition, the author has emphasized *interpersonal interaction* between users and physicians for proper solutions with care. Finally, the author highlighted *managerial issues* regarding integration of wireless solutions, skills and training of the providers, and legal issues which influence mobile health services.

Ivatury et al. (2009) conducted a study on *mobile health hotline services in developing countries (e.g., Bangladesh, India, Pakistan and Mexico)* and found that service quality perceptions are influenced by *information systems*, *interaction between doctors and users* and *overall service benefits*. With regard to information systems, the authors mentioned quality of the network, call answering and routing capacity, call tracking and monitoring capacity, automated diagnosis decision support systems, quality of electronic health records for callers, database of medical information, and overall privacy and security of the system. The study also emphasized the quality of medical interaction between patients and physicians as many medical errors occur because of incomplete interaction which results in wrong diagnosis (IOM 2000). Therefore, quality of consultation over the mobile phone should be given due attention in terms of competency, credibility, courtesy, knowledge, privacy and utmost care (Ivatury et al. 2009).

In another study on *sustainability of mobile health services*, Norris et al. (2008) focused on the key attributes of mobile health technology in terms of *portability*, *immediacy*, *convenience* and *low cost* for their pervasiveness in modern society. They mentioned that mobile technology can play a central role in all aspects of disease management by providing preventive, monitoring, treatment and support services. They further added that such mHealth services have reduced hospitalizations, improved quality of life and controlled costs. However, they have mentioned some challenges to quality perceptions, such as, *privacy and security* of personal health care information and *acceptability* of services to all users. They have also focused on some technological concerns, such as, *affordability* of call charges, *reliability* and *coverage of the network* and *limitations of the mobile device* (e.g., low battery power, low screen, etc.).

Mechael (2009) in her study on mHealth services in developing countries mentioned that *reliability of communication systems* and *security* in health facilities influence quality perceptions. In addition, the author also emphasized crucial factors, such as, *service benefits*, *safety and liability* for unknown contacts under mobile consultation. In a recent study, the Earth Institute (2010) focused on similar findings and mentioned that “[i]n order to successfully incorporate mobile technology into their overall point-of-care support strategy, health care organizations need to consider issues like portability, task structure, ease of use, and system reliability". Mechael (2009) recommended overcoming such barriers for sustainable development of mHealth in poor countries. Finally, the author urged focusing on the literacy level, access to technology, infrastructural facility and cultural factors to evaluate the service performance of mHealth platforms. The author highlighted the importance of two-way mHealth communication which can significantly improve health care in rural settings.

Chatterjee et al. (2009), in examining the success factors for mobile work in health care, mentioned that system quality (i.e., extent of data processing, information access, communicability and portability), content quality (i.e., task structure, urgency, extent of mobility and information complexity), service quality (i.e., system reliability and system support) and outcome variables (i.e., use, satisfaction and net benefits) influence the ultimate viability of this health care paradigm. However, this research was designed from an "IS success model" perspective, thus quality issues did not entirely emerge. In addition, the study embraced qualitative exploration and put forward some propositions to implement mobile work in the health care industry based on an objective viewpoint. As such, the perceptual mapping of quality and its impact on outcome constructs are missing.

In another study on mHealth review in developing countries, Akter and Ray (2010) identified service quality as the major challenge of mHealth implementation. They found that the primary challenges are related to the quality of service delivery platform, quality of interaction between health professionals and patients, and finally the quality of service benefits or service outcome.

Specifically, they articulated platform quality in terms of systems reliability, system efficiency, system availability and system privacy; interaction quality in terms of providers' responsiveness, assurance and empathetic behavior to patients over a mobile platform; and outcome quality as the service benefits derived from this service's systems. Subsequent studies (Akter et al. 2010a; Akter et al. 2010b; Curioso & Mechael 2010; Kahn et al. 2010; Tariq & Akter 2011) supported these findings on mHealth service quality in order to sustain this innovative health care platform in developing countries.

In a recent study on mHealth initiatives around the world, WHO (2011) mentioned that service quality perceptions are mainly influenced by privacy issues in developing countries. In this regard, WHO expressed its concerns that "[s]ecurity and privacy issues are especially critical in low and lower-middle income countries, where mobile phones are often shared among family and community members, leading to potential challenges with protecting confidential health information, particularly in the case of conditions like HIV/AIDS, which remain highly stigmatized". WHO (2011) also explored some contextual factors that inhibit mHealth usage, such as, language barriers, illiteracy, SMS restrictions (160 characters) and lack of technical support in rural areas. Overall, the report emphasizes awareness campaigns to extend the benefits of mHealth to the community.

In addition to mHealth services, this study has explored *general telephone-based health consultations* because of close proximity to our field of study. In this regard, Car and Sheikh (2003) found that users are highly satisfied with such consultations; however, the service quality of such services is profoundly influenced by the *safety* and *reliability* of information. Chapman et al. (2004) identified that *availability, usability, acceptability, service relevance, effectiveness* and *equity (social justice)* influence the service quality perceptions of telephone consultations. Innes et al. (2006) conducted an empirical study and found that *'length of consultation'* influences the information about such services. Derkx et al (2009) found that the quality of service depends on *clinical knowledge* and *communication skills* of the provider. They highlighted '*assurance*' and '*adequate time*' as important elements that satisfy users. They recommended that providers focus on *service outcomes* in terms of physical and emotional benefit to increase service quality perceptions. Toon (2002, p. 324) reported that "prior acquaintance with a patient, access to personal medical records, and continuity of care" influence the quality of telephone consultation with respect to its safety and potentiality. The author identified the main challenge as ensuring the quality of information in terms of its accuracy and appropriateness. The studies on patient satisfaction with telephone consultation reported that satisfaction in this domain is influenced by responsiveness of health service providers, length of consultation and quality of care (Jiwa 2002; McKinstry 2002). Patient satisfaction with consultation is also influenced by meeting patient expectations, identification of physical and emotional needs, and equality of communication skills (Patel et al. 1997; McKinley et al. 2002). Richards (2002) reported that the cost of telephone consultation has a negative correlation with service satisfaction. This finding is supported by Jiwa (2002) who reported that an increase in telephone bills negatively influences this service consumption. With respect to customer satisfaction, a systematic review by Bunn et al. (2009, p. 14) reports that "telephone consultation and triage reduce immediate GP, or home, visits and that, in general, at least 50% of calls can be handled by telephone advice alone (ranging from 25.5% to 72.2%)". Overall, the value of telephone consultation is viewed as reducing the doctor's time, improving access and care (Kainth et al. 2003).

3.6.2 Overall Service Quality Challenges of mHealth Services

The above discussion on mHealth services makes it evident that service quality represents the most critical challenge of this emerging health care paradigm (Akter et al. 2010a; Chatterjee et al. 2009; Kahn et al. 2010; WHO 2011). According to Andaleeb (2008, p. 340), "low quality services breach the central promise in the healthcare relationship between service providers and recipients which can lead to a variety of dysfunctional behaviors among the service recipients, some immediate (anger, confrontation, complaints) and some long-term (decline in loyalty, badmouthing and diversion of customers, and loss of a customer base via defection)". The extant literature on mHealth services makes it evident that overall service quality of this platform is influenced primarily by three dimensions, that is, the quality of service delivery platform, quality of interaction and quality of outcomes (Ahuwalia & Varshney 2009; Akter & Ray 2010; Ivatury et al. 2009; Varshney 2005). Therefore, in Table 3.8, the extant literature identifies three primary dimensions and their corresponding subdimensions as the facets of service quality challenges of mHealth services.

Table 3.8 Major service quality challenges for mHealth services

Quality Dimensions	Service Quality Challenges
Platform	Systems reliability (i.e., database of facilities and standardized drug information); systems efficiency (ease of access, operation efficiency); systems privacy (i.e., security and protection of users' information); systems availability (i.e., network management, capacity management)
Interaction	Responsiveness (i.e., promptness, waiting time); assurance (e.g., competence, credibility, courtesy, knowledge); empathy (i.e., customization capacity of service providers).
Outcome	Functional benefit (i.e., convenience, care, fulfilment) Emotional benefit (i.e., quality of emotional support, etc.)

Sources: Adapted from Fassnacht & Koese (2006), Nelson et al. (2005), Sousa & Voss (2006)

Studies also suggest that these dimensions are interrelated and should be given equal attention to understand the quality dynamics of mHealth (e.g., Akter et al. 2010b). According to Sousa and Voss (2006, p. 357), "[e]-service quality research to date also exhibits a primarily front office orientation, concentrating mainly on the quality of the interaction of an e-service with the end users. However, many of the service quality failures in e-services have been related to fulfilment and back-office operations". Thus, service quality research in mHealth calls for an integrated orientation by combining perceptions of systems, interaction and information (or benefits).

3.6.3 Findings and Gaps

The overall literature survey clearly indicates that there is no theoretical model that can reliably and validly measure the performance of mHealth service quality in developing countries (Table 3.9). According to Kahn et al. (2010, p. 253) *"[t]wo systematic reviews indicated little formal outcome evaluation of mHealth in developing countries"*. However, existing studies have identified some factors which profoundly influence users' quality perceptions. Most of these factors are divided into three dimensions, that is, quality of service platform or service delivery systems (reliability of information systems, availability of network coverage, efficiency of operations, and privacy and security of information), quality of interaction between physicians and users (i.e., responsiveness, customized solutions, clarity of communication and understandability) and finally, quality of service outcomes (i.e., various service benefits). In addition, the literature has mentioned the indirect influence of contextual factors (i.e., demographic and situational characteristics) in measuring the performance of mHealth services.

Table 3.9 Service quality dimensions in different health services

Traditional health services	***Domain***	***Dimensions & subdimensions of service quality***	***Findings in traditional health***
Donabedian (1966, 1980, 1992)	Health care service quality on users' perceptions (conceptual model)	Technical (application of medical science and technology), interpersonal process (interaction between service provider and customer) and amenities of care.	Mainly health care focuses on technical and interpersonal quality.
Andaleeb (2001, 2008)	Patient perceived service quality of hospitals in developing country	SERVQUAL theory	Reliability, responsiveness, assurance and empathy.
Zineldin (2006)	Patient perceived service quality of general hospitals	Technical quality, functional quality, quality infrastructure, quality interaction and quality atmosphere.	Five quality dimensions are significant.
Dagger (2007)	Private out user oncology clinics and general practice clinics	Interpersonal, technical, environment and information quality.	Health service quality, satisfaction and behavioral intentions are strongly correlated.
Mobile health services	***Factors influencing service quality in mobile health care***		***Findings in mHealth***
Ahuwalia & Varshney (2009); Curioso & Mechael (2010); Kahn et al. (2010); Varshney (2005); Norris et al. (2008)	*IS perspective:* software for call routing, tracking and monitoring, database for user records and medical information. *Technology perspective*: network coverage, dependability, saleable architectures. *Managerial perspective:* payment method, security, privacy, ease of use, access, etc. *Medical perspective:* quality of care and diversity of users.		Factors identified under platform (i.e., IS and technology), interaction (i.e., responsiveness) and outcome (i.e., care) perspectives
Akter & Ray (2010); Akter et al. (2010a); Ivatury et al (2009); Mechael (2009); WHO (2011)	*System quality:* call routing, monitoring and tracking, database for medical information, user records, network stability, payment management, customer support. *Interaction quality:* Speed of service delivery, competence, credibility, courtesy, knowledge, customization, etc. *Outcome quality*: convenience, support, fulfilment.		Factors identified under quality of *systems*, *interpersonal interaction* and *outcome* perspectives.
Overall Findings: For mHealth, user-perceived service quality revolves around *platform quality* (i.e., systems reliability, systems availability, systems efficiency and systems privacy), *interaction quality* (i.e., responsiveness, assurance, empathy) and *outcome quality* (i.e., service benefits).			
Major Gap: There is a paucity of research which has articulated and validated the service quality dimensions in mHealth. **Specific Gaps:** Gap 1: Dimensions and subdimensions of mHealth service quality have not been adequately determined. Gap 2: No scale has been developed which is applicable to measure such services. Gap 3: No empirical study based on random sampling has been conducted yet.			

3.7 Service Quality, Satisfaction, Continuance Intentions and Quality of Life

The extant literature identifies that service quality is a context-specific, hierarchical and multi-dimensional construct (Brady & Cronin 2001; Dabholkar et al. 2000; Fassnacht & Koese 2006; Parasuraman et al. 2005), which has a strong association with individual (e.g., satisfaction), economic (e.g., continuance intentions) and social (e.g., quality of life) outcomes (Andaleeb 2001, 2008; Choi et al. 2007; Dagger & Sweeney 2006; Dagger et al. 2007). These effects of service quality dynamics can be encapsulated under the cognitive-affective-conative framework of Oliver (1997, 1999) which begins with cognitive beliefs (e.g., perceived service quality evaluation), mediated by affective responses (e.g., evaluation of satisfaction) and ends with conative effects (e.g., continuance intentions) (Chaudhuri & Holbrook 2001; Dagger et al. 2007). Therefore, this study discusses in detail the effects of service quality on these critical service outcomes in the context of mHealth in developing countries.

3.7.1 Service Quality and Satisfaction

The extant literature has frequently identified overall ‘service quality’ as a cognitive construct which works as an antecedent of an emotive ‘satisfaction’ construct (e.g., Brady & Robertson 2001; Cronin & Taylor 1992; Dagger et al. 2007; Gotlieb et al.1994). In addition to service quality, satisfaction has been instrumental in helping organizations to clarify objectives, define measures of performance and develop performance information systems (Andaleeb 2001). Oliver et al. (1997) specified satisfaction as an essential ingredient of success in the competitive business world. Owing to its strong effects on critical outcome constructs, Wirtz and Lee (2003) urged service providers to effectively manage satisfaction.

Most of the published academic studies in the services sector have also looked at the link between service quality and satisfaction (e.g. Brady & Cronin 2001; Dabholkar et al. 1996, 2000; Kelley & Davis 1994; Oliver et al. 1997; Parasuraman et al. 1994; Zineldin 2006). Similarly, service quality has been correlated with satisfaction in seminal IS literature (e.g., Jiang et al. 2000, 2001; Nelson et al. 2005; Pitt et al. 1995). In this regard, Pitt et al. (1995, p. 174) mentioned that "[t]he principal reason IS departments measure user satisfaction is to improve the quality of service they provide … Irrespective of whether a user interacts with one or multiple information systems, the quality of service can influence use and user satisfaction". DeLone and McLean (2003) in their revised model of IS success proposed a link between service quality and satisfaction in order to measure individual productivity. Rai et al. (2002) observed that IS user satisfaction has a significant impact on IS use, that is, a higher level of satisfaction creates greater user dependence on the system. Zviran and Erlich (2003) in their meta-analysis on IS user satisfaction found that satisfaction is an important outcome variable to evaluate the performance of a system because of its critical effects on decision making and productivity benefits.

Satisfaction theory in health care has argued that patient satisfaction is a critical indicator in assessing and improving the quality of care (Aharony & Strasser 1993; Andaleeb 2000, 2001; Saila et al. 2008). An evaluation of patient satisfaction can help health service providers to track areas for improvement in order to strengthen health care systems (Drain 2001; Hekkert et al. 2009). The extant literature has also identified satisfaction as an emotive attitude which should be measured by totalling the subjective assessments of multidimensional attributes associated with the care experience (Andaleeb 2001; Linder-Pelz 1982). Satisfaction studies in most health care contexts are based on subjective judgments of patients which represent a unique strength of satisfaction scale because of their ability to assess patients' psychological evaluation of service performance (Hekkert et al. 2009). Liljander and Strandvik (1994) viewed satisfaction as the user's own experiences of a service where the outcome has been evaluated in terms of what value was received. Many health care organizations treat users as passive recipients of services or products (Morgan & Murgatroyd 1994). In patient-oriented health care, patients and their service satisfaction are considered first and foremost at every point in the planning, implementation and evaluation of service systems (Andaleeb 2001; Dagger et al. 2007; Edmunds et al. 1987). Although satisfaction has been used in myriad service contexts, to date there has been no empirical research on users' service satisfaction in the mHealth context.

Gap: *There is a paucity of research in mHealth services which has established the relationship between overall service quality and patient satisfaction.*

3.7.2 Service Quality, Satisfaction and Continuance Intentions

Studies have found both a direct relationship between service quality and satisfaction and an indirect relationship between service quality and intention to use through satisfaction (e.g., Cronin & Taylor 1992; Dabholkar et al. 2000; Gotlieb et al. 1994; Mahmood et al. 2000; Zviran & Erlich 2003). DeLone and McLean (2003) confirmed that service quality leads to satisfaction and an increased satisfaction leads to future intentions to use. They confirmed a strong relationship between service satisfaction and future use intentions through their meta-analysis. Rai et al. (2002), in their study to assess the validity of DeLone and McLean's (1992) and

Seddon's (1997) IS success models, found that IS user satisfaction impacts on IS use and a higher level of satisfaction creates greater user dependence on the system.

In health services, satisfaction is generally viewed as more closely aligned with behavioral intentions. Satisfaction is typically modeled as mediating the relationship between service quality and behavioral intentions (e.g., Anderson & Sullivan 1993; Brady & Robertson 2001; Cronin & Taylor 1992; Dabholkar et al. 2000; Gotlieb et al. 1994). Instead of behavioral intentions, this study has used the construct *'intention to continue using'* which is defined as *usage behavior, commonly labelled as post-implementation* (Saga & Zmud 1994) *or post-adoption* (Jasperson et al. 2005). Whereas *'intention to use'* is related to the initial adoption stage and considered a first step towards overall IS success, *'intention to continue using'* focuses on how to promote continued IS use or how to reduce discontinuance (Limayem et al. 2007). Indeed, in order to consider IS use a true success, a significant number of users should have moved beyond the initial adoption stage, using the IS on a continued basis. Bhattacherjee (2001, p. 351-352) confirms the importance of this construct by citing "long-term viability of an IS and its eventual success depend on its continued use rather than [its] first-time use." Thus, IS continuance, IS continuance behavior or IS continuous usage describes "behavioral patterns reflecting continued use of a particular IS which is a form of post adoption behavior" (Limayem et al. 2007, p. 707).

This study focuses on *post-adoption* which actually refers to a suite of behaviors that follow initial acceptance (Rogers 1995), including *continuance, routinization, infusion, adaptation, assimilation*, etc., which is often used as a synonym for continuance in the literature (Karahanna et al. 1999). Past IS research is based on the implicit assumption that IS usage is mainly determined by ‘intention to use’ (in the case of initial adoption); however, this assumption may not be applicable to continued IS usage behavior (Limayem et al. 2007), such as *continued usage of mobile health services*. Because of lack of knowledge in this area (Saga & Zmud 1994), researchers have started exploring this area in more detail (Bhattacherjee 1998; Bhattacherjee 2001, Jasperson et al. 2005; Karahanna et al. 1999; Limayem et al. 2007). Service quality has been linked to satisfaction and behavioral intentions in the health care context (Dagger et al. 2007); however, there are few studies which have clearly modeled both the direct and indirect impact of service quality on continuance intentions through satisfaction.

Gap: *There is a paucity of research in mHealth which has established the direct linkage between service quality and intention to continue using and indirect linkage between service quality and intention to continue using through satisfaction.*

3.7.3 Service Quality, Satisfaction and Quality of Life (QOL)

There is an intricate relationship between service quality, service satisfaction and quality of life (QOL) perceptions. Quality of life is generally viewed as the well-being and happiness of individuals (Ferrans & Powers 1992; Sirgy et al. 2006; Yuan 2001). It is a subjective concept (Dagger & Sweeney 2006) which is often used interchangeably with the well-being of life (Endres 1999; Yuan 2001). Broadly, QOL can be conceptualized as an overall measure or as a measure based on experiences in a variety of domains, such as health care, work, family and leisure (Jeffres & Dobos 1995; Lee et al. 2002; MacFadyen 1999; Samli et al. 1987; Sirgy & Cornwell 2001; Torrance 1987). Thus, from the holistic viewpoint, QOL refers to the subjective evaluation of one’s current life circumstances (Dagger & Sweeney 2006; Inglehart & Rabier

1986). However, in the health care context, QOL is viewed as a subjective, individual, experiential construct which measures overall well-being in a particular health care domain (Dagger & Sweeney 2006).

In reference disciplines (e.g., economic psychology, marketing), the relationship between service quality perception, customer satisfaction and subjective well-being has been explored to evaluate the performance of a service (e.g., Poiesz & von Grumbkow 1988; Sirgy 2001). In information systems, performance is generally measured in terms of its *effectiveness* in achieving goals (e.g., Gefen et al. 2003) or *satisfaction* of using for a particular task (e.g., Bhattacherjee & Premkumar 2004). These outcome variables measure users' feelings or attitudes at the time they use the system, rather than the impact of the system on their overall quality of life (Choi et al. 2007). Although the relevance of IT to quality of life has been acknowledged and recognized in the service systems industry (Sirgy 2001; Sirgy & Samli 1995), IS researchers have remained quiet on the relevance of social outcomes to the IT-based service evaluation. This absence has also been cited by some scholars in IS (e.g., Straub & Watson 2001) who believed that it is one of the goals of any technology to increase the quality of its users' lives.

According to Choi et al. (2007, p. 599), "IS research has examined the individual, organizational, and social impact of information systems, but again without directly addressing the impact of IS on QOL" (Choi et al. 2007). Similarly, health service researchers have put little effort into measuring the social outcome of a new health system which is reflected in Rosenbaum's statement (2008), "[y]et empirical research exploring the health benefits of commercial support is lacking and relatively absent in the services literature". It is noteworthy that QOL is different from the traditional financial or growth-related outcome construct as it is focused on measuring the customer well-being or societal welfare of a service provision (Dagger & Sweeney 2006). In the mHealth context, QOL assessment is particularly important as this new health care paradigm is frequently referred to as a transformative service with a strong positive impact on patients' quality of health life in developing countries (Ivatury et al. 2009; WHO 2011). As such, it is important to understand how service quality evaluations influence social outcome. Despite a natural relationship between quality of service systems, satisfaction and QOL, few studies have developed metrics to assess this relationship (Choi et al. 2007). Therefore, one of the major gaps in the extant literature is that there is no model to date that can reliably and validly measure the impact of mHealth service quality on satisfaction and quality of health life of an individual in the context of a developing country.

<u>Gap:</u> *There are few studies in mHealth which have established the linkage between <u>perceived service quality, satisfaction and an individual's quality of health life</u>*.

3.7.4 Impact of Contextual Factors

Contextual factors refer to both *demographic* and *situational characteristics*. Cooil et al. (2007) note that contextual factors comprise both demographic and situational characteristics and it is important to investigate their effects on the ultimate outcome construct. Generally, demographic characteristics include *gender*, *age* and *income* and situational characteristics incorporate *cost of service*, *experience* and *social influence.* In addition to service experience, cost of service and social influence are important additional situational variables in the case of any service (Andaleeb 2008; Venkatesh et al. 2003). All of these variables fit well with Vargo and Lusch's (2008) premise of phenomenological, experiential factors influencing the determination of service outcome. The extant literature has explored the view that *contextual factors* may have some impact on ultimate outcome constructs (Anderson et al. 2008; Venkatesh et al. 2003). DeLone and McLean (2003) emphasized measuring the contextual variance in empirical investigation because studies found that evaluation of a system varies based on the type of system studied, the context to which it is applied and the stakeholders involved with it (Jiang & Klein 1999; Seddon 1997; Seddon et al. 1999; Whyte et al. 1997). Orlikowski and Iacono (2001) argued that a service system is embedded in some time, place, discourse and community which cannot be ignored in empirical investigation. Studies have shown that individual user differences or demographic characteristics might have impact on service outcomes (e.g., Bryant & Cha 1996; Johnson & Fornell 1991; Söderlund 2002). Anderson et al. (2008) explored both the direct and moderating impact of contextual variables on outcome variables. The authors added that service evaluation differs across customers with different demographics (e.g., gender, age, income) and situational characteristics (e.g., social influence, cost, experience). Mittal and Kamakura (2001) explored the influence of situational factors on repurchase intentions, and Cooil et al. (2007) investigated the role of demographic factors on customer loyalty. Dagger et al. (2007) indicated that relatively few studies in health services have taken into account contextual factors although modeling of such services is urged to be context-specific. As such, there is a paucity of research that explores the impact of contextual variables in measuring the performance of mHealth services. Knowledge about these variables is useful and important for determining the ultimate service outcome.

Gap: *There are few studies in mHealth which have modeled the effects of contextual factors (i.e., demographic and situational characteristics) on the ultimate outcome construct.*

3.8 Overall Gaps in the Literature

The review of the literature clearly indicates that there is a paucity of research in the context of service quality dynamics in the mHealth service systems of developing countries. In this regard, Walsham et al. (2007, p, 317) mention that "[d]espite the importance of the topic area of information systems in developing countries, the literature to date is relatively sparse". Specifically, there is no empirically-tested service quality model for the emerging mHealth platform which is applicable across all contexts. As such, there are some clear research gaps in the context of mHealth service quality and its association with critical service outcomes in terms of *conceptual models, reliable and valid instruments, representative sampling* and *generalizable findings*. These voids offer considerable potential for a significant contribution to the advancement of knowledge in this field. This study believes that these research gaps deserve adequate attention for a contribution in this field considering the importance of the subject in both theory and practice.

3.8.1 Major Gap

There is no study which has investigated service quality in mHealth and the impact of overall mHealth service quality on service satisfaction, continuance intentions and quality of health life in the context of a developing country.

3.8.2 Specific Gaps

In Table 3.10, the study outlines the following specific gaps which emerged from rigorous analysis of the extant literature in terms of the research context (Chapter 2) and theory

(Chapter 3). These specific gaps further highlight the significance of the research questions and rationale of the study.

Table 3.10 Specific gaps in the literature

Theoretical Gaps	**Methodological Gaps**
Gap 1: Dimensions and subdimensions of service quality in the mHealth environment have not been adequately investigated.	Gap 6: There is no instrument that is applicable across different mHealth settings to measure perceived service quality.
Gap 2: Association between service quality, satisfaction and intention to continue using has not been established yet.	Gap 7: No random sampling-based study from an actual user base has been conducted in the mHealth context in a developing country.
Gap 3: Association between service quality, satisfaction and quality of health life has not been established yet.	Gap 8: No generalizable findings are available in this field.
Gap 4: Influence of contextual factors (demographic and situational factors) on service continuance has not been studied yet.	
Gap 5: Overall, there are no theory-based conceptualizations of mHealth service quality that allow for testing a pre-specified model.	

3.9 Summary

The key objective of this chapter was to revisit the extant literature in service quality in an interdisciplinary manner in order to synthesize the findings and gaps that form the foundation for developing the research model in the next chapter. The findings clearly indicate that service quality is a hierarchical, multidimensional and context-specific construct, which has a clear impact on critical service outcomes, that is, satisfaction, continuance intentions and quality of life. Although the review of the literature frequently identifies service quality as a critical concept in the context of mHealth in developing countries, there is a paucity of research which has adequately conceptualized the components and consequences of mHealth service quality. Overall, the review of literature in the research context (Chapter 2) and theories (Chapter 3) identifies some crucial findings and gaps, which solidify the foundation of the research model proposed in the next chapter (Chapter 4: Conceptual Model).

Chapter 4 Conceptual Model[4]

4.1 Overview

The objective of this chapter is to develop a service quality model in mHealth based on the research findings and gaps identified and synthesized in Chapter 2 (Literature Review - Context) and Chapter 3 (Literature Review - Theory). As such, the chapter aims to conceptualize the dimensions and subdimensions of service quality and to measure their overall impact on satisfaction, continuance intentions and quality of life. The review of the literature suggests that service quality dynamics in mHealth are different from those in other health care paradigms as the quality of overall service performance depends on the back office quality (i.e., platform quality), the front office quality (i.e., interaction quality) and the quality of outcomes (i.e., service benefits). However, there is a paucity of research in this domain which has adequately conceptualized service quality dynamics and empirically validated their associations. Thus, to fill this knowledge gap, this study develops a hierarchical, multidimensional and context-specific service quality model for mHealth (hotline) services in developing countries.

This chapter is designed as follows: Section 4.2 outlines the scope of the research model (i.e., the B2C mHealth hotline in developing countries) and the nature of causality. It also discusses the dynamics of the mHealth service quality model by encapsulating its components and

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[4] *Abridged versions of this chapter were published in the following journal and conference:*

- Akter, S., D'Ambra, J. & Ray, P. (2010). Service Quality of mHealth Platforms: Development and Validation of a Hierarchical Model using PLS. ***Electronic Markets**,* 20(3), 209-227.
- Akter, S., Ray, P. & D'Ambra, J. (2011). Modeling Quality Dynamics in IT Services Management. Proceedings of the 32nd ***International Conference on Information Systems (ICIS)***, Shanghai, China.

consequences in a nomological net. Section 4.3 proposes six hypotheses to investigate the association between service quality and outcome constructs, two hypotheses to examine the role of satisfaction as a mediator, two hypotheses to test the role of higher-order service quality as a moderator and finally, two control hypotheses to explore the role of contextual variables. Section 4.4 specifies the nature of the research model as a third-order, hierarchical-reflective model in order to establish further conceptual, methodological and empirical rigor. Finally, Section 4.5 provides a summary of the chapter.

4.2 Conceptual Model

A conceptual model enables systematic accumulation and presentation of knowledge (Gregor 2006). The model proposed in this study explains the service quality dynamics of mHealth hotline services by framing its components and consequences in the context of developing countries (see Figure 4.1). Epistemologically, the model embraces an explaining and predicting paradigm (Gregor 2006) and a proxy view of an IT artifact (Orlikowski & Iacono 2001). Ontologically, the model extends knowledge by developing a hierarchical, multidimensional service quality model to measure mHealth service in developing countries. Specifically, the conceptual model depicts the components and consequences of service quality in the context of B2C mHealth services in developing countries.

The conceptual model is based on the literature in marketing, information systems and health services as the study focuses on a technology-mediated service platform. In service research, such an interdisciplinary approach is important and necessary to adequately address the challenges and opportunities (Ostrom et al. 2010). The conceptual model elucidates an overview of associations in terms of a cognitive (i.e., SQ)-affective (i.e., SAT)-conative (i.e., ICU and QOL) framework (Bhattacherjee 2001; Chiou et al. 2006; Brady & Cronin 2001; Cronin & Taylor 1992; Dagger et al. 2007; Oliver 1997, 1999; Patterson 1997; Taylor & Baker 1994; Woodside et al. 1989). The model links consumer beliefs, affect and intention within the consumer attitude structure, which begins with cognitive beliefs (i.e., evaluating perceived service quality), followed by affective responses (i.e., satisfaction) and ends with conative effects (i.e., ICU and QOL). This relationship simplifies the service quality dominant decision-making process for a service platform (e.g., B2C mHealth care) with an effect on individual (i.e., satisfaction), economic (i.e., continuance intentions) and social (i.e., quality of life) outcomes.

This study defines service quality as a consumer's (or patient's) judgment of, or impression about, an entity's overall excellence or superiority which is consistent with the generic definitions in services' literature (Brady & Cronin 2001; Dabholkar 1996, 2000; Gronroos 1982, 1984; Parasuraman et al. 1985, 1988). The role of users in defining such quality has become a meaningful indicator of health services' quality and represents the most important perspective (Andaleeb 2001, 2008; Dagger et al. 2007; Donabedian 1992; Jun et al. 1998; O'Connor et al. 2000). Therefore, this study focuses on consumer (or patient) *perceived service quality* of mHealth services in developing countries.

In Figure 4.1, the study conceptualizes a service quality model for an mHealth (hotline) service by proposing that users perceive quality at three primary dimensions; firstly, *platform quality* or quality of service delivery systems in terms of systems reliability, systems efficiency, systems availability and systems privacy (DeLone & McLean 1992, 2003; Jiang et al. 2001; Nelson et al. 2005; Parasuraman et al. 2005; Sousa & Voss 2006; Parasuraman et al 1985, 1988; Varshney

2005); secondly, *interaction quality* or quality of medical consultation between physicians and patients over a mobile platform in terms of responsiveness, assurance and empathy, etc. (Andaleeb 2000; Dagger et al. 2007; Parasuraman et al 1985, 1988; Sousa & Voss 2006) and finally, *outcome quality* or *quality of service benefits* which represent functional and emotional dimensions (Davis 1989; Fassnacht & Koese 2006; Ivatury et al. 2009; Sheth et al 1991). The study also proposes that overall mHealth service quality (SQ) has a significant direct and indirect impact on the intention to continue using (ICU) (DeLone & McLean 2003; Wixom & Todd 2005) and quality of life (QOL) in health (Choi et al. 2007; Dagger & Sweeney 2006) through satisfaction (SAT) (Akter et al. 2010b; Dagger et al. 2007).

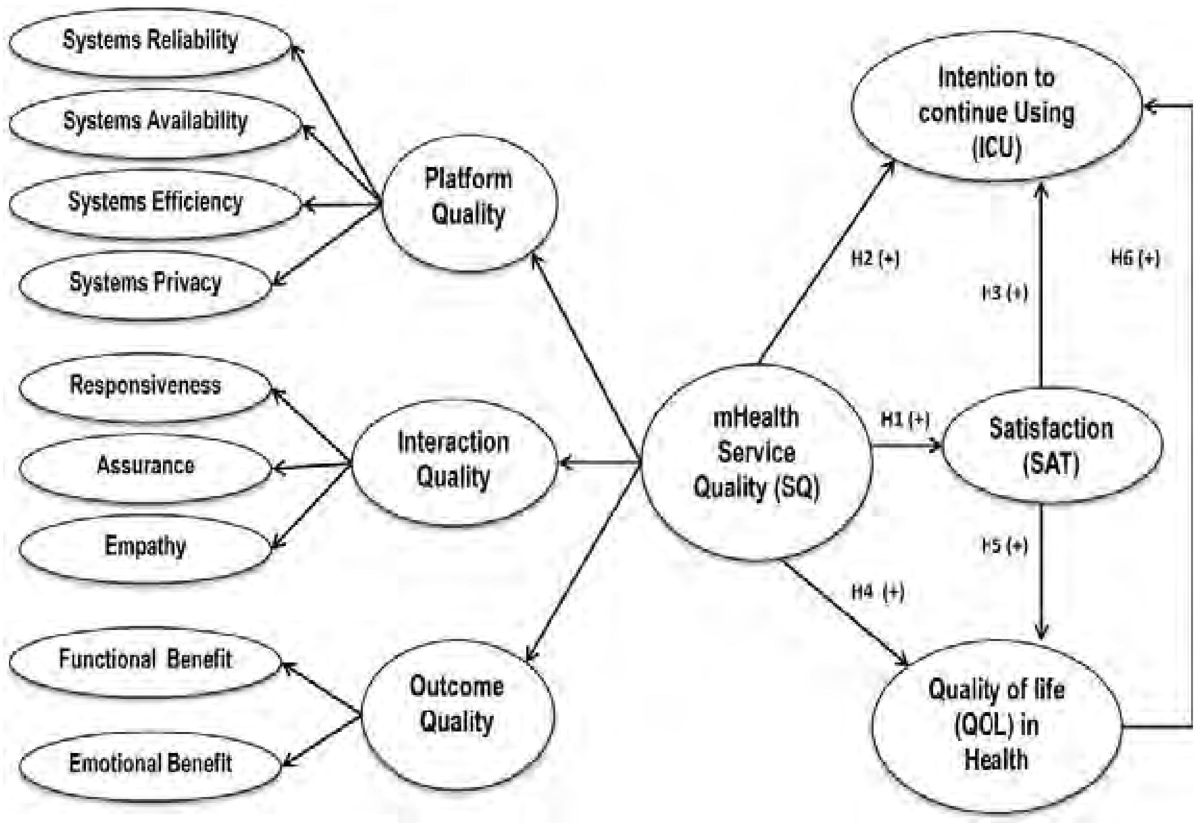

Figure 4.1 Research model

Service quality is an important concept in IS, marketing and health care (Wilson & Lankton 2004); however, in health service systems research, there is no study which directly identified the dimensions of service quality of mHealth and its impact on satisfaction, intention to continue using and quality of life (Akter et al. 2010a; Akter et al. 2010b; Akter & Ray 2010). The uniqueness of the model lies in its integration of front office quality (i.e., interaction between physicians and patients), back office quality (i.e., platform quality or quality of service delivery platform or systems) and outcome quality (i.e., quality of service benefits) to capture overall perceptions of mHealth service quality. Therefore, focusing on users' perceptions (DeLone & McLean 1992, 2003; Jiang et al. 2001; Parasuraman et al. 1988), the study proposes a service quality model (Figure 4.1) which is hierarchical, multidimensional and context-specific to measure the impact of service quality on satisfaction, intention to continue using and quality of life. This study intends to measure only the 'perception score' of service quality because it matches users' evaluation of the service experienced more precisely in health care (Andaleeb 2001, 2008; Brady & Cronin 2001; Cronin & Taylor 1992; Dabholkar et al. 2000; Dagger et al. 2007).

The study specifies that the conceptual model is comprised of hierarchical-reflective constructs because 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; Wetzels et al. 2009) have embraced such a view. As such, the study argues that systems reliability, systems availability, systems efficiency and systems privacy are reflections of *platform quality* and that platform quality is a reflection of *overall service quality*. Similarly, *interaction quality* and its components, and *outcome quality* and its components are reflections of overall service quality. The study specifies mHealth service quality as a hierarchical construct or multidimensional model as service quality involves more than one dimension at multiple levels (Chin 2010; Edwards 2001, Jarvis et al. 2003; Law & Wong 1999; Law et al. 1998; MacKenzie et al. 2005; Netemeyer et al. 2003; Petter et al. 2007, Wetzels et al. 2009). One of the significant advantages of a hierarchical construct is that it allows for more theoretical parsimony and less model complexity (Edwards 2001; Law et al. 1998; MacKenzie et al. 2005). Also, the study adopts the perspective of a reflective model (Jarvis et al. 2003; Petter et al. 2007) because all the dimensions and subdimensions of service quality share a common theme. An in-depth discussion on the nature of the model is presented in Sections 4.4.1 and 4.4.2.

In the following, the study defines the dimensions and subdimensions of the mHealth service quality model (Figure 4.1). Specifically, the study discusses association among constructs by investigating three primary dimensions (i.e., platform quality, interaction quality and outcome quality) and nine subdimensions (i.e., systems reliability, systems efficiency, systems availability, systems privacy, responsiveness, assurance, empathy, functional benefit and emotional benefit) of service quality in the context of mHealth service systems.

4.2.1 Platform Quality

This study proposes platform quality as one of the primary dimensions of mHealth service quality and defines it as the user-perceived quality of the overall service delivery systems in mHealth. In the context of the mHealth (hotline) service, platform quality refers to the performance of the overall service delivery systems which depend on the quality of mobile network coverage and overall back office operations, such as, call routing capacity, call tracking and monitoring, and the database of medical information (Akter et al. 2010a; Akter et al. 2010b; Ivatury et al. 2009; Koivisto 2007; Sousa & Voss 2006; Varshney 2005). It is defined as ‘platform quality’ because it captures users’ perceptions regarding the service quality of health information systems (DeLone & McLean 1992, 2003) and location-based wireless services (Barnes 2003; Chae 2002). According to Varshney (2006, p. 364), “[t]he technology issues related to the introduction of wireless network technologies in healthcare include networking support such as location tracking, routing, scalable architectures, dependability and quality of access”. In the same spirit, this study uses the construct ‘platform quality’ as the performance of mHealth depends on the quality of medical information systems and wireless network technologies. Specifically, the study uses the term ‘platform quality’ because the extant mHealth literature (e.g., Ivatury et al. 2009; Varshney 2005; Vital Wave Consulting 2009; WHO 2011) frequently identifies that overall service systems in mHealth care depend on multi-platform (i.e., IS, wireless network technology, Internet, etc.) reliability, efficiency and availability. Indeed, an mHealth platform with multiple technologies enables users to frequently access and use ubiquitous health services. Sousa and Voss (2006) and Ivatury et al. (2009) support the term ‘platform quality’ as the quality of the overall health care platform is basically determined by all the components related to the virtual interface and virtual back office to provide right-time services. Therefore, this study proposes platform quality as a critical dimension of mHealth service quality because many of the service quality failures in the mobile platform are related to information systems and network technologies (Chae et al. 2002; Nelson et al. 2005; Sousa & Voss 2006).

Shannon and Weaver (1949) defined such communication as the accuracy and efficiency of the communication system that produces information. DeLone and McLean (1992, 2003) refined this dimension by identifying factors, such as ease of use, functionality, reliability, flexibility, portability, integration and importance. Petter & McLean (2009) defined platform quality as the performance of any information system in terms of reliability, convenience, ease of use, functionality and other context-specific system metrics. Nelson et al. (2005, p. 205) identified *platform quality* as a dimension of service quality by stating, "… elements of system quality often are intermingled with dimensions that are closely related to service quality". Petter et al. (2008, p. 238) cited this dimension as "the desirable characteristics of an information system. For example: ease of use, system efficiency, system reliability, and ease of learning, as well as system features of intuitiveness, sophistication, flexibility, and response times".

This study puts forward *platform quality* based on IT quality theory (Nelson et al. 2005), E-S-QUAL theory (Parasuraman et al. 2005), mobile service quality theory (Barnes 2003; Chae et al. 2002), wireless health care theory (Varshney 2005; Ivatury et al. 2009; Vital Wave Consulting 2009) and multichannel service quality theory (Sousa & Voss 2006). The study conceptualizes *platform quality* to measure the quality of overall back office operations (information systems) and mobile communication in mHealth service systems. Thus, based on the extant literature and a close observation of mHealth hotline services in developing countries (see Exhibit 2.1 and Figure 2.2 in Chapter 2), the study articulates *systems reliability*, *systems efficiency*, *systems availability* and *systems privacy* as the subdimensions of platform quality in this ubiquitous health care service. The study defines these subdimensions with their implications in the following paragraphs.

Firstly, *systems reliability* measures service promise and service dependability (DeLone & McLean 2003; Evans & Wurster 1999; Nelson et al. 2005; Parasuraman et al. 2005; Sousa & Voss 2006). In mHealth, *systems reliability* ensures that the service is free of any disruption or interference so that patients can rely on this platform. According to Sousa and Voss (2006, p. 362), “[i]n such a context, integration between the different technologies is paramount to ensure high levels of IT reliability”. The extant literature on mHealth has frequently identified systems reliability as a major construct to ensure technical soundness of the platform (e.g., Ahluwalia & Varshney 2009; Varshney 2005). For example, Akter and Ray (2010) mentioned that a moment of disruption with regard to network or connection during the time of mHealth service consumption may have a significant detrimental effect on users’ perceptions regarding systems reliability. Mechael (2006) identified reliability of the communication systems as one of the six barriers for implementing mHealth. Thus, this study proposes perceived systems reliability as an important subdimension of perceived platform quality.

Secondly, *systems availability* measures timeliness, promptness of service and capacity to provide location-specific information (Chae et al. 2002; DeLone & McLean 2003; Parasuraman et al. 2005, Schell 2002; Sousa & Voss 2006). This particular dimension makes the mobile platform different from other electronic platforms. In fact, the ultimate promise of mHealth, that is, ‘any-time anywhere’ medical service, lies in this dimension (Akter et al. 2010b; Varshney 2005). Ivatury et al. (2009) emphasized this dimension of the mHealth (hotline) service by suggesting that it focus on better mobile coverage and call quality to serve patients in any corner of the country. In order to ensure right-time availability of the mHealth platform, Sousa and Voss (2006, p. 364) highlighted “… good levels of scalability enabling convenient and rapid customer access". This dimension measures service availability, waiting time, network availability, network stability, etc. Therefore, this study puts forward perceived systems availability as a critical subdimension of perceived platform quality.

Thirdly, *systems efficiency* refers to the extent to which a system can be adapted to meet various needs (Nelson et al. 2005). It is defined as the extent to which the system is simple to use and structured properly (Parasuraman et al. 2005). For example, in the context of an mHealth service, a patient may come up with different needs during service consumption; the platform needs to be efficient enough to address each of these needs with adequate information. In this case, the virtual back office of the mHealth platform plays a significant role in ensuring ease of use and operations. As such, systems efficiency indicates overall operational competence of the platform and its ability to meet a variety of needs in changing situations. This dimension also represents a platform's ability to provide information in an organized manner (Nelson 2005). Overall, efficiency refers to the simplicity of using a service system (Sousa & Voss 2006; Parasuraman et al. 2005). The extant research on electronic service quality has identified systems efficiency as a critical component of platform quality (Fassnacht & Koese 2006; Norris et al. 2008; Parasuraman et al. 2005; Sousa & Voss 2006). Thus, this study proposes perceived systems efficiency as a significant subdimension of perceived platform quality.

Finally, *systems privacy* measures absence of the intrusive nature of technologies, such as, security of personal information (DeLone & McLean 2003; Friedman et al. 2000; Nelson et al. 2005; Parasuraman et al. 2005; Sousa & Voss 2006; Urban et al 2000). In other words, privacy refers to the extent to which the platform is safe and there is no possibility of information leaks

(Parasuraman et al. 2005). In order to ensure privacy, the mHealth platform needs to ensure the secure operation of the associated back office (Sousa & Voss 2006). In this context, Kahn et al. (2010, p. 256), mentioned that "[u]se of mHealth must ensure that patient confidentiality is not compromised". In the same spirit, Norris et al. (2008) expressed their concerns on mHealth privacy by mentioning the vulnerability of electronic storage and transmission of sensitive data. Similarly, Feder (2010, p. 262) reflected this issue by stating that "[m]any patients have expressed concerns about the system's privacy". As such, privacy appears to be one of the major challenges of mHealth in developing countries as perceived by patients (WHO 2011). Thus, this study incorporates perceived systems privacy as a critical subdimension of perceived platform quality.

Overall, the dimensions of platform quality represent user perceptions regarding the soundness of the overall mHealth service delivery systems over time. An mHealth service with higher platform quality should be perceived as reliable, available, efficient and private. These four cognitive attributes of the perceived platform quality dimension indicate that any deleterious effects of any one of these dimensions can have a negative impact on the overall service quality perception. These dimensions also represent the ability of mHealth to provide patients with a seamless service experience across a variety of situations. Thus, the study puts forward platform quality as a critical contributor to patients' perceptions of overall mHealth service quality. Table 4.1 summarizes perceived platform quality and its components with their definitions, measures and supporting theories.

Table 4.1: Perceived platform quality

Platform quality captures users' perceptions regarding quality of the overall service delivery systems in mobile health care in terms of 'systems reliability', 'systems efficiency', 'systems availability' and 'systems privacy'.

Root constructs	*Definitions*	*Measures*	*Theories*
Systems reliability	The degree to which the mHealth platform is dependable over time.	It measures service promise, service dependability and error-free service.	E-S-QUAL (Parasuraman et al. 2005), IT quality (Nelson et al. 2005), IS success (DeLone & McLean 2003).
Systems efficiency	The degree to which the mHealth platform can adapt to a variety of user needs and changing conditions.	It measures the ability to meet different needs in changing conditions. Also service recovery ability after failure.	E-S-QUAL (Parasuraman et al. 2005), IT quality (Nelson et al. 2005).
Systems availability	The degree to which the mHealth platform is available on an 'any-time' and 'anywhere' basis.	It measures service availability, waiting time, network availability, network stability, etc.	Mobile Internet service quality (Chae et al. 2002) E-S-QUAL (Parasuraman et al. 2005); multichannel service quality (Sousa & Voss 2006).
Systems privacy	The degree to which the mHealth platform is safe and protects user information.	It measures information protection and sharing.	E-S-QUAL (Parasuraman et al. 2005); multichannel service quality (Sousa & Voss 2006), wireless health service (Angst & Agarwal 2009; Varshney 2005)

4.2.2 Interaction Quality

This study proposes perceived *interaction quality* as one of the primary dimensions of mHealth service quality. This dimension is predicated on the provider-consumer interface over the mobile platform during a service experience which is the key element in overall service quality (Brady & Cronin 2001; Hartline & Ferrell 1996). The study incorporates the definition of Shostack (1985) who defined interaction as ‘‘a period of time during which a consumer directly interacts with a service’’. Bitner (1990) also recognized that ‘‘interaction is the service from the customer’s point of view’’. In the context of mHealth, it is defined as the perceived quality of interpersonal interaction between patients and health professionals over the mHealth service platform. This dimension clearly indicates the provider’s ability to recognize and respond to the consumer’s stated or unstated needs, interests and concerns, which is an important aspect of service quality and an important part of the overall service experience (Teboul 2006). According to Dagger et al. (2007, p. 126), “[a]s services are produced, distributed, and consumed in the interaction between a service provider and a customer, the interpersonal process is crucial to the customer’s ultimate perception of the service provider’s performance”. The interpersonal interaction that takes place during service consumption often influences service quality perception to a large extent (Bitner et al. 1994; Brady & Cronin 2001; Dabholkar et al. 2000; Dagger et al. 2007). Barnes and Vidgen (2006) suggested that interaction quality is more important over the web-based data services than in traditional physical services. In the context of mHealth, Kahn et al. (2010, p. 256) mentioned that “good provider-patient communication is essential for chronic disease management”. As such, the extant literature strongly suggests incorporating an interaction dimension in the perception of overall service quality in mHealth (e.g., Akter & Ray 2010; Ivatury et al. 2009).

To measure interpersonal interaction quality, the SERVQUAL theory (Parasuraman 1985, 1988) has frequently been used both in marketing (Sousa & Voss 2006) and IS (DeLone & McLean 2003). However, in the context of electronic services, seminal studies (e.g., DeLone & McLean 2003; Sousa & Voss 2006) suggested three dimensions (i.e., responsiveness, assurance and empathy) of the SERVQUAL model to capture the dimensions of interaction quality as they are most relevant in this context. Furthermore, through extant case studies (see Exhibit 2.1 and Figure 2.2 in Chapter 2), this study observes that when a patient interacts with a physician over the mHealth hotline platform, he or she perceives quality in terms of promptness in providing solutions (i.e., responsiveness), knowledge and competence of the provider (i.e., assurance) and individual attention to his/her needs (i.e., empathy). Thus, this study puts forward these three dimensions to measure the quality of perceived interaction between physicians and patients in the mHealth hotline environment, which are discussed in the following paragraphs.

Firstly, *responsiveness* refers to the willingness of the service providers to help users and to deliver prompt service over an electronic channel (Kettinger & Lee 1997; Parasuraman et al. 1985, 1988; Pitt et al. 1995). It is also defined as the communication skills of the providers in managing users' concerns during the service exchange. Studies found responsiveness to be an important component of interaction quality (e.g., Brady & Cronin 2001; Witkowski & Wolfinbarger 2002). According to Andaleeb (2001, p. 1367), "[b]eing responsive to patients and communicating openly with them are other vital components of health service delivery." This dimension indicates that 'response time' and 'punctuality' are integral components of interaction quality. Prgomet et al. (2009, p. 798) mentioned that patients use mHealth "where time is a critical factor and a rapid response is crucial". Indeed, time is a critical factor in evaluating this service performance and quick attention to patients' needs is necessary over the mHealth platform. Overall, recent studies support the link between increased responsiveness and increased interaction quality in any cultural setting (e.g., Reynolds & Smith 2010). Thus, this study puts forward perceived responsiveness as a critical subdimension of perceived platform quality.

Secondly, a*ssurance* refers to the knowledge and courtesy of providers with patients in order to establish trust and confidence (Kettinger & Lee 1995; Parasuraman 1988). In mHealth, this dimension indicates the competence, knowledge and skills of physicians in dealing with patients over the mobile platform (Akter et al. 2010a). The providers in this platform are expected to instill assurance through their professionalism and efficacy in every interaction and encounter with patients. To the patients, assurance also refers to the expectation that they will be treated fairly by maintaining the right procedures. In this context, Andaleeb (2001, p. 1362) mentioned that, "[i]f patients perceive their service providers as lacking in these qualities, the sense of assurance that they will receive proper medical attention will be diminished". Andaleeb (2001, 2008) found assurance to be a critical component of interaction quality in traditional health care in developing countries. Reynolds and Smith (2010, p. 232) mentioned that 'assurance' is likely to play a predominant role in developing and collectivist cultures. In this context, the authors mentioned that, "[w]hile there is less evidence with respect to the relationship between perceptions and overall quality evaluations, there is some evidence to support the proposition that assurance will be an important predictor in developing collectivist countries". Therefore, this study conceptualizes perceived assurance as a critical dimension of the interaction quality which will finally contribute to overall service quality perception.

Finally, *empathy* refers to customized attention to the users and the ability to understand their needs (Kettinger & Lee 1995; Parasuraman 1988). This dimension measures the attitude and behavior of physicians in health care in understanding patients' specific needs (Bitner 1990; Brady & Cronin 2001). This understandability is reflected by the caring, helpful and courteous behavior of service providers in responding to patients' concerns (Andaleeb 2001). Hojat et al. (2005) defined empathy in health care as "a *cognitive* (as opposed to affective) attribute that involves an *understanding* of the inner experiences and perspectives of the patient, combined with a capacity to *communicate* this understanding to the patient". The authors added that interpersonal interaction is a key factor in patient care which underscores the role of empathy in health service research. Empathy has also been identified as a key theme in general service literature as customers' perceptions of service quality are influenced to a large extent by the degree of interpersonal empathetic behavior (Rosenbaum & Massiah 2007). In health care, providers are expected to express empathy and provide personal attention to patients' needs (Grougiou & Pettigrew 2011) because patients assess a health service on the basis of its provider's ability to extend empathetic concern to them. Some studies identify this dimension as a sense of moral responsibility and internalized social responsibility to help patients (e.g., Lee et al. 2005). Thus, this study conceptualizes empathy as one of the key subdimensions of the patient-physician interaction quality in the mHealth environment.

Overall, this study believes that responsiveness, assurance and empathy are salient components of the interaction quality in the context of mHealth, in which the service provision is characterized as a technology-mediated highly interactive and complex environment. The study proposes these three cognitive attributes as the defining characteristics of the patient-physician interaction quality in the context of mHealth (hotline) services in developing countries. Table 4.2 summarizes the perceived interaction quality and its components with their definitions, measures and supporting theories.

Table 4.2 Perceived interaction quality

Interaction quality refers to the quality of intensive interaction between users and physicians in the form of consultation over the mHealth platform. The quality of interpersonal interaction over the mHealth platform is conceptualized with the subdimensions 'responsiveness', 'assurance' and 'empathy'.			
Root Constructs	*Definitions*	*Measures*	*Domain*
Responsiveness	It refers to the willingness to help patients and provide prompt service over the electronic channel.	Willingness and promptness of the mHealth service provider to deliver service.	These three constructs are the dimensions of the SERVQUAL theory (Parasuraman et al. 1988) which have been applied in the following domains to measure interaction quality: Ecommerce & IS (DeLone & McLean 2003) Multichannel service (Sousa & Voss 2006) Traditional health services (Andaleeb 2001, 2008; Dagger et al. 2007) Mobile health services (Akter et al. 2010b)
Assurance	It measures knowledge and courtesy of the mHealth service provider to inspire trust and confidence.	Knowledge, competence, courtesy and trust of the mHealth provider.	
Empathy	It measures caring and individualized attention of the mHealth provider to patients.	Understandability of the patients' needs and ability to provide individualized attention.	

4.2.3 Outcome Quality

This study proposes *outcome quality* as the final primary dimension of service quality. The study defines outcome quality as the quality of perceived service benefits from the service systems (Brady & Cronin 2001; Fassnacht & Koese 2006), in other words, what a consumer receives as a result of his or her interactions with the service platform (Akter et al. 2010a; Akter et al. 2010b). 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"*. Campbell et al. (2000) emphasized distinguishing between the process quality and outcome quality in every interaction between provider and consumer. The extant literature in marketing has underscored the importance of outcome quality in terms of service benefits which may have varying importance to the user (e.g., Batra & Ahtola 1990; Sheth et al. 1991). In the IS discipline, outcome quality in terms of utilitarian and hedonic benefits drew substantial attention in IT use and continuance (e.g., Fassnacht & Koese 2006; Kim & Han 2011; Turel et al. 2007; Venkatesh & Brown 2001). Indeed, outcome quality indicates what the customer is left with while the service is experienced or once the encounter is over (Brady & Cronin 2001; Gronroos 1984; Rust & Oliver 1994).

In health care, McAlexander et al. (1994) identified outcome quality as a basic dimension of overall service quality perception. Studies in traditional health care found that there is a direct relationship found between service outcome (service benefit) and service quality (e.g., Dagger et al. 2007; Donabedian 1988; Ruyter & Wetzels 1998). In a review study on the impact of mobile devices in health care, Prgomet et al. (2009, p. 792) hinted at such a relationship by connecting the benefits of mHealth in terms of enhanced productivity, improved information access, improved communication, reduced medical errors, greater mobility and improved service quality. In the context of mHealth hotline services, Ivatury et al. (2009) mentioned that poor service benefits led to poor service quality perception, hence poor health care outcomes. Although outcome quality frequently appeared in mHealth studies as a significant construct, “the extent to which handheld devices provide benefits due to their mobility has been significantly underinvestigated” (Prgomet et al. 2009, p. 799). As such, studies in mHealth underscored the importance of measuring the perceived outcome of such services (e.g., Kuziemsky et al. 2005; Lindquist et al. 2008; Martins et al. 2005). Thus, to fill this knowledge gap, this study puts forward outcome quality as one of the dimensions of overall mHealth service quality. In services’ research, this construct is measured as a perceptual construct using subjective judgment (Dagger et al. 2007; Fassnacht & Koese 2006). The present study found two key subdimensions of outcome quality, that is, *functional benefit* and *emotional benefit* which are discussed in the following paragraphs.

Functional benefit refers to the degree to which the mHealth service serves its actual purpose (Fassnacht & Koese 2006). According to Sheth et al. (1991), functional or utilitarian benefit plays a predominant role in buying decisions or service exchange. The utilitarian perspective views service as a means of accomplishing some task-related end (Babin et al. 1994; Holbrook & Batra 1987). Most studies in IS also found that functional benefit (i.e., perceived usefulness) plays a critical role in developing a positive attitude towards information technology use (Bhattacherjee 2001; Davis 1989; Limayem 2007). These studies suggest that customers make rational, calculated assessments of the functional benefit in order to use a particular service system (e.g., Bhattacherjee 2001; Davis 1989; Hong & Tam 2006; Kim et al. 2007; Limayem

2007). Citing the role of functional benefit in mHealth, Kahn et al. (2010, p. 256) stated that, "[t]he complex care required for people living with HIV/AIDS has fostered use of mHealth tools. Several groups have reported increased mobile access among such people, with some evidence of resulting improvement in medication adherence and health". In the context of the mHealth (hotline) service, Ivatury et al. (2009) mentioned the role of functional benefit in terms of time, cost, privacy and better solutions. However, there are few studies in the mHealth environment which have adequately articulated this dimension as a component of outcome quality to capture overall service quality perceptions. Thus, the study conceptualizes perceived functional benefit as a dimension of perceived outcome quality.

Emotional benefit refers to the degree to which the mHealth service arouses positive feelings (Fassnacht & Koese 2006). The extant literature specified emotional benefit as primarily non-instrumental and experiential (Kim & Han 2009; Sweeney & Soutar 2001). Studies have also found that emotional benefit has a strong impact on our beliefs and attitudes, and dictates our decision making and action (Gratch & Marsella 2004). Some studies suggest that specific emotional benefits (e.g., positive feeling, arousal, stimulation, encouragement) influence users' attitudes towards use and continuance of a new IT (e.g., Brown et al. 2004; Kim et al. 2004; Venkatesh et al. 2003). However, according to Beaudry and Pinsonneault (2010, p. 690), "[l]ittle attention has been given to understanding how emotions can influence initial IT use". Furthermore, Beaudry and Pinsonneault (2005) mentioned that users' perceptions of a new system and its performance features generated emotional benefits which further constituted their behaviors towards the system. Studies in consumer behavior consider emotional benefit instrumental as it strongly influences the buyer's decision-making process (e.g., Babin et al.

1994). Hirschman and Holbrook (1982) divided consumers into problem solvers (utilitarian benefits' seekers) and hedonists (positive stimulation seekers). Hirschman (1982) further mentioned that consumption experiences might have hedonic qualities which influence overall quality perceptions. Emotional benefit has received much attention in recent years in service research to stimulate users' beliefs regarding service quality perception (Fassnacht & Koese 2006; Koivumäki et al. 2008; Sweeney & Soutar 2001). This is particularly important for the mHealth service system that provides both functional and emotional benefit to patients. In health care, this dimension indicates patients' feelings regarding service experience in terms of encouragement or stimulation (Dagger et al. 2007). This benefit particularly removes any sort of mental unease experienced by patients with their health problems (Akter et al. 2010a). According to Feder, mHealth enables patients in developing countries by providing all the positive support and now "[p]atients have more power to drive their own care and convey their concerns to doctors" (2010, p. 263). Thus, by articulating this hedonic benefit as a critical component of outcome quality, this study puts forward this subdimension to capture the overall service quality perception in mHealth.

This study proposes outcome quality as a critical primary dimension in mHealth which incorporates functional and emotional benefits as its subdimensions. Although the importance of outcome quality has been cited frequently in the extant literature, very few studies have examined its contribution in service quality evaluation (Dagger et al. 2007). In this regard, Fassnacht and Koese (2006) mentioned that, "[e]specially, functional and emotional benefit deserves more research attention in order to further examine the role it plays in evaluating QES". Thus, this study proposes functional and emotional benefits as facets of outcome quality in capturing overall perceptions of mHealth service quality in developing countries. Table 4.3 summarizes perceived outcome quality and its components with their definitions, measures and supporting theories.

Table 4.3 Perceived outcome quality

Perceived *outcome quality* refers to the functional and emotional benefits of service in the mHealth environment (Fassnacht & Koese 2006; Kim & Han 2011; Turel et al. 2007).			
Root Constructs	*Definitions*	*Measures*	*Theories*
Functional or utilitarian benefits	The extent to which the service serves its actual purpose.	It measures purpose fulfilment and convenience of the service.	E-service quality (Fassnacht & Koese 2006) Health service quality (Dagger et al. 2007; McAlexander et al. 1994; Sweeney & Soutar 2001)
Emotional or hedonic benefits	The extent to which using the service arouses positive feelings.	It measures positive feelings and encouragement of the service received.	Consumer behavior (e.g, Babin et al. 1994; Batra & Ahtola 1990; Hirschman & Holbrook 1982; Hirschman 1982; Sheth et al. 1991) IT adoption and continuance (Beaudry & Pinsonneault 2005, 2010; Davis 1989; Nelson et al. 2005; Limayem et al. 2007; Turel 2007; Kim & Han 2009, 2011).

4.3 Hypotheses Development

This study argues that mHealth service quality is a hierarchical construct which consists of three primary dimensions (i.e., platform quality, interaction quality and outcome quality) and nine subdimensions (i.e., system reliability, system availability, system efficiency, system privacy, responsiveness, assurance, empathy, functional benefit and emotional benefit). The overall service quality construct reflects an overall assessment of the standard of service received (Akter et al. 2010a; Brady & Cronin 2001; Dagger et al. 2007). The study models the effects of the overall mHealth service quality construct on satisfaction, intention to continue using and quality of life as these concepts offer distinctive perspectives to enrich the understanding of mHealth consumption behavior (see Figure 4.1). In the following sections, the study discusses the association between constructs and proposes relevant hypotheses.

4.3.1 Service Quality and Satisfaction

Service satisfaction becomes an important cornerstone for service-oriented business practices around the world (Szymanski & Henard 2001). In health care, satisfaction is a major indicator in measuring the effects of quality or overall service performance (Aharony & Strasser 1993; Carey & Seibert 1993; Hall & Dornan 1988; Saila et al. 2008). Satisfaction also leads to favorable results, such as higher rates of patient retention and higher profits (Peyrot et al. 1993; Zeithaml 2000). As such, customer (or patient) satisfaction turns into an integral part of health care organizations' strategic processes (Andaleeb 2001; Choi et al. 2004; Reidenbach & McClung 1999). Donabedian (1988) suggests that satisfaction should receive equal importance to service quality in order to design and manage the health care systems effectively.

Satisfaction is an 'affective response' (Giesh & Cote 2000; Halstead et al. 1994) although scholars report this construct from different viewpoints, such as a fulfilment response (Oliver 1997), an overall evaluation (Fornell 1992), a psychological state (Howard & Sheth 1969), a global evaluative judgment (Westbrook 1987) and a summary attribute phenomenon (Oliver 1993). Service quality is a cognitive construct, whereas satisfaction is an attitudinal construct (e.g., Brady & Robertson 2001; Cronin & Taylor 1992; Gotlieb et al. 1994; Voss et al. 2004). Thus, the extant literature identifies satisfaction as an affective response to the cognitive service quality approach (Oliver 1997; Taylor & Baker 1994; Tse & Wilton 1988; Pascoe 1983). This distinction suggests a causal model that identifies service quality as an antecedent to satisfaction (Choi et al. 2004). In health care settings, numerous studies support this causal linkage between service quality and satisfaction (Andaleeb 2000, 2001, 2008; Bowers et al. 1994; Dagger et al. 2007; Reidenbach & Sandifer-Smallwood 1990; Woodside et al. 1989). The impact of overall service quality on patient satisfaction is a dominant concern in the health services (Dagger et al. 2007; Gilbert et al. 1992). Several researchers (e.g., Dabholkar et al. 2000; Dagger et al. 2007) have used this construct directly using multi-item measures to evaluate its impact on satisfaction and behavioral intentions. According to Dabholkar et al. (2000, p. 169):

"A practical reason for using overall measures of service quality (i.e., without reference to any specific factors) is to capture customer evaluations of overall service quality directly. Such measures provide better feedback to managers about how customers view overall service and better prediction of behavioral intentions."

IS researchers (e.g., Bailey & Pearson 1983; Baroudi & Orlikowski 1988; DeLone & McLean 1992, 2003; Doll & Torkzadeh 1988; Ives et al. 1983; Jia et al. 2008; Nelson et al. 2005) used a quality-based approach for measuring user satisfaction and suggested that it is an indispensable indicator to measure IS performance. According to DeLone and McLean (2003, p. 17), "[i]t is essential that IS researchers distinguish between the management control variables and the desired results in terms of quality, use satisfaction, and impacts". Similarly, the health care literature suggests that service quality should be separately conceptualized and linked to satisfaction (Babakus & Mangold 1992; Dagger et al. 2007; Reidenbach & Sandifer-Smallwood 1990; Taylor & Cronin 1994) in order to maximize performance and to minimize failures (Zeithaml & Bitner 2000). In traditional health care, 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 (e.g., Andaleeb 2001; Dagger et al. 2007). In the context of mHealth, the provision of health service quality has been linked with satisfaction levels, as mentioned by the Earth Institute (2010, p. 38), "pregnant women who received text messages for prenatal support had significantly higher satisfaction levels than those who did not receive any text message support". In a similar spirit, Ivatury et al. (2009) urged measuring this association in order to measure the performance of mHealth services in developing countries. Thus, given the important link between service quality and satisfaction, this study posits satisfaction as a function of perceived service quality in the context of mHealth services:

H1: Service quality has a positive impact on satisfaction in mHealth services.

4.3.2 Service Quality, Satisfaction and Continuance Intentions

The success of a technology-mediated service platform, such as mHealth, depends a lot on ongoing usage rather than initial acceptance (Bhattacherjee 2001; Limayem et al. 2007; Venkatesh & Davis 2000). As such, an increasing body of research in this domain depends on continuance theory (Akter et al. 2010a; Akter et al., 2012a). This study defines continuance as a usage stage when technology-based service use (e.g., mHealth) transcends conscious behavior and becomes part of normal routine activity (Bhattacherjee 2001). The continuance decision is similar to consumers' repurchase decision which is primarily based on satisfaction with a particular product or service (Anderson & Sullivan 1993; Oliver 1980, 1993). Bhattacherjee (2001, pp. 351-352) highlights the importance of continuance in IT services by saying that "long-term viability of an IS and its eventual success depend on its continued use rather than [its] first-time use". Thus, continuance behavior is a highly relevant construct from a practical perspective because service usage obviously continues well beyond the initial adoption (Montoya et al. 2010).

Both service quality and service satisfaction have profound impact on future use intentions (Cronin et al. 2000; DeLone & McLean 2003; Venkatesh et al. 2003; Wixom & Todd 2005). According to Dabholkar et al. (2000, p. 144) "… 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 quality impact on intentions to use and also an indirect impact on intentions to use through satisfaction (Wixom & Todd 2005; DeLone & McLean 2003). However, this study uses '*intention to continue using*' instead of '*intention to use*' as it is necessary for an IS to be truly able to measure net benefits (DeLone & McLean 2003; Teo et al.

2007). Intention to continue using is defined as a behavioral pattern reflecting continued use of a particular IS (Limayem 2007). It is also defined as a usage stage when IS use transcends conscious behavior and becomes part of normal routine activity (Bhattacherjee 2001).

Some studies refer to intention to continue using as a usage behavior, commonly labelled as *post-implementation* (Saga & Zmud 1994) or *post-adoption* (Jasperson et al. 2005) which are equally important to attaining information technology implementation. Hence, this study focuses on *post-adoption* which actually refers to a suite of behaviors that follows initial acceptance (Rogers 1995), including *continuance*, *routinization*, *infusion*, *adaptation*, *assimilation*, etc., which is often used as a synonym for 'intention to continue using' in the literature (Karahanna et al. 1999). 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; Teo et al. 2008). Also, in health services, quality perceptions and satisfaction have a strong influence on one's inclination to continue using such services (Andaleeb 2001). A growing number of service providers are interested in knowing about this relationship because it predicts overall financial performance (Bernhardt et al. 2000; Eskildsen & Kristensen 2003; Kristensen et al. 2006; Rucci et al. 1998). Therefore, the study hypothesizes that:

H2: Service quality has a positive impact on continuance intentions.

H3: Satisfaction has a positive impact on continuance intentions.

4.3.3 Service Quality, Satisfaction and Quality of Life (QOL)

Quality of life (QOL) generally refers to the degree of fulfilment of one's needs, goals and wishes (Campbell et al. 1976; Diener 1984; Yuan 2001). QOL also refers to individuals' subjective assessment of their overall life including their health (Ferrans 1990; Ferrell et al. 1989). This study views QOL as a perceived, individual, experiential concept. Given the mHealth context of the present study and the importance of health care as a critical element in quality of life (Giler 1987), the study defines QOL as a sense of overall well-being in health (Aaronson et al. 1996; Dagger & Sweeney 2006). The extant literature reports that the experience of service quality of an entity and level of QOL are interlinked as studies show that better quality experience of a particular service system leads to a greater satisfaction with life (Sirgy 2001; Lee et al. 2002). As such, Dagger and Sweeney (2006) mention that service evaluation might have a strong influence on the social outcome (e.g., QOL) in addition to the traditional economic outcome (e.g., profitability, loyalty or service continuance).

IS researchers have identified the role of QOL by citing the impact of IS on individual, organizational and social levels (e.g., Choi et al. 2007; DeLone & McLean 2003; Petter et al. 2008; Myers et al. 1997; Seddon et al. 1999; Walsham et al. 2007). The relevance of IT to quality of life has been acknowledged and recognized in the health care industry (Sirgy 2001; Sirgy & Samli 1995). According to Straub & Watson (2001), *"[o]ne of the goals of any technology should be to increase the quality of its users' lives"*. In line with this view, Walsham et al. (2007) mention, "[t]he question has now become not whether, but how ICTs can benefit development". As such, Croon Fors and Stolterman (2004) mention that there is a growing need to understand IT service dynamics which change and affect human lives.

The premise of this section is that people have a variety of health care needs that they seek to fulfill, and the more they satisfy these needs, the more they feel good about the quality of their lives (Heisel & Flett 2004). The study designates *"quality of health life"* as an alternative outcome variable of overall service quality and it is more interested in how mHealth services contribute to *quality of (health) life* than in how satisfied users are with their lives generally. In the general health service context, prior studies found that there is a link between service quality, satisfaction and quality of life perceptions (Dagger & Sweeney 2006; House 1986). Since service satisfaction contributes to and enhances well-being, it is related to the quality of health life of an individual (Choi et al. 2007). According to Dagger and Sweeney (2006, p. 5), "perceptions of service quality and service satisfaction may have the potential to contribute to the quality of life experienced by individuals". Studies also confirmed that these concepts (i.e., service quality, satisfaction and QOL) are distinctive, and urged an evaluation of their association to enrich the understanding of consumer behavior (e.g., Lee & Sirgy 2004; Sirgy et al. 2006; Zeithaml 2000). However, no studies have yet framed the direct impact of overall service quality on QOL and indirect impact through satisfaction in the mHealth domain. Also, this study is interested in exploring the association between QOL and intention to continue using as it expects that a better quality of health life through the mHealth experience will increase patients' further intentions to use this service. Thus, the study hypothesizes that:

H4: Service quality has a positive impact on quality of life.

H5: Satisfaction has a positive impact on quality of life.

H6: Quality of life has a positive impact on continuance intentions.

Table 4.4 presents a summary of outcome constructs (i.e., satisfaction, intention to continue using and quality of health life) with their definitions, measures and supporting theories.

Table 4.4 Definitions and measures of outcome constructs

Service satisfaction	**Intention to continue using**	**Quality of health life**
This study defines satisfaction as a user's overall evaluation of his/her experiences with the mHealth services.	This study defines intention to continue using as a usage stage when mHealth use transcends conscious behavior and becomes part of normal routine activity.	This study defines QOL as a sense of overall well-being in health care.
Measures: *Satisfaction* *Contentment* *Pleasure* *Delight*	***Measures:*** *Reuse intentions* *Commitment*	***Measures:*** *Improvement in overall health* *Closer to ideal health life* *Level of health life*
Theories Spreng et al. (1995); Dagger et al. (2007)	***Theories*** Bhattacherjee (2001); Limayem (2007).	***Theories*** Dagger & Sweeney (2006); Choi et al. (2008)

4.3.4 Mediating Effects of Satisfaction

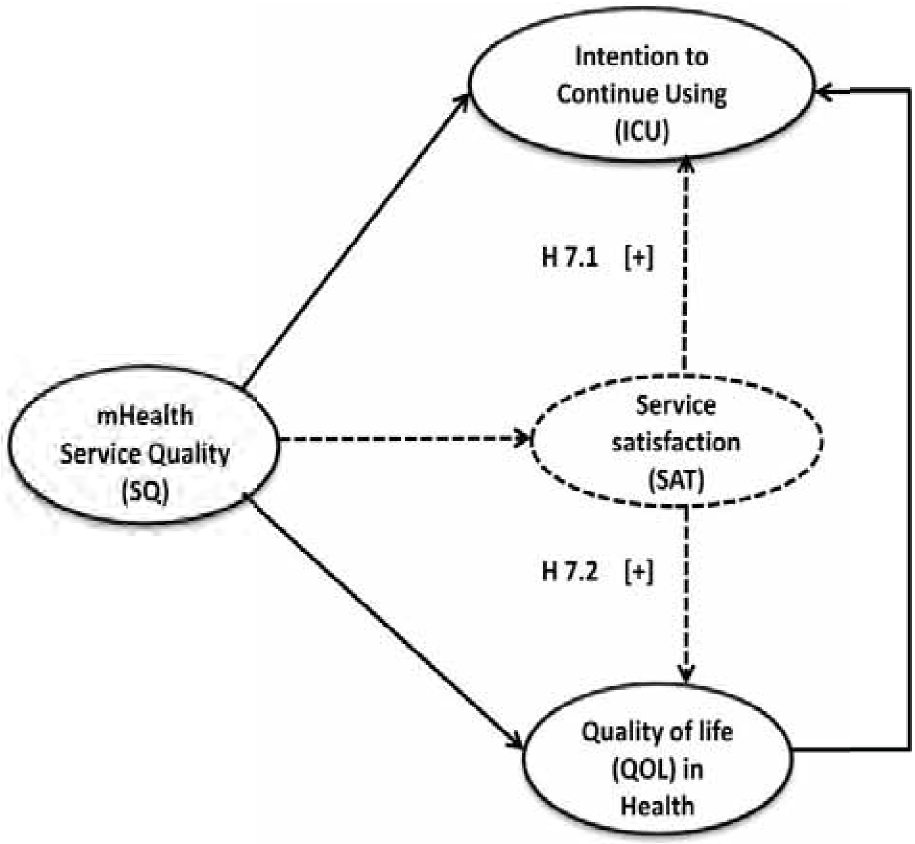

Figure 4.2 Mediating effects of satisfaction

Satisfaction is a major driver of positive QOL perception and continuance intentions, and, therefore, achieving high consumer satisfaction is a key goal of any service system (Bhattacherjee 2001; Chiou et al. 2006; Fornell et al. 1996; Oliver 1997). In Figure 4.2, this study identifies satisfaction as a mediator because, firstly, service quality (predictor) influences satisfaction (mediator); secondly, satisfaction influences ICU and QOL (criterion variables) and, finally, service quality influences the criterion variables in the absence of the mediator's influence (Baron & Kenny 1986; Holmbeck 1997). In addition, satisfaction as a mediator or an 'affective' attitude between 'cognitive beliefs' (e.g. service quality) and 'conative' constructs (e.g. ICU and QOL) draws much attention in psychology (Ajzen & Fishbein 1980), marketing (Bansal et al. 2005; Dagger & Sweeney 2006) and information systems literature (Bhattacherjee 2001; Limayem et al. 2007). Thus, the study puts forward satisfaction as a critical mediator in the research model and argues that it is important to explore the mediating role of satisfaction in high-involvement mHealth services:

H 7.1: Satisfaction mediates the relationship between service quality and continuance.

H 7.2: Satisfaction mediates the relationship between service quality and QOL.

4.3.5 Moderating Effects of Service Quality

This study defines a moderator as "a variable that affects the direction and/or strength of the relation between an independent or predictor variable and a dependent or criterion variable" (Baron & Kenny 1986, p. 1174). In fact, moderation occurs when a predictor (satisfaction) and moderator (service quality) have a joint effect in accounting for incremental variance in the criterion variables (i.e., ICU and QOL) beyond that explained by the base model (Cohen & Cohen, 1983). Although the effects of a moderator have received significant attention, most studies do not test them separately. In this regard, Chin et al. (2003, p. 1) comment that "[s]ome conceive variables as moderators, either explicitly or implicitly, but never test them empirically as an interaction term, just as an independent variable (e.g., the extensive work on contingency theory). Some never empirically test the moderators at all, choosing to put forth a theoretical model that adds to an ever-growing list". Thus, in Figure 4.3, the study puts forward the higher-order service quality construct as a moderator, which might have an influence on the links between SAT-ICU and SAT-QOL. As such, the variation in service quality might influence the strength or the direction of these links (Baron & Kenny 1986; Holmbeck 1997). Surprisingly, research on the moderating role of higher-order service quality on both these associations is non-existent. This study finds this omission intriguing in order to explore complex interdependencies among latent variables (Chin et al., 2003; Homburg & Giering 2001). In addition, an analysis of moderating effects is of high relevance as complex relationships are typically subject to contingencies in the causal network of consumer attitudes. Thus, the study hypothesizes that:

H 8.1: Service quality moderates the relationship between satisfaction and continuance.

H 8.2: Service quality moderates the relationship between satisfaction and QOL.

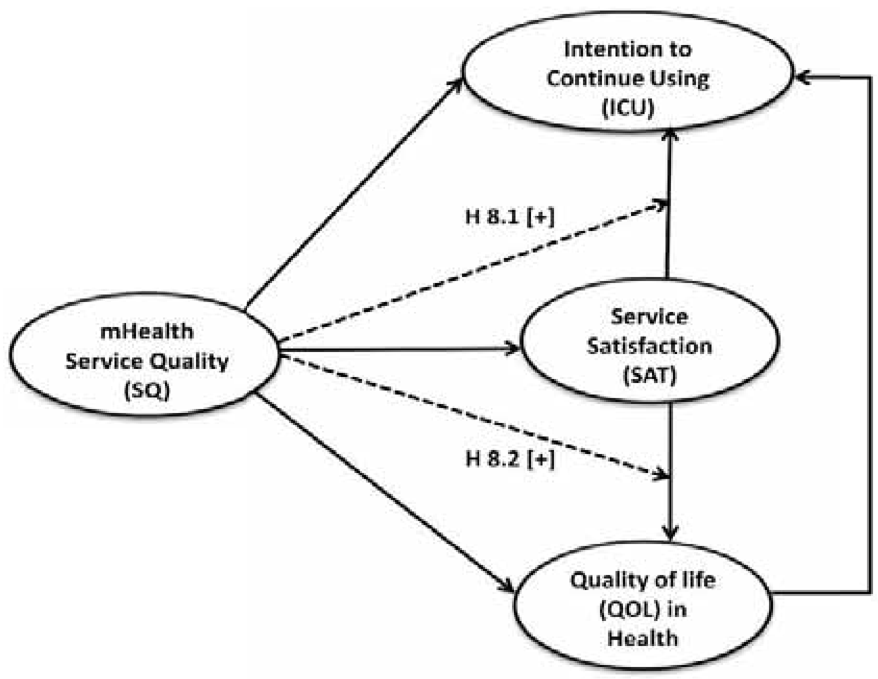

Figure 4.3 Moderating effects of service quality

4.3.6 Control Variables (Demographic and Situational Factors)

In order to discern the impact of contextual factors on the research model, this study assumes demographic and situational factors as control variables (see Figure 4.4) and models their direct impact on the ultimate outcome construct (i.e., ICU). The extant research has evidenced that *demographic factors* contribute to individual user differences on behavioral intentions (Venkatesh 2003). Likewise, some studies have mentioned the critical role of *situational factors* on behavioral intentions (Kleijnen 2007). Overall, studies (Cooil et al. 2007; Venkatesh & Davis 2000) suggest investigating the impact of contextual variables on the ultimate outcome construct, that is, intention to continue using (ICU), in this study.

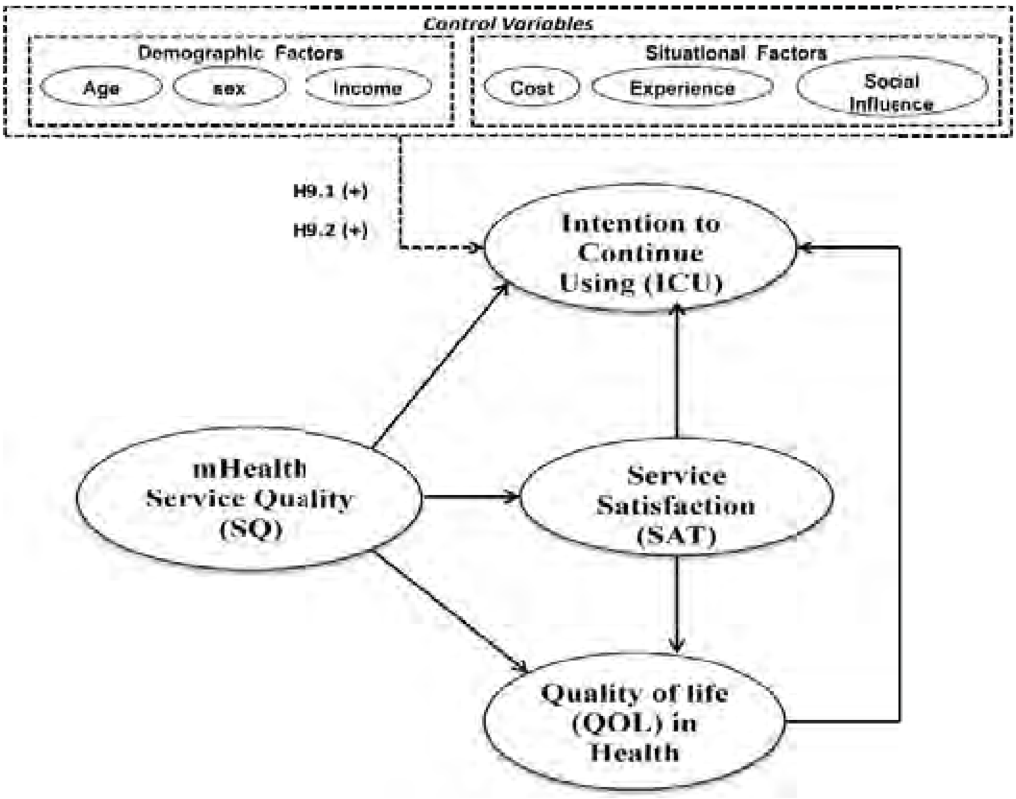

Figure 4.4 Effects of control variables

This study defines demographic characteristics as the attributes relating to the individual user, such as, age, gender and income (see Table 4.5). As situational factors, the study refers to the characteristics specific to the context, such as, cost of service, individual experience and social influence in predicting continuance intentions. The study specifies these control variables as formative measures as changes in these variables will cause changes in the corresponding constructs (Jarvis et al. 2003). The measures in the constructs capture differing aspects of demographic (i.e., age, gender and income) and situational (i.e., cost, experience and social influence) factors and, as such, the operationalization of these variables is conducted in a formative manner. Formally, this specification implies that $\eta = \gamma_1 x_1 + \gamma_2 x_2 + ... + \gamma_n x_n + \zeta$ where γ_i is the expected effect of x_i on η and ζ is a disturbance term (Bollen & Lennox 1991; Diamantopoulos & Siguaw 2006). As a result, the theoretical direction of causality is from measures to constructs which indicates that measures are the defining characteristics of the constructs (Jarvis et al. 2003; Petter et al. 2007). In addition, this specification indicates that measures do not covary with each other and they are not interchangeable. Furthermore, the nomological net for indicators is different as indicators are not required to have the same antecedents and consequences (Jarvis et al. 2003). The extant research supports the formative nature of demographic and situational factors which are made up of distinct items in modeling the effects on endogenous constructs (Kleijnen 2007; Cooil et al. 2007; Akter et al. 2012). Thus, this study proposes demographic and situational factors as formative control variables which influence the ultimate dependent variable, that is, intention to continue using mHealth services.

Knowledge about both demographic and situational characteristics is useful and important for creating user segments and serving their specific needs. In the context of an mHealth (hotline) service, Ivatury et al. (2009, p. 198) mention that “[m]ore research is needed to better understand caller demographics”. Although this study has specified both demographic and situational characteristics as control variables, it is interested in measuring the level of direct influence of both these constructs on continuance intentions. According to Jarvenpaa et al. (1985): *“Testing relationships between hypothesized variables without ruling out effects of moderating or exogenous variables means that internal validity has not been completely addressed through statistical or experimental controls”*. Thus, this study posits that demographic factors and situational factors have influence on continuance intentions:

H 9.1 (control hypothesis): Continuance intentions vary as per the demographic characteristics (i.e., age, gender and income).

H 9.2 (control hypothesis): Continuance intentions vary as per the situational characteristics (i.e., cost, social influence and experience).

Table 4.5 Control variables

Demographic Characteristics	*Situational Characteristics*
The study defines demographic characteristics as the attributes relating to the individual user. Root variables: *Age, Gender, Income*	The study defines situational characteristics as attributes specific to the context of the user. Root variables: *Cost, Experience and Social Influence*

4.4 Specifying the Theoretical Model

Specification of the theoretical network elucidates the theoretical meaning of the constructs and their relationships. According to Bagozzi (2011, p. 263), "... the theoretical meaning of a construct inheres in what it is and to what it relates conceptually. A construct standing alone is less rich in meaning than one that is explained by something else or one that also explains or predicts something else." Thus, the nature of the theoretical model, its constructs and their relationship should be specified in order to ensure conceptual, methodological and empirical rigor (Blalock 1968; Costner 1969; Edwards & Bagozzi 2000; Jarvis et al. 2003; Petter et al. 2007). Indeed, the potential for measurement errors due to misspecification of the research model affects conceptual soundness and prohibits theory development due to improper results (Edwards & Bagozzi 2000; Jarvis et al. 2003; Petter et al. 2007; Wetzels et al. 2009).

4.4.1 mHealth Service Quality is a Hierarchical Model

The proposed mHealth service quality is a hierarchical construct model. Hierarchical constructs or multidimensional constructs are defined as constructs with more than one dimension where each dimension captures some portion of the overall latent variable (Edwards 2001; Jarvis et al. 2003; Law et al. 1998; Law & Wong 1999; MacKenzie et al. 2005; Netemeyer et al. 2003; Petter et al. 2007; Wetzels 2009). Hierarchical modeling has both theoretical and practical implications (Edwards 2001). Theoretically, hierarchical modeling shows that users aggregate their evaluation of subdimensions to form primary dimensions, which in turn lead to an overall perception of a particular construct. Empirically, hierarchical modeling has proven to be successful in increasing theoretical parsimony and reducing model complexity (Edwards 2001; Law et al. 1998; MacKenzie et al. 2005). Due to the multidimensional nature of higher-order constructs, they are entirely different from unidimensional constructs which have a single underlying dimension (Netemeyer et al. 2003). Since theoretical models require the capture of specific dimensions of a construct, hierarchical modeling can be used to capture specific facets of a construct. Indeed, a hierarchical structure can better capture the complexity of human perceptions (Dabholkar et al. 1996). As such, it is defined as measure-specific modeling which allows the matching of specific independent and dependent variables (Fischer 1980). In matching the level of abstraction, hierarchical modeling has also proven to be beneficial (Edwards 2001) which has already been reflected in the studies of Akter et al. (2010a), Akter et al. (2011b), Brady and Cronin (2001), Chin and Gopal (1995), Dagger et al. (2007), Fassnacht and Koese (2006) and Wetzels et al. (2009). Overall, the conceptual justification of such modeling will be complemented by empirical findings in terms of construct reliability and validity in Chapter 8.

The extant research on service quality has specified this construct as a hierarchical construct in most cases (Akter et al. 2010a; Brady & Cronin 2001; Dabholkar et al. 1996; Dagger et al. 2007; Fassnacht & Koese 2006; Rust & Oliver 1994). The past studies show that service quality consists of some dimensions and subdimensions which in turn share a common theme reflected by the higher-order global perceived service quality construct. For instance, Rust and Oliver (1994) proposed a multilevel-multidimensional conceptual model for service quality in health care. Dabholkar et al. (1996) developed and validated a hierarchical conceptualization of service quality at three levels: overall perception, primary dimensions and subdimensions. In the same spirit, Brady and Cronin (2001) found that service quality is a third-order construct which consists of three first-order dimensions and nine subdimensions across four service industries. Fassnacht and Koese (2006) conducted their study on online services and found that service quality has three primary dimensions and nine subdimensions. The findings of Dagger et al. (2007) were consistent with a previous study which confirmed that service quality is a hierarchical construct which is comprised of four primary dimensions and nine subdimensions in general medical service. Aligned with these explorations, this study specifies the mHealth service quality model as a third-order, hierarchical construct model which consists of three second-order dimensions (i.e., platform quality, interaction quality and outcome quality) and nine first-order dimensions (i.e., systems reliability, systems availability, systems efficiency, systems privacy, responsiveness, assurance, empathy, functional benefit and emotional benefit).

4.4.2 mHealth Service Quality is a Reflective Model

The specification of the measurement perspective or the use of reflective or formative modeling should be explicitly based on the 'auxiliary theory' (Blalock 1968; Costner 1969) specifying 'the nature and direction of the relationship between constructs and measures' (Chin 1998a; Edwards & Bagozzi, 2000, p. 156). In a similar spirit, Pedhazur and Schmelkin identified that the specification of the type of manifest variable "depends on the theoretical formulations about the construct" (1991, p. 54). The extant research on measurement model specifications (Chin 2010; Edward & Bagozzi 2000; Jarvis et al. 2003; Petter et al. 2007; Wetzels et al. 2009) supports service quality as a reflective model within the broader quality-based nomological network. Aligned with these findings, this study specifies service quality as a reflective model based on the decision criteria of Jarvis et al. (2003), Petter et al. (2007) and Akter et al. (2010a; 2011a), which are discussed in the following paragraphs.

Firstly, the study specifies the research model (Figure 4.1) as reflective because the theoretical direction of causality is from constructs to items. More specifically, this decision rule indicates that measures are manifestations of constructs, that is, changes in the constructs cause changes in the measures . For instance, the construct *systems privacy* in mHealth is measured by Akter et al. (2010a) using the following measures: “It protects my personal information” and “It does not share information with others”. It indicates that the measures are one representation of the construct where a change in the construct itself is reflected by a change in the measures rather than the measures causing the change in the construct (Jarvis et al. 2003; Petter et al. 2007).

Secondly, the study identifies the research model (Figure 4.1) as reflective because measures of each construct are interchangeable, have a common theme and reflect unidimensionality. It also indicates that dropping one of the measures would not change the conceptual meaning of a construct because items are manifestations of constructs. For instance, Akter et al. (2010b) measured the construct *empathy* in mHealth as follows: “They understand my specific needs”, “They have my best interests at heart” and “They give me individual care”. These three measures are interchangeable, share one theme and any measure can be easily dropped without changing the conceptual meaning of the construct (Jarvis et al. 2003; Petter et al. 2007).

Through the above discussion, the study makes it evident that mHealth service quality is a third-order, hierarchical-reflective construct model because the dimensions and subdimensions are viewed as manifestations of overall service quality. The service quality construct exists separately at a deeper and more embedded level than its dimensions and subdimensions, and a change in service quality is expected to produce a change in all second-order and first-order dimensions (see Figure 4.1).

4.4.3 Nature of the mHealth Service Quality Theory

The theoretical model of this study is specified as ***explaining and predicting*** **(EP)** which implies *"both understanding of underlying causes and prediction, as well as description of theoretical constructs and the relationships among them"* (Gregor 2006, p. 23). The proposed theory determines the components that reflect the service quality of mHealth and its overall impact on service satisfaction, intention to continue using and quality of health life in a developing country context. This type of theory explains 'What is', 'Why', 'When' and 'When will be' and is most prevalent in the positivist-quantitative research. This theory is also identified as a *'variance type of theory'* which looks at the degree to which one variable can predict changes in another variable using statistical techniques and larger samples (Huber & Van de Ven 1995; Markus & Robey 1988). Typical examples of this theory are the Technology Acceptance Model (TAM) (Davis et al. 1989) and DeLone and McLean's dynamic model of IS success (1992, 2003) which aim to explain and predict behavior around the IT phenomenon.

In Table 4.6, this study presents the overall structure of the proposed explaining-predicting service quality theory.The theory presents the constructs of the research model in terms of first-order, second-order and third-order hierarchy.The theory also determines the nature of the relationship among constructs which is based on hierarchical-reflective modeling. The boundary of the proposed theory is also determined by presenting a cognitive-affective-conative framework of service quality in the B2C mHealth (hotline) context. In this case, mHealth users in developing countries were used as samples and mobile phone-based health service systems were used as the technological platform. The theory also presents causal relationships among constructs to extend knowledge in this particular domain.

Table 4.6 An overview of the mHealth service quality theory

<table>
<tr><td colspan="2">Theory Overview</td></tr>
<tr><td colspan="2">The proposed theory on the mHealth service quality explains the dimensions (perceived platform quality, interaction quality and outcome quality) and subdimensions of service quality and its overall impact on satisfaction, intention to continue using and quality of life based on users’ perceptions in the developing country context. This theory is formulated on generic service quality theories in IS, marketing and health service research.</td></tr>
<tr><td>Theory component</td><td>Instantiation</td></tr>
<tr><td>Means of representation</td><td>Diagram and explanation</td></tr>
<tr><td>Primary constructs</td><td>First-order constructs: systems reliability, systems efficiency, systems availability, systems privacy, responsiveness, assurance, empathy, functional benefit and emotional benefit.
Second-order constructs: platform, interaction and outcome quality
Third-order construct: overall service quality (SQ)
Outcome constructs: SAT, ICU, QOL
Control variables: demographic and situational factors.</td></tr>
<tr><td>Statements of relationship</td><td>Overall, mHealth service quality is a third-order construct, which is reflected by perceived platform quality, interaction quality and outcome quality. Perceived platform quality is reflected by systems reliability, systems efficiency, systems availability and systems privacy. Perceived interaction quality is reflected by responsiveness, assurance and empathy. Perceived outcome quality is reflected by functional and emotional benefit. Overall service quality (SQ) determines satisfaction (SAT), continuance intentions (ICU) and quality of life (QOL) in health.</td></tr>
<tr><td>Scope</td><td>The theoretical model is formed focusing on an mHealth (hotline) in the context of a developing country because of the prevalence of this service in this setting. In testing, quality perceptions and usage-related beliefs were examined, mHealth users were used as samples and the technology examined was a mobile phone-based health service system.</td></tr>
<tr><td>Causal explanations</td><td>Under the base model, the study hypothesizes that:

H1: Service quality has a positive impact on satisfaction in mHealth.
H2: Service quality has a positive impact on continuance intentions.
H3: Satisfaction has a positive impact on continuance intentions.
H4: Service quality has a positive impact on quality of life.
H5: Satisfaction has a positive impact on quality of life.
H6: Quality of life has a positive impact on continuance intentions.</td></tr>
<tr><td>Testable propositions</td><td>Yes</td></tr>
</table>

4.5 Summary

The objective of this chapter was to develop an mHealth service quality model and its association with user satisfaction, continuance intentions and quality of life in the context of mHealth services in developing countries. With the support of relevant literature, the proposed research model specifies that service quality in mHealth is a third-order, hierarchical-reflective model which has significant positive impact on consequential latent variables (i.e., SAT, ICU and QOL). The study proposed six hypotheses to investigate the association between higher-order service quality and outcome constructs in the base model and three hypotheses to examine the role of satisfaction as a mediator, higher-order service quality as a moderator and finally, contextual factors as control variables on the extended model. The study then specified the nature of the research model to establish rigor in research methodology and empirical findings. Overall, the conceptual model of the study filled the gaps identified in Chapter 2 (Literature Review (Context)) and Chapter 3 (Literature Review (Theory)) by proposing a service quality model for B2C mHealth (hotline) services in developing countries. The entire model is based on nine hypotheses to examine the main effects (H1-H6), mediating effects (H7.1-H7.2), moderating effects (H8.1-H8.2) and the effects of control variables (H9.1-H9.2). The study discusses research methodology in the next chapter to validate the proposed conceptual model with its hypothetical relationships.

Chapter 5 Research Methodology (1): Research Paradigm[5]

5.1 Overview

The objective of this chapter is to link the nature of the research model identified in the last chapter (Chapter 4) with epistemological beliefs in this chapter to validate the conceptual propositions. As Simon (1980) states, "… [s]cience may be said to progress on its methods. The production of knowledge depends very much on the techniques for collecting, analyzing, and interpreting data and on the way they are applied". In a similar spirit, this chapter argues that the importance of exploring a research paradigm relies very much on the methods used to answer research questions, test hypotheses and on the careful application of research design. This chapter is a prerequisite for Chapters 6, 7 and 8. Chapter 6 outlines the pilot study for instrumentation, Chapter 7 outlines the data analysis technique for hierarchical modeling and finally, Chapter 8 outlines the analysis and results of the main study.

This chapter is designed as follows: Section 5.2 specifies that the nature of the theory is 'explaining and predicting', the research philosophy is 'quantitative-positivist' and the IT artifact is based on a 'proxy view'. Section 5.3 argues that the research method is 'field study' using

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[5] *Abridged versions of this chapter were published in the following journals:*

- Akter, S., D'Ambra, J. & Ray, P. (2011). Trustworthiness in mHealth Information Services: An Assessment of a Hierarchical Model with Mediating and Moderating Effects using Partial Least Squares (PLS). ***Journal of the American Society for Information Science and Technology (JASIST)***, *62(1), 100-116.*
- Akter, S., D'Ambra, J. & Ray, P. (2010). Service Quality of mHealth Platforms: Development and Validation of a Hierarchical Model using PLS. ***Electronic Markets***, 20(3), 209-227.

cross-sectional survey design. The next sections discuss sampling strategy (Section 5.4), measurement instruments (Section 5.5) and data analysis techniques (Section 5.6). Finally, Section 5.7 provides a summary of the chapter. Overall, this chapter establishes rigor in the research design by justifying the application of relevant research techniques at each phase using adequate logic and support from the literature.

5.2 Research Philosophy

"……..understanding in terms of cause and effect was an a priori characteristic of the human mind underlying all human knowledge." (Kant 1781)

This study embraces Kant's view and proposes a positivist research philosophy based on the assumption that the world of phenomena has an objective reality which can be expressed in causal relationships and measured in data in a representative and accurate manner (Kaplan & Duchon 1988; Straub et al. 2004). Whereas the purpose of interpretivist research is to understand any system in the social context (how they are embedded in, how they impact on and are impacted by context) (Cecez-Kecmanovic 2005; Walsham 1993), the essence of a positivist approach is to "discover" the objective physical and social reality by crafting precise measures that will detect the dimensions of reality that interest the researcher (Orlikowski & Baroudi 1991). It is premised on the existence of a priori fixed relationships within phenomena which are typically investigated with structured instrumentation to test theory, in an attempt to increase predictive understanding of phenomena (Orlikowski & Baroudi 1991). It is assumed that these phenomena are patterned and exhibit regularity, and the role of positivistic research is to discover these patterns and regularities and describe them in the form of cause–effect relationships (Cecez-Kecmanovic 2005). Furthermore, it is believed that such laws are useful for effective *control* and *prediction* of systems development and use, users' behavior and attitudes towards systems, and ultimately, systems’ success or failure (Cecez-Kecmanovic 2005). Accordingly, the purpose of this study is to identify the causal networks (Marshall & Rossman 1989) that can explain and predict overall mHealth service quality (Gregor 2006) and its effects on satisfaction, continuance intentions, and quality of life.

The theory proposed here conforms to Gregor’s (2006) *‘explaining & predicting’* paradigm which is in line with a positivistic mindset. Such theories explain something that is new and interesting, poorly or imperfectly understood beforehand, and discover the regularities that will allow adequate prediction of the model (Gregor 2006). As a result, this study reflects a positivist notion by formulating an empirically-testable theory to establish ‘law-like generalizations’ (Orlikowski & Baroudi 1991), such as, platform quality, interaction quality and outcome quality as components of the overall perception of service quality in mHealth.

Orlikowski and Iacono (2001, p. 125), state that “[r]esearchers are interested in examining individual’s perceptions to better understand what motivates them to accept or use new technologies …” The authors argue that perceptual, cognitive and attitudinal responses to systems are the critical variables in explaining and predicting technology and its effects in the world. The authors also add that researchers examine users’ perceptions to understand the dynamics of any system using a proxy view. Markus and Robey (1988) characterize this approach as "variance theory formulations of logical structure and an imperative conception of causal agency." Mohr (1982) argues that such theory has explanations of causality reliant on the identification of sufficient and necessary antecedent conditions for an outcome.

Thus, utilizing a quantitative-positivist research paradigm, this study intends to validate an ‘explaining and predicting’ theory which is founded on a ‘proxy view’ of the IT artifact (see Table 5.1). Embracing such philosophical paradigms, the conceptual model of the study has already developed mHealth service quality to adequately explain and predict the service outcomes.

Table 5.1 An overview of the research philosophy adopted in this study

Research Paradigm	***Features***	***Approach of the study***
Positivist-Quantitative Approach This approach says that "the world of phenomena involves an objective reality that can be measured and that relationships between entities in this world can be captured in data that is reasonably representative and accurate." (Straub et al. 2004)	• It captures objective reality • It is value free. • Research language is formal and impersonal. • Theory and research design is context free, based on cause and effect, prediction and control, reliability and validity and representative surveys. (Adapted from Creswell 1994)	This study is based on a positivist-quantitative paradigm as it has developed a causal network of a third-order service quality model and its effect on satisfaction, intention to continue using and quality of life in the context of mHealth in developing countries.
Explaining & Predicting Theory This theory implies both an understanding of underlying causes and prediction, as well as description of theoretical constructs and the relationships among them. (Adapted from Gregor 2006)	• Theory component: instantiation • Means of representation: words and diagrams • Primary constructs: antecedent conditions • Scope: theoretical model is given in a general form • Causal explanation: present • Testable propositions: statistical methods (Adapted from Gregor 2006)	The study hypothesizes that *service quality* is a third-order construct based on three second-order dimensions and nine first-order dimensions. The overall service quality influences *satisfaction*, *intention to continue using* and *quality of life* in the context of mHealth. The study validates this causal theory using PLS path modeling.
Proxy View of IT Artifact Information technology is represented in terms of measures of users' perception of technology. (Adapted from Orlikowski & Iacono 2001)	• Perceptual, cognitive and attitudinal responses to IS • Conceptualization of perception through surrogate variables • Should capture contextual variations in IT artifacts through careful theorizing. (Adapted from Orlikowski & Iacono 2001)	This study captures users' perceptions of overall service quality and its outcomes using some surrogate variables in the mHealth context of a developing country.The study also proposes demographic and situational factors as control variables to capture the contextual variations in mHealth service perceptions.

5.3 Research Method

"Research methods shape the language we use to describe the world, and language shapes how we think about the world" (Benbasat & Weber 1996, p. 392).

Since this study identified a causal network of relations in capturing a service quality perception of mHealth, a *field study* was conducted in a natural setting using human subjects (Jenkins 1985). For this field study, the study used the survey method which refers to a structured questionnaire given to a sample of a population to elicit specific information from the respondents (Malhotra 2004). This study adopted the *survey method* because it explains causal relationships between constructs and hence provides generalizable statements on the research setting (Pinsonneault & Kramer 1993; Gable 1994). Moreover, surveys can accurately document the norm, identify extreme information and delineate associations between variables in a sample (Gable 1994). Vidich and Shapiro (1955) highlighted the relatively superior 'deductibility' of the survey method in field studies. They observed that "[w]ithout the survey data, the observer could only make reasonable guesses about his area of ignorance in the effort to reduce bias". Straub et al. (2004) also recommended survey research for explanatory and predictive theory in order to ensure greater confidence in the generalizability of the results.

For the survey method, the study adopted *cross-sectional design* which involves the collection of information only once from any given sample of population elements (Malhotra 2004). This study adopted cross-sectional design over a longitudinal study because it ensures representative sampling and minimum response bias (Dabholkar et al. 2000). Besides, the majority of empirical studies conducted to measure service quality have been cross-sectional (e.g., Brady & Cronin 2001; Carman 1990; Dabholkar et al. 2000; Dagger et al. 2007; Finn & Lamb 1991; Parasuraman et al. 1988). In addition, because longitudinal studies are cumbersome, costly and time consuming, researchers in most cases favored cross-sectional study in order to gain an improved understanding of service quality and greater predictive power (Brady & Cronin 2001; Dabholkar et al. 2000; Dagger et al. 2007; Parasuraman et al. 1985, 1988, 1991, 2005).

5.4 Sampling Process

Data were collected from Bangladesh, one of the leading mHealth service-providing developing nations, under a global mHealth assessment project from January to March 2010. This study focused on mHealth hotline (or mobile telemedicine) services in Bangladesh, which serve patients by providing right-time medical services over mobile phone (Akter & Ray 2010; Ivatury et al. 2009). Currently, more than 24 million subscribers of *Grameen Phone* in Bangladesh have access to such mHealth services under a B2C framework (Akter et al. 2011a). This study has selected *Grameen mHealth* for several reasons. Firstly, Grameen mHealth is the leading mHealth platform in Bangladesh, which has been providing this service since 2006 (Ivatury et al. 2009). Secondly, the provider has 100% network coverage all over the country which allows anyone to access mHealth service from anywhere. Thirdly, the operator has more than 200,000 mobile phone kiosks (rental mobile phones) around the country which ensures access to mHealth service to anyone at any time. Finally, in recent years, the Grameen mHealth platform (i.e., mobile telemedicine/mobile health hotline) has become very popular in Bangladesh as well as in the developing world (e.g., India, Pakistan, Mexico, South Africa, Peru, etc.) for delivering right-time medical services at an affordable cost (Akter & Ray 2010; Ivatury et al. 2009). WHO (2011) reports this particular mHealth service as the most frequently reported (68%) and successfully implemented mHealth initiative in developing countries to provide diagnostic and treatment support.

5.4.1 Target Population with Sampling Frame, Unit and Element

Specifying the target population is the fundamental building block of sampling design process. Generally, the target population represents the sample elements or objects that have the relevant information and about which inferences are drawn (Malhotra 2004). The target population also draws the boundary line between respondents and non-respondents. Thus, it is necessary to be as specific as possible to decide on who should and who should not be in the sample. The population was defined as the subscribers of *Grameen Phone* in Bangladesh which is more than 24 million people (Akter et al. 2010a; Akter & Ray 2010). Two urban areas (*Dhaka City* and *Khulna City*) and three rural areas (*Netronkona*, *Keranigonj* and *Kaligonj*) were selected as sample frames. In urban areas, assuming most people have access to mHealth through their own mobile phones, respondents were selected from residential homes after asking some quick screening questions. And in the rural setting, location intercept was used in addition to the in-home technique because people who do not have their own mobile phones generally access mHealth from “a local mobile phone kiosk”. Table 5.2 presents an overview of the sampling process.

5.4.2 Sampling Technique

In the absence of lists for drawing a random sample, surveys were undertaken in two urban areas and three rural areas of Bangladesh using area wise cluster sampling. Area wise cluster sampling is very common in developing countries in which the clusters (e.g., geographic areas such as divisions, blocks and other area descriptions) are used as sampling units (Akter et al. 2010a; Akter et al. 2011a; Andaleeb 2001, 2008; Malhotra 2004).

Table 5.2: An overview of the sampling process

Sampling process	Sampling strategy of the study	Comments
Target population	Mobile health hotline (or mobile telemedicine) service users in Bangladesh (more than 24 million people).	The aggregate of all the elements sharing some common set of characteristics comprising the population for our research problem.
Sampling frame	Two urban areas (Dhaka City and Khulna City) and three rural areas (Netronkona, Keranigonj and Kaligonj)	These urban and rural clusters represent sample units of the target population.
Sampling unit	All residential homes and local mobile phone kiosks in two urban areas and three rural areas.	These sample units contain the elements of the target population to be sampled.
Sampling elements	18+ males and females who have experience of using this service at least once in the last year.	These respondents meet our qualifications and are able to give information to test inferences.
Sampling strategy	Probability sampling	Area wise cluster sampling as it represents different socio-economic groups.
Sample size	400 completed samples	110 for pilot and 290 for the main study.

Under area wise cluster sampling, this study applied multi-stage area sampling in which the study randomly selected sample units at each stage (Andaleeb 2001; Malhotra 2004). Areas were selected in a manner so that different socio-economic groups were represented. From each area, firstly, thanas (or suburbs) were selected randomly; then, streets/villages were selected from each thana (or suburb); and finally, residential homes were selected from each street/village. In order to obtain a probability sample, systematic random sampling was applied at each stage so that each sample unit/element had an equal chance of being selected. One of the advantages of this technique is its representation of different socio-economic groups (Andaleeb 2008); ideally each cluster is a small-scale representation of the population. This technique also increases sampling efficiency by decreasing costs (Hair et al. 2010). In the context of developing countries, it is cost-effective and easy to implement (Malhotra 2004).

5.4.3 Administration of the Survey Instrument

The data gathering strategy under the survey method is generally predicated on the *nature of survey interaction* and the *mode of questionnaire administration* (Malhotra et al. 2004). In terms of survey interaction, this study applied *in-home and location intercept techniques* jointly because these methods provide maximum response rates in comparison with postal mail, telephone and online surveys in the context of a developing country (Andaleeb 2001, 2008; Malhotra 2004). This strategy was executed in a physical setting in the local language in Bangladesh (Andaleeb 2001). The study developed the initial version of the questionnaire in English using the extant literature and findings from focus group discussions and in-depth interviews. In the next step, the study translated the measures into the local language (Bangla) and retranslated it into English until a panel of experts, fluent both in English and Bangla, confirmed that the two versions were reasonably comparable (Andaleeb 2000, 2001, 2008). Before the pilot study, the study conducted a pre-test of the Bangla questionnaire with 15 samples to confirm that the phrasing, layout, length and progression of questions and that the range of scales were appropriate (for details, see Chapter 6: Instrument development and validation). Upon responses from the pre-test, the study made context-specific adjustments to finalize the pilot version of the questionnaire (see Appendix 6.F: English Questionnaire and Appendix 8.L: Bangla Questionnaire). For health service research, this procedure is quite popular for capturing users' perceptions which has already been reflected in the works of Andaleeb (2000, 2001, 2008) and Dagger (2007). The inherent benefits of this technique are its high control over the sample, high response rate, speedy data collection and large amount of data (see Table 5.3).

Table 5.3 Administration of survey instrument

Data gathering technique: In-home and location intercept techniques	**Questionnaire filling technique:** Self-completion and interviewer-filled techniques
This study applied location intercept and in-home data gathering techniques for the following reasons: • High control over the sample; • Higher response rate; • Speedy data collection; • Large amount of data.	In addition to self-completion, this study applied interviewer-completed surveys for the following reasons: • Illiterate sample elements in the context of a developing country; • Higher response rate and no missing values or mistakes; • Face-to-face culture.

In all survey interactions, interviewers were given a letter of introduction from a reputable university, which contained the phone number so respondents could see that the study was authentic. The academic purpose of the study was explained to those who agreed to be interviewed, with adequate assurance of anonymity and freedom to not answer particular questions or to withdraw their opinion from the interview at any stage. Both self-completion and interviewer-filled survey techniques were used to receive a higher valid response (Hair et al. 2010). Since there are a large number of illiterate sample elements among the target population, interviewer-filled questionnaires were really helpful in maximizing the response rates (Andaleeb 2008; Malhotra 2004) (see Table 5.3).

5.4.4 Sample Profile

A total of 400 surveys were completed. Of the total number of surveys, 110 surveys were completed for the pilot (or exploratory) study in January 2010 and 290 surveys were completed for the main (or confirmatory) study in March 2010. The response rate for the pilot study was 75% (110/147) and the response rate for the main study was 71% (290/410), thus the net response rate was 73%. As the study intended to measure effects and make generalizations about a population, the size of the response rate compellingly exceeds the minimum threshold level (> 60%) for a face-to-face survey (Wholey et al. 2004). Of the pilot study, six surveys were excluded and of the main study, nine surveys were excluded because of excessive missing data, don’t know answers, or N/A answers and response biases. Finally, 104 surveys were analyzed for the pilot (exploratory) study and 283 surveys were analyzed for the main (confirmatory) study. The demographic profile of the respondents both in the exploratory and confirmatory study represents a diverse cross-section of the population and is depicted in Table 5.4.

Table 5.4 Demographic profile of respondents

Items	Categories	Statistic (%)
Gender	Male	51.2
	Female	48.8
Age	18-33	49.5
	34-49	37.4
	50+	13.1
Income (per month in US$)	< $70	46.9
	$71-$141	21.1
	$142-$212	14.5
	$212+	17.5
Location	Urban	51.4
	Rural	48.6
Occupation	Education, teaching & research	32.5
	Domestic worker/housewife	23.2
	Personal business	12.5
	Public organization	7.10
	Private organization	21.2
	Others	3.50
Time of service	9:01 AM – 5: 00 PM (Day)	38.6
	5:01 PM – 10:00 PM (Evening)	45.0
	10:01 PM – 5:00 AM (Night)	14.1
	5:01 AM – 09:00 AM (Morning)	2.30

Of the respondents, 51.2% were male; 49.5% were between 18 and 33 years, 37.4% were between 34 and 49 years, and the remaining 13.1% were older than 50 years. A total of 46.9% of respondents had income of less than $70 per month with the different educational backgrounds including primary education to doctoral qualifications. A total of 51.4% of respondents were from urban areas, whereas 48.6% were from rural areas. Of the total number of respondents, 40.8% were involved in private organizations, public organizations and personal businesses, 32.5% were from the education, research and teaching community, 23.2% were domestic workers (or housewives) and the remaining 3.5% had other involvements. The demographic analysis also indicated that 38.6% of respondents used this service during regular business hours, whereas 61.6% used this service during non-business hours.

5.5 Measurement Instrument

Given the infancy state of mHealth implementation, there is a paucity of reliable and valid instruments to adequately capture the dimensions of service quality in this context. Thus, the study fills this knowledge gap by developing and validating a service quality scale for the mHealth environment. In the following sections, the scale development, validation and adaptation procedures are briefly discussed. However, the next chapter (Chapter 6) discusses in detail the entire instrumentation procedures for the study.

5.5.1. Scale Development and Validation for Service Quality Constructs

This study developed and validated a higher-order service quality scale for mHealth by following the instrument development and validation procedures of seminal studies, such as Churchill (1979) and Moore and Benbasat (1991). To execute the entire procedures, the study consulted with the extant literature, such as Parasuraman et al.’s (1988) generic service quality model, Dabholkar et al.’s (1996) hierarchical service quality model, Parasuraman et al.’s (2005) E-S-Qual model, Fassnacht and Koese’s (2006) service quality model in the electronic service domain and Dagger et al.'s (2007) higher-order service quality model in general health care. In addition, to establish rigor in instrument development and validation, the study focused on scale reliability and validation techniques suggested by Straub (1989), Boudreau et al. (2001), Straub et al. (2004), Chin (2010) and MacKenzie et al. (2011). Table 5.5 outlines the service quality scales that have been developed and validated in the next chapter.

Table 5.5 Scale development and validation for mHealth service quality

Third-Order Construct	**Second-Order Constructs**	**First-Order Constructs**	**Scale Development and Validation**
Service Quality	**Platform quality**	Systems reliability Systems availability Systems efficiency Systems privacy	Scales developed and validated for the study. (See Chapter 6).
	Interaction quality	Responsiveness Assurance Empathy	Scales developed and validated for the study. (See Chapter 6).
	Outcome quality	Functional benefit Emotional benefit	Scales developed and validated for the study. (See Chapter 6).

5.5.2. Scale Adaptation for Outcome Constructs: Satisfaction, Continuance and QOL

This study adapted previously published multi-item scales for outcome constructs, that is, satisfaction, continuance intentions and quality of health life (see Table 5.6). Firstly, the study adapted the ‘*satisfaction*’ scale from Spreng et al.’s (1996) study who designed a seven-point semantic differential scale with four bipolar adjectives: ‘very dissatisfied/very satisfied,’ ‘very displeased/very pleased,’ ‘very frustrated/very contented,’ and ‘absolutely terrible/absolutely delighted.’ The study adapted this scale because “affect” such as satisfaction is best measured using a semantic differential scale (Ajzen & Fishbein 1977). Besides, this satisfaction scale better captures post-usage affect rather than pre-usage affect with regard to any services consumption (Akter 2010a). Secondly, the study adapted ‘*intention to continue using*’ from Bhattacherjee et al.’s (2001) study who designed a scale with three items on a seven point-Likert scale to measure IT service continuance intentions. This scale is suitable for the study as it intends to measure mHealth service continuance intentions. Thirdly, the study adapted the *quality of life* construct from Choi et al. (2007) who developed the seven-point Likert scale with four items to measure QOL in the context of mobile data services. This scale is a good fit for the study as it intends to measure users’ attitudes with regard to QOL after using mHealth services. It is worth noting that all these scales have been operationalized using reflective measures in the previous studies (see Table 5.6). This study applied these scales in the mHealth context and validated their reliability and validity in the broader nomological network in the next chapter (see Chapter 6).

Table 5.6 Scale adaptation for outcome constructs

Constructs	Definitions	Scale Adaptation
Satisfaction	Users' affect with (or feelings about) prior mHealth services' use.	Adapted from Spreng et al. (1996).
Intention to continue using	Users' intentions to continue using mHealth services.	Adapted from Bhattacherjee et al. (2001).
Quality of health life	QOL is defined as a sense of overall well-being in health.	Adapted from Choi et al. (2007).

5.6 Data Analysis Technique

This study conducted exploratory factor analysis with the pilot data (n = 104) in Chapter 6 to determine the dimensionality, reliability and validity of the service quality instrument. Through exploratory findings, the study confirms mHealth service quality as a multidimensional, hierarchical model which is comprised of three primary dimensions (i.e., platform quality, interaction quality and outcome quality) and nine subdimensions (i.e., systems reliability, systems availability, systems efficiency, systems privacy, responsiveness, assurance, empathy, functional benefit and emotional benefit). The study also conducted exploratory factor analysis with the pilot data on three outcome constructs (i.e., satisfaction, intention to continue using and quality of life). It is noteworthy that the outcome constructs have been adapted from past studies, thus factor analysis at this stage re-confirms their dimensionality structure, reliability and validity.

The exploratory findings of Chapter 6 are used for discussing hierarchical modeling in Chapter 7. In Chapter 7, the study discusses in detail the nature of PLS path modeling or component-based SEM and the procedures for estimating a hierarchical service quality model using this technique. The study also discusses how to establish rigor in a PLS-based complex-hierarchical model by estimating power analysis, predictive relevance and the Goodness of Fit (GoF) index. Based on the discussion in Chapter 6 (Instrument Development and Validation) and Chapter 7 (Estimating A Hierarchical Model using PLS), the study estimates the measurement and structural model in Chapter 8 (Analysis and Results) using the main data (n = 283) in order to present findings for the confirmatory study.

5.7 Summary

The core objective of this chapter was to link the nature of the conceptual model (Chapter 4) with the research paradigm (Chapter 5) to establish rigor in research design. As part of that process, the study specified the nature of the theory as 'explaining and predicting', the research philosophy as 'positivist-quantitative, the research method as 'field study', the data collection technique as 'cross sectional survey', the sampling strategy as 'area wise cluster sampling' and the data analysis technique as 'exploratory factor analysis' for the pilot study and 'PLS path modeling' for the main study. This chapter also briefly touched upon the measurement instruments of the study. However, the next chapter (Chapter 6) discusses in detail the entire procedures of instrument development, validation and adaptation techniques for the study.

Chapter 6 Research Methodology (2): Instrument Development and Validation[6]

6.1 Overview

The main objective of this chapter is to develop and validate an instrument to measure service quality in mHealth. Given the infancy stage of mHealth implementation, there is a paucity of reliable and valid instruments for adequately capturing the dimensions of mHealth service quality. A summary of the extant literature on mHealth evaluation (see Table 6.1) shows that there is no study to the best of the researcher's knowledge which has attempted yet to develop and validate an mHealth service quality scale. In addition, poor theoretical development, inadequate conceptualization of constructs and a lack of valid operationalization of measures have aggravated the pursuit of the scale development process in this context. Furthermore, prior service quality scales were not specifically designed for use in mHealth settings and may not be entirely appropriate in this case because service quality is a dynamic, multidimensional concept (Akter et al. 2010a; Brady & Cronin 2001; Parasuraman et al. 2005) for which evaluations need to be context-dependent (Dagger et al. 2007). Therefore, the key objective of this chapter is to develop and validate a multidimensional service quality scale in mHealth.

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[6] *An abridged version of this chapter is under review in the following journal:*

- Akter, S., D'Ambra, J. & Ray, P. Development and Validation of An Instrument to Measure User Perceived Service Quality in mHealth. Second Round at ***Information & Management (I&M)*** *(Manuscript ID: INFMAN-S-11-00162).*

This chapter is designed as follows: Section 6.2 discusses the instrument development process using qualitative study and established scale development techniques. Next, Section 6.3 discusses the instrument testing process using exploratory factor analysis. These explorations lead to a discussion on the nature of the mHealth service quality scale in Section 6.4 and the nature of the outcome constructs in Section 6.5. Finally, Section 6.6 provides a summary of the chapter.

6.2 Instrument Development Process

In order to develop an instrument to measure mHealth service quality, this study began by investigating the dimensions and subdimensions that influence service quality in mobile health care as outlined in the conceptual model (Chapter 4). Through this process, the study identified three primary dimensions and nine subdimensions that reflect customers' (or patients') perception of overall service quality in mHealth. Firstly, platform quality reflects the quality of overall service delivery systems. Platform quality refers to the performance of any service platform in terms of systems reliability, systems availability, systems efficiency and systems privacy (Akter et al. 2010a; Nelson et al. 2005; Petter & McLean 2009). Secondly, interaction quality indicates the quality of interpersonal communication between patients and providers over the mobile platform. Interaction quality reflects the level of responsiveness, assurance and empathy of physicians in delivering health service to patients over the mobile platform (Parasuraman et al. 1988, 2005; Sousa & Voss 2006). The final primary dimension is outcome quality which represents the functional and emotional benefits of mHealth services (Akter et al. 2010a; Dagger et al. 2007; Fassnacht & Koese 2006). Throughout our conceptual exploration, service quality in mHealth was identified as a higher-order, multidimensional construct with three primary dimensions and nine subdimensions. Thus, the study expected that findings of the qualitative study would support the initially conceptualized components through formal instrument development procedures. As a result, the study conducted the following qualitative study to investigate the dimensions and subdimensions of the mHealth service quality model in order to confirm its contextual appropriateness.

Table 6.1: Literature related to mHealth evaluation

Study	Year	Subject area
Ammenworth et al.	2000	Application of mobile work in healthcare
Maglaveras et al.	2002	Mobile telemedicine for home care
Hameed	2002	General application of mobile computing healthcare
Varshney	2005	Pervasive healthcare
Varshney	2006	General application of wireless technology in healthcare
Jen et al.	2007	Mobile ICT for hospital outpatient service
Varsheny	2008	Wireless patient monitoring with emergency messages
Patrick et al.	2008	Challenges of using mobile phone for health
Junglas et al.	2009	Mobile ICT for frontline health employees
Lorenz & Oppermann	2009	Mobile phone-based healthcare monitoring for elderly
Chatterjee et al.	2009	Success factors for mobile work in healthcare
Ahluwalia & Varshney	2009	Composite service quality
Sneha & Varshney	2009	Ubiquitous patient monitoring
Ivatury et al.	2009	Qualitative evaluation of mHealth hotline services
Kahn et al.	2010	Applications, opportunities and challenges
Curioso & Mechael	2010	Collaboration between healthcare and IT
Feder	2010	mHealth solutions in Mexico
Akter & Ray	2010	Transformation of healthcare in developing countries
Han et al.	2010	Mobile ubiquitous health service scenario design
WHO	2011	Distribution of mHealth services in the developing world

6.2.1 Qualitative Study

This study focused on mHealth hotline (or mobile telemedicine) services in Bangladesh, which is one of the leading developing countries for such services. This study defines an mHealth hotline service as a personalized and interactive health service over mobile phone, which provides ubiquitous and universal access to medical advice and information to patients (Akter et al. 2010a; Akter et al. 2011a; Akter & Ray 2010). Currently, more than 24 million people in Bangladesh have access to such mHealth services provided by *Grameen mHealth* (Akter et al. 2010a; Ivatury et al. 2009; WHO 2011). Under this platform, patients can access this service any time by dialing some unique digits (e.g., '789' in Bangladesh) from their mobile phones and receive health services in the form of medical information, consultation, treatment, triage, diagnosis, referral and counseling from registered physicians.

The study obtained qualitative data from three *focus group discussions (FGD)* and 10 in-*depth interviews* (DI) (Dagger et al. 2007; Fassnacht & Koese 2006; Malhotra 2010; McDaniel & Gates 2010) conducted with mHealth (hotline) consumers in Bangladesh. A total of 24 participants, eight per focus group, were involved in three focus group sessions. Screening criteria were used to select respondents for FGDs and DIs. Respondents had to be at least 18 years' of age and to have had Grameen mHealth service experience in the past 12 months. Participants ranged in age from 18 to 62 years and both genders had equal participation. Each FGD session was conducted by two moderators and lasted about 90 minutes. In addition, ten DIs were conducted to explore users' insights on the research agenda. In the context of both focus group discusssion and in-depth interviews, the moderators were selected based on their proficiency in English and Bangla (Andaleeb 2000, 2001, 2008). Participants were recruited using convenient sampling in order to ensure productive findings and the richest data for scale development (Dagger et al. 2007).

The study followed a procedure to arrange FGDs and DIs. Firstly, potential participants who met the screening criteria were provided with an invitation letter from a reputable university, which contained the phone number for respondents to check that the study was authentic. The academic purpose of the study was explained in the letter with adequate assurance of anonymity and the freedom to not answer particular questions or to withdraw opinions from the discussion at any stage. Secondly, potential respondents were contacted via mobile phone after one week to fix the schedule for FGD/DI sessions. Thirdly, each participant was provided with an SMS confirming the date, time and venue of the FGD/DI session. Finally, each participant was reminded a day before via a mobile phone call about the time and place of the FGD/DI session. In each session, respondents were asked the following questions in the local language (Bangla) to evaluate their mHealth experiences and to identify the service quality dimensions. The study translated the following discussion questions into the local language (Bangla) and retranslated them into English until a panel of experts, fluent both in English and Bangla, confirmed that the two versions were reasonably comparable (Andaleeb 2000, 2001, 2008; Fassnacht & Koese 2006; Liu et al. 2009; Mullen 1997; Tiu & Liu 2007).

a. In your opinion, what makes mHealth different from other health services?
b. What are the primary dimensions of service quality of this health service?
c. What technical level of communication is important to you?
d. How do you evaluate your interpersonal interaction with physicians over this platform?
e. What benefits do you primarily seek from this health service?
f. Any positive or negative experience that you have had while consuming this service?

The answers of both focus group discussions and in-depth interviews were recorded, synthesized and sorted into different themes using a manual content analysis system by an analyst who was proficient both in English and Bangla (Dagger et al. 2007). The objective of this analysis was to identify the dimensions and subdimensions of mHealth service quality (D'Ambra & Rice 2001). The analysis was conducted in several steps. Firstly, key responses were identified and highlighted in the transcript. Secondly, responses reflecting different dimensions of service quality were categorized. Thirdly, recurring themes (or subdimensions) were extracted under each dimension by two academic judges proficient in English and Bangla (Andaleeb 2000, 2001, 2008). These academic judges were not part of the present study in order to ensure their neutral opinion on the development process (Moore & Benbasat 1991). In this case, conflicting responses were discussed until agreement was reached and the overall inter-judge reliability was 0.86 (Appendix 6.B) exceeding the threshold level of 0.70 (Straub et al. 2004). Finally, each subdimension was double-checked, refined and substantiated by revisiting the raw responses.

The findings of the qualitative study frequently identified service quality as a multidimensional and hierarchical concept. 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 information services from this platform") under multiple dimensions (see Appendix 6.A). Throughout this process, the study found support for three primary dimensions (i.e., *platform quality*, *interaction quality* and *outcome quality*) and nine subdimensions (*systems reliability*, *systems availability*, *systems efficiency*, *systems privacy*, *responsiveness*, *assurance*, *empathy*, *functional* and *emotional benefits*) (see Appendix 6.A) which were proposed in the conceptual model. Although the qualitative findings supported the dimensions and subdimensions of the mHealth service quality model (Figure 4.1) proposed in Chapter 4, the study further consulted the following literature to strengthen the argument:

6.2.1.1 Platform quality

Platform quality in mHealth reflects users' perceptions regarding the technical level of communication (Akter et al. 2010a; Delone & McLean 1992, 2003; Petter & McLean 2009). In qualitative findings, four core subdimensions were confirmed to constitute customers' perceptions of platform quality in mHealth; these were termed as *systems reliability*, *systems availability*, *systems efficiency* and *systems privacy*. The first subdimension, *systems reliability*, indicates the degree to which the mHealth platform is dependable over time (Akter et al. 2010a; 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" and "It is dependable". The second subdimension, *systems availability*, defines the degree to which the mHealth platform is available on an 'any-time' and 'anywhere' basis (Akter et al. 2010a; Chae et al. 2002; Parasuraman et al. 2005). It was frequently referred to as a unique and crucial indicator of platform quality in mHealth as suggested by the following comments, "I can access the mHealth platform whenever I want" and "I can receive medical service right away." The third subdimension, *systems efficiency*, defines the degree to which the mHealth platform can be adapted to a variety of user needs and changing conditions (Akter et al. 2010a; DeLone & McLean 2003; Nelson et al. 2005; Parasuraman et al. 2005). In fact, it reflects the adaptability of the platform as reflected by the comment "It can flexibly adjust to meet my variety of needs." The final subdimension, *systems privacy*, refers to the degree to which the mHealth platform provides the security of protecting health information services provided to patients (Akter et al. 2010a; Parasuraman et al. 2005; Varshney 2005). In mHealth, '*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” and “It does not share my personal information with others”. Therefore, the study believes that these four subdimensions are the salient indicators of platform quality in the context of mHealth (hotline) services in developing countries.

6.2.1.2 Interaction quality

Interaction quality indicates the quality of interpersonal interaction and the dyadic interplay between a service provider and a user (Dagger et al. 2007). It is defined as a ‘‘a period of time during which a consumer directly interacts with a service’’ (Bitner et al. 1990). The qualitative findings indicate that when a user interacts with a physician under the mobile telemedicine platform, he or she perceives quality in terms of the knowledge and competence of the provider, promptness in providing solutions and individual attention to the user’s needs. Three core subdimensions underpinned customers’ perceptions of interaction quality: *responsiveness*, *assurance* and *empathy*. The first subdimension, *responsiveness*, refers to the willingness of the service provider to help users and to deliver prompt service (Parasuraman et al. 1988; Sousa & Voss 2006). Participants in the qualitative interview referred to this factor as willingness and promptness of the provider to deliver the mHealth service, as indicated by the comment, “Physicians show a sincere interest to solve my problems.” The second subdimension, *assurance*, measures the degree to which the mHealth platform is safe (Parasuraman et al. 1988; Sousa & Voss 2006). It is an important dimension for inspiring trust and confidence among users, as reflected by the comments, “I feel safe while consulting with physicians” and “Physicians’ behavior stimulates my confidence to deal with this healthcare platform.” The third subdimension of *empathy* reflects the caring and individualized attention of the provider to the patients. It indicates the providers' understanding of the users' needs and their ability to provide individualized attention (Parasuraman et al. 1988; Sousa & Voss 2006). Comments such as "Physicians understand my specific needs" or "Physicians give me individual care" are evidence of the importance of care in the interaction quality. Therefore, the study believes that these three subdimensions are the salient indicators of interaction quality in the context of mHealth (hotline) services in developing countries.

6.2.1.3 Outcome quality

This study proposes *outcome quality* as a critical dimension of service quality which refers to the benefits of the service process, or to what a consumer receives as a result of his or her interactions with an mHealth provider (Aharony & Strasser 1993; Gronroos 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 highlights the importance of perceived outcome quality in health care in terms of several service benefits, which may have varying importance to the user (Andaleeb 2001; Sheth 1991). The direct relationship between outcome quality (or service benefits) and service quality is also cited in some health care studies (Andaleeb 2001). The findings of the qualitative study supported two key subdimensions of outcome quality, that is, *functional benefit* and *emotional benefit* (Fassnacht & Koese 2006). The first subdimension, *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". Studies in IS found that utilitarian benefit (i.e., usefulness) plays a critical role in developing a positive attitude towards information technology implementation (e.g., Bhattacherjee 2001; Davis 1989; Limayem et al. 2007). The second subdimension of *emotional benefit* refers to the degree to which the mHealth service arouses positive feelings (Fassnacht & Koese 2006). Comments such as, "I feel hopeful having service from this platform" or "I believe my future health will improve having this service" highlight the importance of hedonic benefit. This hedonic benefit has received much attention in recent years to stimulate users' beliefs regarding service quality perception (Sweeney & Soutar 2001).

6.2.2 Scale Development

In order to develop scales for the subdimensions of mHealth service quality (i.e., systems reliability, systems availability, systems efficiency, systems privacy, responsiveness, assurance, empathy, functional (utilitarian) benefit and emotional (hedonic) benefit), at this stage, *items creation* and *items sorting* were undertaken. The objective of *items creation* was to ensure *content validity* by selecting the right items for the construct. On the other hand, the objective of *items sorting* was to guarantee *construct validity* by determining the convergence and divergence of items through a sorting process.

6.2.2.1 Items creation

In order to create an items' pool for each construct, at this stage, items were identified from existing instruments; additional items were created through exploratory interviews; and finally, qualitative findings were matched with existing scales to match construct definitions (Churchill 1979; MacKenzie et al. 2011; Moore & Benbasat 1991) by an analyst having proficiency in both English and Bangla. In order to develop scales for *platform quality*, the study adapted items from electronic service quality studies (e.g., Fassnacht & Koese 2006; Nelson et al. 2005; Parasuraman et al. 2005); however, no valid and reliable scales were identified to measure *systems privacy* and *systems reliability*. New scales thus had to be developed for these constructs. For *interaction quality*, the study adapted items from generic service quality models (Brady & Cronin 2001; Parasuraman et al. 1988) and relevant health care studies with context-specific modifications (Akter et al. 2010a; Andaleeb 2001; Dagger et al. 2007). Finally, in order to develop items for *outcome quality*, the study adapted items from both electronic (Fassnacht & Koese 2006) and health service quality studies (Dagger et al. 2007).

In culling items under the the subdimensions of systems reliability, systems efficiency, systems availability, systems privacy, responsiveness, assurance, empathy, functional benefits and emotional benefits, the study ensured that the items confirmed the appropriate conceptual definition of the focal construct (Churchill 1979; Nunnally & Bernstein 1994) and the proper specification of the measurement model (Petter et al. 2007). Utilizing the suggestions of MacKenzie et al. (2011, p. 301), the study addressed the following two issues in culling items under each construct: "(1) How distinctive are the essential characteristics from each other (apart from their common theme)? (2) Would eliminating any one of them restrict the domain of the construct in a significant or important way?" It is noteworthy that in making decisions about selecting items, the study confirmed that the items are manifestations of the focal construct which exists separately at a higher embedded level than its subdimensions (Bollen & Lennox 1991; Jarvis et al. 2003; Petter et al. 2007). This is due to the reflective nature of the conceptual model which has already been specified in Chapter 4.

In selecting items for different constructs of service quality, Cronbach's alpha coefficient of 0.60 (or composite reliability 0.7) was used as the cut-off value to ensure the reliability of the psychometric properties (Straub et al. 2004). Most of the scales in previous instruments tended to follow the format of a seven-point Likert scale ('strongly disagree' to 'strongly agree') which was retained for this study as well. Finally, the items' pools were created for nine subdimensions of service quality after a rigorous reevaluation of the existing items and addition of new items to adjust the context for the current study. Those items that seemed redundant or confusing were eliminated.

6.2.2.2 Items sorting

The objective of this phase was to assess construct validity by ensuring domain coverage and reliability of items for each construct. Firstly, domain coverage was assessed with the help of a panel of two judges proficient in English and Bangla who sorted each item under the subdimensions of service quality by applying a Q-sort procedure. This technique also indicated the degree of "correct" placement of items within different categories of constructs, which provided adequate evidence of construct validity by ensuring convergence and divergence of items. A different set of judges proficient in Bangla and English which was comprised of a user, student and professor was used in two different sorting rounds (Moore & Benbasat 1991; Chin et al. 2008). According to Moore and Benbasat (1991, p. 200), "[t]his range of backgrounds was chosen to ensure that a range of perceptions would be included in the analysis". In a similar spirit, Chin et al. (2008) used students and academics in creating a fast-form approach to measuring technology acceptance and other constructs. In this regard, Gefen and Straub (2004) stated that students can be used as surrogates for respondents as long as they represent the target population. Secondly, reliability of the classification scheme was assessed on the results of two rounds of the Q-sort application. It should be noted that reliability and validity analysis at this phase was based on qualitative analysis rather than strict quantitative techniques (Straub et al. 2004). Reliability was assessed on the percentage of items placed in the target construct, which was 82 %. This overall placement ratio also indicates the inter-judge raw agreement scores and associated Kappa scores, which averaged 0.86 and 0.81 respectively (see Appendix 6.B). These findings suggest good reliability coefficients as they compellingly exceeded the threshold level (Kappa > 0.70) (Straub et al. 2004). Thus, based on the overall findings, the study reduced the items for the various scales to at least three for each scale. The selection process resulted in the following number of items for each construct,a total number of 33 items (see Table 6.2).

Table 6.2 Items development for service quality constructs

Dimension	Subdimensions	Items
Platform Quality	**Systems Reliability**	SQ1. This service platform works smoothly. SQ2. This service platform performs reliably. SQ3. This service platform is dependable.
	Systems Availability	SQ4. This platform is always available. SQ5. I can receive medical service right away. SQ6. It does not have long waiting time.
	Systems Efficiency	SQ7. This service platform can be adapted to meet variety of needs. SQ8. This service platform can flexibly adjust to new conditions. SQ9.This service platform is versatile in addressing needs as they arise. SQ10. This service platform is well organized.
	Systems Privacy	SQ11.This platform protects information about my personal problems. SQ12.This platform does not share my personal information with others. SQ13. This platform offers me a meaningful guarantee.
Interaction Quality	**Responsiveness**	SQ14. Physicians of mHealth platform provide prompt service. SQ15. Physicians are never too busy to respond to my requests. SQ16. Physicians are willing to help me. SQ17. They provide the service by a certain time.
	Assurance	SQ18.The behavior of physicians instills confidence in me. SQ19. I feel safe while consulting with physicians. SQ20. Physicians have the knowledge to answer my questions. SQ21. Physicians are competent in providing service.
	Empathy	SQ22. Physicians give me personal attention. SQ23. Physicians give me individual care. SQ24. Physicians understand my specific needs. SQ25: Physicians have my best interests at heart.
Outcome Quality	**Functional Benefit**	SQ26. It serves my purpose very well. SQ27. I believe having service from this platform has been worthwhile. SQ28: It is convenient to use this health service. SQ29. Overall this service is useful to me.
	Emotional Benefit	SQ30. I feel positive using this health service. SQ31. I feel hopeful as a result of having this service. SQ32. I feel encouraged as a result of having this service. SQ33. I feel confident using this service.

6.3 Instrument Testing

The study followed a procedure to conduct instrument testing. Firstly, the primary version of the items in English (see Table 6.2) was developed and then these items were translated into the local language (Bangla) (Andaleeb 2000, 2001, 2008). Secondly, the local version was retranslated until a panel of experts proficient in both languages agreed that the two versions were reasonably comparable (Fassnacht & Koese 2006). With regard to translation-retranslation, Teo and Liu (2007, p. 28) commented that "[t]his process was conducted not only because it can prevent any distortions in meaning across cultures where necessary, but also because it can enhance the translation equivalence." It is worth noting that back-translation is an established mechanism in cross-country research which ensures that the local language version has the same meaning as the version in the original language (Mullen 1995). Thirdly, the study conducted a pre-test of 15 convenient samples to ensure that the question content, wording, sequence, format and layout, question difficulty and instructions were appropriate (Churchill 1979; Moore & Benbasat 1991; MacKenzie et al. 2011). Finally, upon response from the pre-test, the study made context-specific adjustments to finalize the main version of the questionnaire (see Appendix 6.F: English Questionnaire and Appendix 8.L: Bangla Questionnaire).

In the absence of lists from which which to draw a random sample, *multi-stage area wise cluster sampling* was used because of its representation of different socio-economic groups (discussed in Chapter 5). In terms of survey interaction, *in-home* and *location intercept techniques* were used jointly because these methods provide maximum response rates in comparison with other methods in a developing country context (Akter et al. 2008; Andaleeb 2001; Malhotra 2004). Both self-completion and interviewer-filled survey techniques were used to receive a higher valid response (Hair et al. 2010). In all survey interactions, the academic purpose of the study was explained with adequate assurance of anonymity. The population was defined as patients (or users) who had experience of using mHealth services in the past 12 months. After a quick screening question, interviewers proceeded with the survey questions. For the exploratory study, a total of 110 responses were collected in January 2010 of which 104 were analyzed (discussed in Chapter 5).

6.3.1 Exploratory Factor Analysis (EFA)

The study conducted exploratory factor analysis (EFA) using a principal component analysis (PCA)-based extraction method and varimax rotation procedure to assess the initial measurement scale (Liu et al. 2009; Moore & Benbasat 1991; Straub et al. 2004; Treiblmaier & Filzmoser 2010). The study used PCA for the extraction of variances because it is the most suitable technique to reduce a larger number of items under few underlying latent dimensions (Straub et al. 2004). It helps in assessing construct validity by examining factor loadings which ensures that items load on the right factor (Churchill 1979; Gerbing & Anderson 1988). The objective of such factorial validity is to assess constructs independent of the nomological net. According to Straub et al. (2004, p. 25) "[w]hen PCA is used, in this case of exploratory factor analysis technique, researchers can simply test the groups of variables separately". In addition, the study used varimax as a rotation method because it generates multiple factors maintaining orthogonality (Hair et al. 2010; Malhotra 2010). As such, in IS research Ba and Pavlou (2002) and Segars and Grover (1993) used PCA with varimax rotation procedure in order to demonstrate convergent and discriminant validity. Finally, the study used eigenvalues greater than 1 in order to determine the number of factors: this is also known as latent root criterion (Malhotra 2004). According to Hair et al. (2010, p. 109), "the rationale for the latent root criterion is that any individual factor should account for the variance of at least a single variable if it is to be retained for interpretation”. Thus, all factors with eigenvalues less than 1 are considered insignificant and are not taken into account to determine the number of factors.

The study used the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett’s test of sphericity to evaluate the appropriateness of factor analysis. The KMO measure ensured the overall measure of sampling adequacy as it was 0.803 (> 0.50) and Bartlett’s test of sphericity provided support for a significant correlation among the variables as it was 2514.764, df = 528, significant at p = 0.000 (Hair et al. 2010; Malhotra 2004). Nine factors with eigenvalues greater than 1 were extracted and they, after rotation, were 4.192, 3.350, 2.939, 2.877, 2.569, 2.386, 2.379, 2.310 and 2.182 (Liu et al. 2009). The sums of squared loadings from the nine factors have the cumulative value of 76.312% in explaining the total variance in data (see Appendix 6.C).

Throughout the process of exploratory factor analysis, those items were deleted that did not load properly on a particular factor (< 0.40) or if they had cross loadings (see Table 6.3). In this way, SQ6, SQ10, SQ13, SQ14, SQ20, SQ25, SQ26 and SQ30 were deleted. Reliability analysis (i.e., Cronbach’s alpha) of the extracted nine factors was then conducted, which compellingly exceeded the cut-off value of 0.70 (Nunally & Bernstein 1994). Further scale refinement was done by examining corrected item–total correlation to improve the reliability. All the items were retained through this procedure. In summary, the initial instrument was refined by removing SQ6, SQ10, SQ13, SQ14, SQ20, SQ25, SQ26 and SQ30. The remaining 25 items were retained for the next run of factor analysis.

Table 6.3 Results of exploratory factor analysis in the pilot study

Code	Items	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9
SQ1	This service platform works smoothly.						0.688			
SQ2	This service platform performs reliably.						0.899			
SQ3	This service platform is dependable.						0.838			
SQ4	This platform is always available.								0.888	
SQ5	I can receive medical service right away.								0.831	
SQ6	It does not have long waiting time.*									
SQ7	It can be adapted to meet variety of needs.				0.835					
SQ8	It can flexibly adjust to new conditions.				0.853					
SQ9	It is versatile in addressing needs as they arise.				0.791					
SQ10	It is well organized.*									
SQ11	It protects info. about my personal problems.									0.928
SQ12	It does not share my personal info. with others.									0.906
SQ13	It offers me a meaningful guarantee.*									
SQ14	Physicians provide service by a certain time.*									
SQ15	Physicians provide prompt service.			0.828						
SQ16	Physicians are never too busy to respond.			0.890						
SQ17	Physicians are willing to help me.			0.885						
SQ18	The behavior of physicians instills confidence.									
SQ19	I feel safe while consulting with physicians.							0.596		
SQ20	Physicians are competent in providing service.*							0.520		
SQ21	Physicians have the knowledge to answer.									
								0.600		
SQ22	Physicians give me personal attention.	0.817								
SQ23	Physicians give me individual care.	0.839								
SQ24	Physicians understand my specific needs.	0.713								
SQ25	Physicians have my best interests at heart.*									
SQ26	It is convenient to use this health service.*									
SQ27	It serves my purpose very well.									
SQ28	I believe this service is worthwhile.					0.773				
SQ29	Overall this service is useful to me.					0.682				
						0.640				
SQ30	I feel positive using this health service.*									
SQ31	I feel hopeful as a result of having this service.		0.848							
SQ32	I feel encouraged having this service.		0.823							
SQ33	I feel confident using this service.		0.820							

*Item scores not reported due to low factor loadings (< 0.40) or similar loadings on more than one factor. (See Appendix 6.C)

As shown in Table 6.4, the second round of factor analysis with varimax rotation yielded nine factors based on an eigenvalue cut-off of 1. The refined model explained 82.462% of the cumulative variance (see Appendix 6.D).

Table 6.4 Results of exploratory factor analysis of the refined scale

Factor	Items	New Code	Loadings	Item Total Correlation	Eigenvalue	Cumulative Variation	Cronbach's Alpha
Systems Reliability	SQ1 SQ2 SQ3	SR1 SR2 SR3	0.700 0.905 0.851	0.582 0.801 0.706	2.765	11.061	0.831
Systems Availability	SQ4 SQ5	SA1 SA2	0.908 0.896	0.686 0.686	2.765	22.121	0.814
Systems Efficiency	SQ7 SQ8 SQ9	SE1 SE2 SE3	0.854 0.866 0.807	0.787 0.890 0.775	2.757	33.148	0.908
Systems Privacy	SQ11 SQ12	SP1 SP2	0.946 0.932	0.861 0.861	2.502	43.154	0.924
Responsiveness	SQ15 SQ16 SQ17	RE1 RE2 RE3	0.868 0.907 0.892	0.844 0.897 0.870	2.298	52.347	0.937
Assurance	SQ18 SQ19 SQ21	AS1 AS2 AS3	0.731 0.662 0.628	0.544 0.606 0.457	2.090	60.707	0.716
Empathy	SQ22 SQ23 SQ24	EM1 EM2 EM3	0.831 0.861 0.738	0.810 0.812 0.722	2.032	68.836	0.887
Functional Benefit	SQ27 SQ28 SQ29	FB1 FB2 FB3	0.805 0.719 0.680	0.592 0.512 0.518	1.779	75.952	0.720
Emotional Benefit	SQ31 SQ32 SQ33	EB1 EB2 EB3	0.851 0.859 0.890	0.862 0.830 0.862	1.627	82.462	0.926

The remaining items were split into nine factors: systems reliability, systems availability, systems efficiency, systems privacy, responsiveness, assurance, empathy, functional benefit and emotional benefit. Both the KMO measure (0.76 > 0.50) and Bartlett's test of sphericity ($p = 0.000$) were significant (see Appendix 6.D). The KMO measure confirms the overall measure of sampling adequacy by exceeding the threshold level and Bartlett's test of sphericity confirms a significant correlation among the variables (Hair et al. 2010; Malhotra 2004). The minimum Cronbach's alpha was 0.716 for assurance, satisfying a minimum requirement of 0.70. The minimum corrected-item-total correlation was 0.457, exceeding the cut-off value of 0.40 recommended by Straub et al. (2004). Thus, the reliability of the refined quality model was established. Overall, the study reports that all the constructs are composed of three items, except systems reliability and systems availability which are made up of two items. Straub et al. (2004) and Chin (2010) confirmed operationalization of a minimum of two valid items for a construct in exploratory factor analysis. This is supported by the scale development study of Liu et al. (2009) and Wetzels et al. (2009) which extracted two items for factors from EFA for further operationalization in CFA.

6.4 Nature of the mHealth Service Quality Scale

"If the measurement model is improperly specified, it may lead to inappropriately dropping items that are necessary to capture the complete domain of the construct, result in the use of inappropriate scale evaluation indices, and bias estimates of the relationships between the construct and other constructs".

In order to address the above concerns of MacKenzie et al. (2011, p. 329), this study specifies service quality as a hierarchical-reflective construct model (Figure 6.1) which is adequately supported by the conceptual logic, qualitative findings and factor structures in the pilot study. The findings of the pilot study confirm that mHealth service quality is a higher-order, multidimensional construct which is comprised of three primary dimensions (i.e., platform quality, interaction quality and outcome quality) and nine subdimensions (i.e., systems reliability, systems availability, systems efficiency, systems privacy, responsiveness, assurance, empathy, functional benefit and emotional benefit).

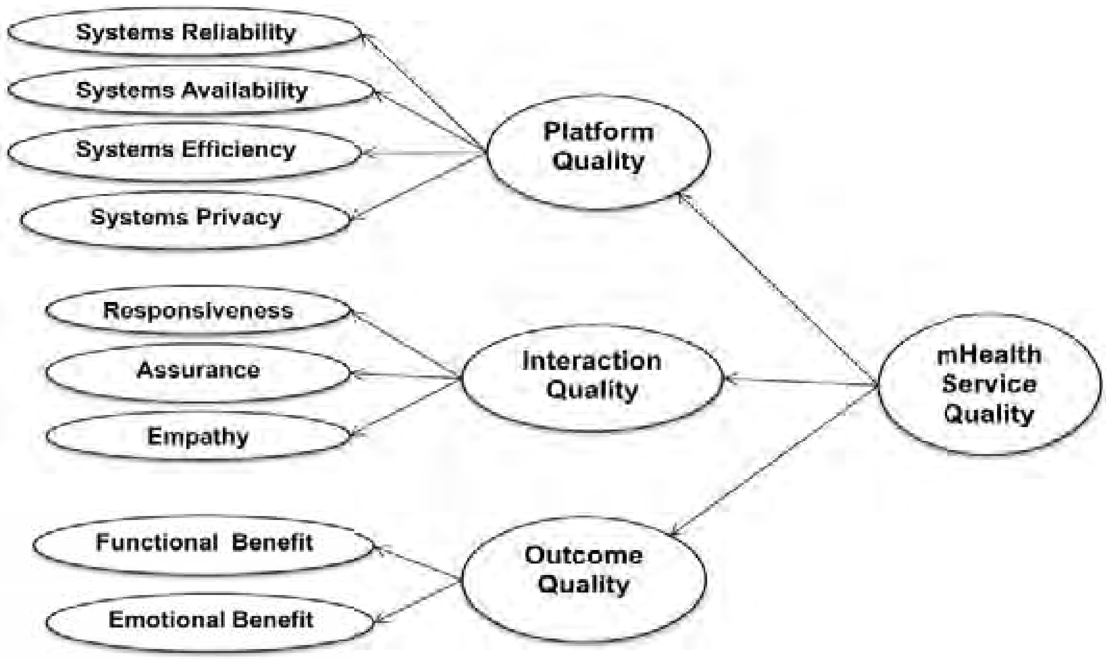


Figure 6.1 A hierarchical-reflective mHealth service quality model

Because of the reflective nature of the items, the subdimensions of mHealth service quality reflect their corresponding dimensions which, in turn, reflect overall service quality (see Figure 6.1). The findings of the exploratory study confirm this reflective perspective because all the indicators in the research model share a common theme and dropping an indicator does not alter the conceptual domain of the construct (Petter et al. 2007). The findings also confirm that correlation between measures under a construct is highly positive (Bollen & Lennox 1991) and internal consistency is significant (Jarvis et al. 2003). Furthermore, the findings provide evidence for unidimensionality of reflective constructs which allowed elimination of some measures during the scale refinement stage in order to improve construct validity without affecting content validity. Overall, the extant literature on service quality (Fassnacht & Koese 2006; Rust & Oliver 1994) and measurement model specifications (Chin 2010; Edwards & Bagozzi 2000; Jarvis et al. 2003; Wetzels et al. 2009) have supported this view of hierarchical-reflective modeling. Table 6.5 presents the justifications for specifying the research model as a reflective model based on the findings of the exploratory study.

Table 6.5 Nature of the reflective service quality model**

Reflective mHealth Service Quality Model*	**Reasons for Reflective Model**
$Y_i = \beta_{i1} X_1 + \varepsilon_i$ **where,** Y_i = the i^{th} indicator β_{i1} = coefficient represents effect of latent variable on indicator X_1 = latent variable (e.g., system reliability) ε_i = measurement error for indicator *i*	• All the constructs are reflective • Direction of causality is from construct to items • Indicators are manifestations of the construct • Changes in the construct cause changes in the indicators • Indicators are interchangeable, having a common subdimension, and dropping of an indicator should not change the conceptual domain of the construct • Indicators are expected to covary with each other • Indicators are required to have the same antecedents and consequences (that is, same nomological net)
** Each indicator of a reflective model is represented by its own equation.* ***Adapted from Akter et al. (2010a), Jarvis et al. (2003), Petter et al. (2007), Chin (2010).*	

6.5 Nature of the Outcome Constructs

This study adapted the scales of outcome constructs (i.e., satisfaction, intention to continue using and quality of life) from past studies, as DeLone & McLean suggested (2003, p. 11), "... where possible, tested and proven measures should be used". Thus, in line with this view, satisfaction (SAT) was adapted from Spreng et al. (1996), intention to continue using (ICU) was adapted from Bhattacherjee (2001) and quality of life (QOL) was adapted from Choi et al. (2007) (see Appendix 6.F). It is worth noting that all these scales have been operationalized using reflective measures in the extant literature. At this stage, the study conducted exploratory factor analysis (EFA) using varimax rotation with the pilot data (n = 104) to re-confirm their dimensionality structure and corresponding reliability (see Table 6.6). These insights will play a critical role in estimating the research model using confirmatory factor analysis (CFA) in Chapter 8.

The KMO measure of sampling adequacy and Bartlett's test of sphericity confirm the appropriateness of factor analysis respectively by ensuring overall sampling adequacy (0.861 > 0.50) and a significant correlation among variables significant at p = 0.000 (see Appendix 6.E). Three outcome constructs (i.e., satisfaction, intention to continue using and quality of life) re-confirm their dimensionality in this study as eigenvalues were greater than 1 and they, after rotation, were 3.625, 2.484 and 2.319 (see Table 6.6). The sums of squared loadings from the three components have the cumulative value of 76.616% in explaining the total variance in data. The minimum Cronbach's alpha was 0.825 for QOL, satisfying a minimum requirement of 0.60 for exploratory study (Gefen et al. 2000; Hair et al. 2010). The minimum corrected-item-total correlation was 0.616, exceeding the cut-off value of 0.40 recommended by Straub et al. (2004).

Thus, the reliability of the three outcome constructs and their corresponding scales were established for this study (see Table 6.6).

Table 6.6 Dimensionality and reliability of outcome constructs

Factor	Items	Loadings	Item-Total Correlation	Eigenvalue	Cumulative Variation	Cronbach's Alpha
Satisfaction (SAT)	SAT1 SAT2 SAT3 SAT4	0.845 0.881 0.796 0.787	0.802 0.834 0.868 0.823	3.625	32.955	0.928
Intention to continue using (ICU)	ICU1 ICU2 ICU3	0.881 0.656 0.743	0.694 0.680 0.670	2.484	55.539	0.843
Quality of life (QOL)	QOL1 QOL2 QOL3 QOL4	0.644 0.680 0.711 0.879	0.628 0.670 0.686 0.616	2.319	76.616	0.825

6.6 Summary

The objective of this chapter was to develop an instrument which can be used to monitor and improve service quality of an innovative IT artifact, that is, mHealth. The entire scale development and validation process adequately addressed the recent concerns of MacKenzie et al. (2011, p. 329), that is, *"[i]f the researcher does not properly test the measurement model and evaluate the scale, it is difficult to determine whether the hypothesized measurement relationships are consistent with the data or to know how to refine the scale to improve its psychometric properties"*. The creation process has successfully integrated the suggestions of seminal instrument development studies (Churchill 1979; Moore & Benbasat 1991; Straub 1989) and extended their contribution by introducing sophisticated reliability and validity techniques (Boudreau et al. 2001; Hair et al. 2010; MacKenzie et al. 2011; Straub et al. 2004). The result is a parsimonious 25-item instrument grouped into nine scales with a high degree of reliability and validity which is one of the significant contributions of this study. The overall findings of this chapter provide critical insights for estimating the research model (see Chapter 8: Analysis and Results) using component-based SEM or, PLS path modeling. In the next chapter (Chapter 7), the study discusses in detail how PLS path modeling will be applied to estimate the hierarchical-reflective mHealth service quality model.

Chapter 7 Research Methodology (3): Estimating A Hierarchical Model Using PLS[7]

7.1 Overview

This chapter specifies the data analysis technique of the study in estimating the research model. The chapter argues that PLS path modeling, or component-based SEM, is best suited for estimating the third-order, reflective, mHealth service quality model. The chapter justifies that PLS leads to more theoretical parsimony and less model complexity for estimating a higher-order model. Although conceptual and empirical contributions of hierarchical modeling have been cited in numerous covariance-based SEM (CBSEM) studies, component-based SEM (PLS) has been under-researched and most of the literature still remains largely conceptual (Wetzels et al. 2009). Thus, the main objective of this chapter is to demonstrate the rigor of PLS as a data analysis technique in estimating the research model.

This chapter is designed as follows: Section 7.2 specifies that the nature of the research model is a third-order, reflective, hierarchical model. Section 7.3 justifies the logic for applying PLS path

[7] *Abridged versions of this chapter were published in the following conference and journals:*

- Akter, S., D'Ambra, J. & Ray, P. (2011). An Evaluation of PLS based complex models: The Roles of Power Analysis, Predictive Relevance and GoF index. Proceedings of the 17th ***Americas Conference on Information Systems (AMCIS)***, Detroit, USA.
- Akter, S., D'Ambra, J. & Ray, P. (2011). Trustworthiness in mHealth Information Services: An Assessment of a Hierarchical Model with Mediating and Moderating Effects using Partial Least Squares (PLS). ***Journal of the American Society for Information Science and Technology (JASIST)****, 62(1), 100-116.*
- Akter, S., D'Ambra, J. & Ray, P. (2010). Service Quality of mHealth Platforms: Development and Validation of a Hierarchical Model using PLS. ***Electronic Markets****,* 20(3), 209-227.

modeling in estimating such a model. Section 7.4 demonstrates how to operationalize PLS for estimating the research model applying repeated use of manifest variables. Section 7.5 discusses power analysis, predictive relevance and the GoF index for evaluating the results of a PLS-based complex-hierarchical model. Finally, Section 7.6 provides the summary of the chapter.

7.2 Hierarchical-Reflective Service Quality Model

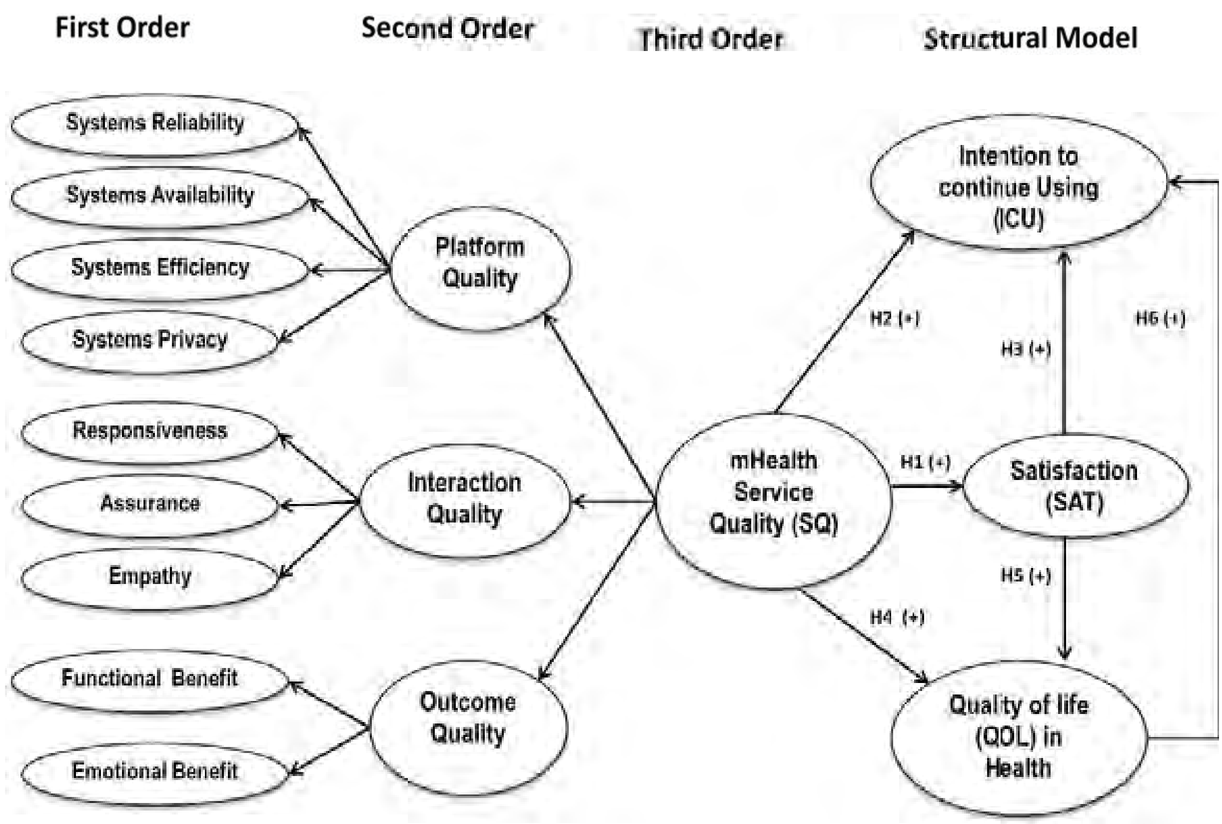


Figure 7.1 The research model

The conceptual explorations (Chapter 4) and the findings of the pilot study (Chapter 6) confirmed that mHealth service quality is a third-order, hierarchical-reflective model (see Figure 7.1). 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; Wetzels et al. 2009) also supports such a hierarchical view. As discussed earlier, the significant advantage 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). In addition, the study adopts the perspective of a reflective model because conceptual logic and findings of the pilot study confirmed that all the indicators in the research model are manifestations of constructs and share a common theme and that dropping an indicator does not alter the conceptual domain of the construct (Jarvis et al. 2003; Petter et al. 2007). Furthermore, internal consistency is very high among indicators and the correlation between two indicators is highly positive for a reflective construct (Jarvis et al. 2003; Petter et al. 2007).

7.3 Using Component-based SEM or PLS Path Modeling to Estimate the Hierarchical-Reflective Model

There is little doubt that quantitative research has made a great impact in social science research since John Stuart Mill and the 19th century experimental positivists (Stafford 2011). The whole beauty of this research paradigm lies in embracing inferential statistics and related cause and effect modeling to validate theories that explain complex concepts (Akter et al. 2011b). In this context, the emergence of structural equation modeling (SEM) over the last three decades has brought a new level of sophistication to quantitative modeling by its versatile applications to address a variety of substantive and methodological issues (Hair et al. 2011). SEM, a second generation multivariate technique, allows the simultaneous modeling of associations among multiple independent and dependent variables (Chin 2010). Coupling the econometric perspective of prediction and the psychometric perspective of construct validity, it enables the measurement of unobservable (latent) variables using observable measures (or manifest variables, items or indicators) by explicitly modeling measurement error (Chin 1998a). It is widely used for its inherent flexibility in testing a theoretical model with multiple predictors and criterion variables against empirical data.

7.3.1 Component-based SEM

Component-based SEM, or PLS path modeling, can be traced back to the original development by Herman Wold (1966) using least squares for principal components and canonical correlations. The basic algorithm was refined in subsequent studies to discuss the theory and application of PLS for path modeling (Wold 1975, 1980, 1982, 1985). Subsequent researchers have synthesized and extended Wold's work in social science and business research by highlighting the theoretical and practical significance of this algorithm (Chin 1998b; Chin & Newsted 1999; Lohmöller 1989). PLS path modeling is based on an algorithm that, firstly, estimates the best weights of each block of the measurement model and then estimates the path coefficients in the structural model (Chin & Newsted 1999). Thus, the latent variable component scores or weight estimates depend on how well the measurement model and structural model are specified. Overall, PLS is a causal modeling approach that maximizes the explained variance of endogenous constructs.

7.3.2 Philosophical Perspective of Component-based SEM

Philosophically, component-based SEM is predicated on positivist epistemological belief which extends knowledge by testing theories empirically (Orlikowski & Barudi 1991; Urbach & Ahlemann 2010). Assuming an a priori fixed relationship within phenomena, this philosophy identifies and tests the causal chain through hypothetico-deductive logic and analysis (Urbach & Ahlemann 2010). Component-based SEM or PLS path modeling is suitable for this study as its objective is to develop and test a theoretical model through explaining and prediction (Chin 2010; Hair et al. 2011). In addition, PLS can effectively handle a small sample size, a construct with fewer items and increased model complexity (Chin 1998a; Chin 1998b). Overall, PLS provides component-based loading and structural paths similar to covariance-based SEM without requiring distributional assumptions (Fornell & Bookstein 1982). Because of these flexible assumptions about the data, PLS path modeling provides robust estimations for a large, complex, hierarchical model.

7.3.3 Why Component-based SEM for this Study?

In SEM, the dominant paradigm is the covariance-based approach which uses the maximum likelihood (ML) function to minimize the difference between the sample covariances and those predicted by the research model. As such, the resultant covariance matrix is assumed to be based on sufficient interdependent observations based on multinormal distribution. Although covariance-based SEM (CBSEM) is the dominant approach in such modeling, it involves various constraints regarding the distributional properties (multivariate normality), measurement level, sample size, model complexity, identification and factor indeterminacy (Chin, 1998b, 2010; Fornell & Bookstein 1982; Hair et al. 2011; Hulland 2010). In the case of a large hierarchical model, CBSEM typically results in positively-biased model fit indices as the degrees of freedom increase with the increasing number of indicators and latent variables (Akter et al. 2011b; Chin & Newsted 1999; Mulaik et al. 1989). Most CBSEM studies seem to focus on a simple theoretical framework which restricts the development of complex modeling in multivariate analysis (Chin et al. 2008). As such, this study adopts component-based SEM or PLS path modeling to estimate the complex, hierarchical service quality model.

7.3.4 Component-based SEM for Complex Modeling

The idea of complex modeling is deeply rooted in the objective and requirements of research philosophies. Based on the concept of verisimilitude (i.e., trust likeness or nearness to the truth), Meehl (1990, p. 14) stated that models always suffer imperfection in capturing reality which necessitates their reliance on two principles, that is, incompleteness and falseness. Whereas *'incompleteness'* refers to the capacity to capture complex reality, *'falseness'* represents how well the contradictions between the model and the real world are matched. Although these two principles are critical to approximate reality, "[m]ost SEM studies seem to focus on the falsity of a model as opposed to its completeness. In part because of algorithmic constraints, few SEM models are very complex (i.e., have a large number of latent variables). Emphasis on model fit tends to restrict researchers to testing relatively elementary models representing either a simplistic theory or a narrow slice of a more complex theoretical domain" (Chin et al. 2008, p. 294). The philosophy of verisimilitude urges scholars to recognize that "scientific theories are never impeccably veridical in all aspects" (Rozeboom 2005, p. 1335) and thus, practical theory adjudication should not ask whether a research model is true but how it is true and to what extent it is true. In order to explore that degree of truth, PLS path modeling is clearly in an advantageous position due to its soft modeling assumptions which enable this technique to adequately capture the complex reality (Akter et al. 2011b).

In exploring CBSEM, Shah and Goldstein (2006) found an average of 4.4 latent variables and a mean of 14 indicators per model in a review of 93 articles. This again reflects that maximum likelihood (ML) is unable to model a large number of latent variables and indicators with a small sample size (Jöreskog & Yang 1996; Kelava et al. 2008; Klein & Moosbrugger 2000; Moosbrugger et al. 2009). In a comparative study between PLS and ML, Vilares et al. (2010, p. 302) confirmed that "ML estimators were much more sensitive to the various potential deficiencies in data and in the model specification. When asymmetric data is used and especially formative block is used, the quality of the estimates decreases drastically". Although some researchers (e.g., Marsh et al. 2004) used a small sample size under a ML estimate; they restricted their models by at least three indicators per construct to ensure the desired model fit. Criticizing such constraints, MacCallum (2003) stated that it is difficult to capture the complexity of the empirical phenomena with a small number of common factors. This was also echoed in Blalock's (1979, p. 881) statement that "reality is sufficiently complex that we will need theories that contain upward of fifty variables if we wish to disentangle the effects of numerous exogenous and endogeneous variables on the diversity of dependent variables that interest us". The author further added that there is a natural imbalance between generalizability and parsimony in developing models so 'parsimony' could be sacrificed in building complex models to describe more diverse settings and populations. Thus, in pursuit of capturing reality adequately, complex models should be developed and validated (Chin 2010).

This study defines a complex model as a larger model with many latent variables and indicators, such as, a model with 10 or more constructs and 50 or more items (Chin 2010). Thus, according to this definition, the research model of the study is a complex model as it contains 16 constructs (i.e., 9 first-order + 3 second-order + 1 third-order + 3 outcome constructs) and more than 50 items. In this particular case, using CBSEM causes difficulties in handling such larger models "due to the algorithmic nature requiring inverting of matrices" (Chin 2010, p. 661). As such, PLS is the suggested technique to estimate a large complex model because it can remove the uncertainty of improper solutions. In addition, in complex modeling, PLS provides robust solutions using its flexible assumptions in any complex setting (exploratory or confirmatory). According to Lohmoller (1989, p. 64), "[i]t is not the concepts nor the models nor the estimation techniques which are 'soft', only the distributional assumptions". Thus, scholars (e.g., Fornell & Bookstein 1982; Hulland 1999) suggest that PLS path modeling is more suitable for real-world applications and more advantageous to employ in a complex setting (see Table 7.1).

Table 7.1 Advantages of component-based SEM in complex modeling

Criterion	Component-based SEM (PLS)	Covariance-based SEM (CBSEM)
Objective	Prediction oriented	Parameter oriented
Approach	Variance-based	Covariance-based
Assumptions	Nonparametric	Parametric
Parameter estimates	Consistent at large	Consistent
Number of latent variables	Any numbers	Limited numbers (max. 8)
Latent variable scores	Explicitly estimated	Indeterminate
Minimum sample size	20-100	200-800
Model complexity	High complexity	Low complexity

Sources: Adapted from Akter et al. (2011b) & Chin & Newsted (1998)

7.3.5 Component-based SEM for Complex Hierarchical Modeling

Applications and research on complex hierarchical modeling using component-based SEM are at the early stage of development and are still limited (Wetzels et al. 2009; Chin 2010). Hierarchical constructs are simply defined as constructs with more than one dimension (Edwards 2001; Jarvis et al. 2003; Law et al. 1998; Law & Wong 1999; MacKenzie et al. 2005; Netemeyer et al. 2003; Petter et al. 2007). PLS path modeling allows for estimating the hierarchical model in order to achieve more theoretical parsimony and less model complexity (Edwards 2001; Law et al. 1998; MacKenzie et al. 2005, Wetzels et al. 2009). For instance, using PLS path modeling, Chin and Gopal (1995) developed the second-order hierarchical-reflective model, what they specified as the "molecular model", in which belief towards group support systems (GSS) adoption is framed as a latent variable with reflective constructs. In a similar vein, Wetzels et al. (2009) recently developed a fourth-order hierarchical-reflective model in online experiential value to predict e-loyalty. Akter et al. (2010a, 2011a) developed a third-order service quality model and a second-order trustworthiness model for mHealth services.

Hierarchical modeling can be done in two different ways based on the relationship between latent variables and manifest variables, that is, *hierarchical-reflective modeling* and *hierarchical-formative modeling*. In the reflective model, the latent variables affect the manifest variables ($LVs \rightarrow MVs$) whereas in the formative one, the manifest variables affect the latent variables ($MVs \rightarrow LVs$). The reflective construct is generally viewed as giving rise to its indicators (Fornell & Bookstein 1982) but the formative construct views its indicators as defining characteristics (Rossiter 2002). Thus, the proposed service quality model is a hierarchical-reflective model.

The extant literature identifies the hierarchical-reflective model as a *molecular model* (Chin & Gopal 1995), *superordinate construct model* (Edwards 2001), *principal factor model* (Jarvis et al. 2003), *latent model* (Law et al. 1999), *common latent construct model* (Mackenzie et al. 2005) or *the factor model* (Wetzels et al. 2009). The hierarchical-formative model is known as a *molar model* (Chin & Gopal 1995), *aggregate construct* (Edwards 2001), *composite latent variable model* (Jarvis et al. 2005), *aggregate model* (Law et al. 1998) and a *composite latent construct model (*MacKenzie et al. 2005*)* (see Table 7.2).

Table 7.2 Hierarchical-reflective and hierarchical-formative models

Studies	Hierarchical-Reflective Model	Hierarchical-Formative Model
Chin & Gopal (1995)	Molecular model	Molar model
Edwards (2001)	Superordinate construct model	Aggregate construct model
Jarvis et al. (2003)	Principal factor model	Composite latent variable model
Law et al. (1998)	Latent model	Aggregate model
Mackenzie et al. (2005)	Common latent construct	Composite latent construct model
Wetzels et al. (2009)	Factor model	The composite model

Recent studies suggest that the research objectives and theoretical expectations influence specification of the construct as either reflective or formative (e.g., Mackenzie et al. 2011). Thus, the same construct can be conceptualized as both formative and reflective to serve the purpose of two separate studies (Borsboom 2005). Scholars therefore suggest relying on the objectives of the study and conceptual soundness to determine the relationship between constructs and their indicators (Bagozzi 2011). Therefore, based on the nature of causality in the conceptual model and the logic of model specification, this study identifies mHealth service quality as a third-order, hierarchical-reflective model with three primary dimensions and nine subdimensions.

As discussed earlier, this study focuses on a higher-order reflective model which consists of constructs involving more than one dimension, and indicators are manifestations of the construct (Edwards 2001; Jarvis et al. 2003; Law and Wong 1999; Law et al. 1998; MacKenzie et al. 2005; Netemeyer et al. 2003; Petter et al. 2007; Wetzels et al. 2009). Particularly in this case, PLS can be used to avert the limitations of covariance-based SEM with regard to distributional properties, measurement level, sample size, model complexity, identification and factor indeterminacy (Chin 1998; Fornell & Bookstein 1982; Wetzels et al. 2009). In addition, it is suitable for this study because it can give more accurate estimates of mediating and moderating effects by accounting for the measurement error that attenuates the estimated relationships and improves the validation of theories (Chin et al. 2003; Helm et al. 2010; Henseler & Fassott 2010). Also, PLS works better when the objective is 'prediction', the model is relatively complex and the phenomenon under study is new or changing (Chin & Newsted 1999).

Overall, PLS ensures robust solutions in estimating complex hierarchical models (Chin 2010). For instance, Chin and Gopal (1995) developed a GSS adoption model which linked reflective belief dimensions (e.g., relative advantage, ease of use, compatibility and enjoyment) with intention to adopt and explained 73.7% of overall variance. In Wetzel et al.'s (2009) study, the fourth-order experiential value construct is composed of two third-order dimensions, three second-order dimensions and seven first-order dimensions. The experiential value is identified as a reliable and valid construct (CR = 0.85, AVE = 0.74) which explains 57% of attitudinal loyalty and 42% of behavioral loyalty. In Akter et al.'s (2010) study, the third-order reflective, service quality construct is composed of three primary dimensions and nine subdimensions. The third-order model is identified as a reliable and valid construct (CR = 0.96, AVE = 0.51) which explains 60% variance of satisfaction, 62% variance of quality of life and 63% variance of intention to continue using. In a recent study, Akter et al. (2011a) developed another second-order reflective model for trustworthiness which consists of four primary constructs, that is, ability, benevolence, integrity and predictability. The second-order trustworthiness construct proves its construct validity (CR = 0.96, AVE = 62) and explains 70% of consumer trust variance and 66% of continuance intentions variance. A summary of studies on hierarchical modeling using PLS is depicted in Table 7.3.

Table 7.3 Component-based SEM for hierarchical modeling

Studies	Domain	Nature of the Higher-order Model
Chin & Gopal (1995)	Group support systems (GSS) adoption.	Second-order molar (reflective) and molecular (formative) modeling of GSS adoption.
Wetzels et al. (2009)	Online CD and book retailers.	Fourth-order reflective model of online experiential value.
Akter et al. (2010a)	mHealth service quality	Third-order reflective service quality model.
Akter et al. (2011a)	mHealth trustworthiness	Second-order reflective trustworthiness model.

7.4 Estimating the Hierarchical mHealth Service Quality Model

This study estimated the third-order, hierarchical-reflective service quality construct model by using all the manifest variables of the underlying second-order (i.e., platform quality, interaction quality and outcome quality) and third-order dimensions (i.e., systems reliability, systems availability, systems efficiency, systems privacy, responsiveness, assurance, empathy, functional benefit and emotional benefit) (see Table 7.4).

For estimating this hierarchical construct model, this study repeatedly used the manifest variables. For example, the second-order platform quality construct consists of four first-order latent variables (i.e., systems reliability, systems availability, systems efficiency and systems privacy) which contains 10 manifest variables altogether (see Figure 7.2), thus the platform quality construct was measured using all 10 manifest variables of the underlying first-order dimensions. Under this technique, the manifest variables were used repeatedly, initially for first-order latent variables (i.e., systems reliability, systems availability, systems efficiency and systems privacy) to create primary loadings and then for the second-order latent variable (i.e., platform quality) to create secondary loadings (see Figure 7.3). This approach was then replicated over other dimensions (i.e., interaction quality and outcome quality) and extended to estimate the third-order service quality construct which consists of three second-order dimensions (i.e., platform quality, interaction quality and outcome quality) and nine first-order dimensions (systems reliability, systems availability, systems efficiency, systems privacy, responsiveness, assurance, empathy, functional benefit and emotional benefit), representing 25 manifest variables (see Figure 7.4).

Table 7.4 Estimating a hierarchical-reflective service quality model

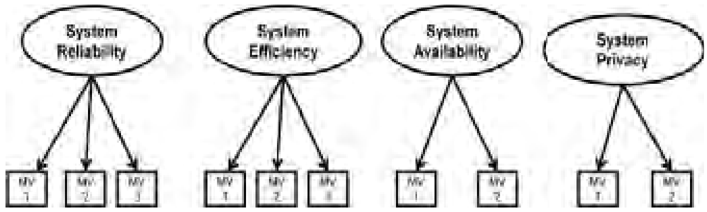
<table>
<tr><td>Construction of Hierarchical-Reflective Model</td><td>Service Quality as a Hierarchical-Reflective Model</td></tr>
<tr><td>Figure 7.2 shows four first-order, reflective latent variables (LVs) (system reliability, system efficiency, system availability and system privacy) of platform quality, which are related to their respective manifest variables (MVs).</td><td>

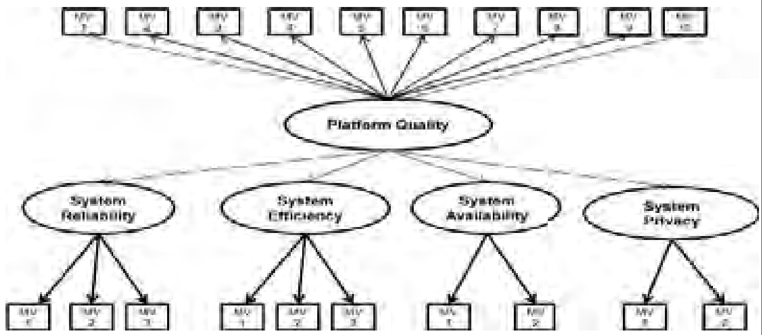
Figure 7.2 First-order latent variables of platform quality</td></tr>
<tr><td>Figure 7.3 shows platform quality as a second-order reflective variable which is constructed by relating it to the block of the underlying first-order latent variables. For instance, platform quality is constructed by using 10 MVs (3+2+3+2) of four first-order LVs. Likewise, interaction quality and outcome quality have been constructed as a second-order reflective model.</td><td>

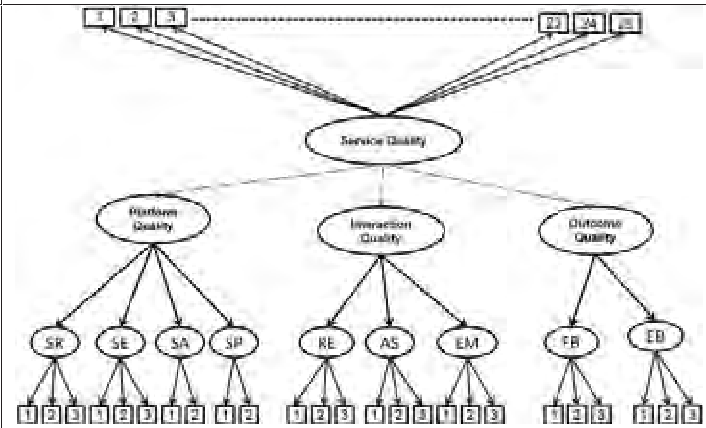
Figure 7.3 Platform quality as a second-order reflective construct</td></tr>
<tr><td>Figure 7.4 shows service quality as a third-order reflective variable, which is constructed by using all the manifest variables (25 MVs) of the three second-order LVs. For instance, service quality is constructed by 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>

Figure 7. 4: Service quality as a hierarchical-reflective construct</td></tr>
</table>

Overall, the manifest variables in this model were used three times, that is, to estimate the first-order latent variables, second-order latent variables and the third-order latent variable (see Table 7.4). Since PLS path modeling produces 'determinate latent variable scores', thus the factor scores of lower-order variables were used for higher-order factors (Chin 1998; Tenenhaus et al. 2005; Wetzels et al. 2009). Furthermore, there is no restriction on the residual covariance structure in terms of the measurement error terms and disturbance terms in PLS path analysis which helps to identify a model (Chin & Newsted 1999; Fornell & Bookstein 1982).

Therefore, PLS path modeling was used in this study to estimate the parameters of the outer model (or measurement model) through the repeated use of manifest variables (Guinot et al. 2001; Lohmoller 1989; Noonan and Wold 1983; Tenenhaus et al. 2005; Wold 1982). Using this approach, this study created the third-order service quality construct that represents all the manifest variables of the underlying second-order and first-order latent variables. Since the study specifies the research model as a hierarchical-reflective model, thus all the first-order and second-order latent variables are assumed to be correlated (Bollen 1989; Guinot et al. 2001; Hunter & Gerbing 1982; Marsh & Hocevar 1985; Rindskopf & Rose 1988) which can be specified by the following equations (Table 7.5).

Table 7.5 outlines the equation for estimating the hierarchical-reflective, service quality model in mHealth. For instance, the equation for the first-order model specifies first-order latent variable (η_j), its indicators (y_i), loadings (Λ_y) and an error term (ε_i). The equation of the second-order model specifies the first-order factors (η_j) in terms of the second-order latent variables (ξ_k) and error (ζ_j) for the first-order factor and second-order latent variable loadings (Γ). For estimating the third-order service quality model, the equation is extended, where the term $\beta\,\eta_j$ refers to the higher-order factors (i.e., first-order and second-order latent variables) and $\Gamma\,\xi_k$ refers to the highest-order latent variable (i.e., third-order latent variable).

Table 7.5 Estimation of a third-order reflective service quality model using PLS

First-order model	Second-order model	Third-order model (Extension of second-order model)
$y_i = \Lambda_y \,.\, \eta_j + \varepsilon_i$ y_i = manifest variables (*e.g., items of system reliability*) Λ_y = loadings of first-order latent variable η_j = first-order latent variable (e.g., *system reliability*) ε_i = measurement error	$\eta_j = \Gamma \,.\, \xi_k + \zeta_j$ η_j = first-order factors *(e.g., system reliability)* Γ = loadings of second-order latent variable ξ_k = second-order latent variable *(e.g., platform quality)* ζ_j = error of first-order factors	$\eta_j = \beta \,.\, \eta_j + \Gamma \,.\, \xi_k + \zeta_j$ $\beta\,\eta_j$ = second-order latent variables (e.g., *platform quality, interaction quality* and *outcome quality*) except the highest-order $\Gamma\,\xi_k$ = third-order latent variable *(e.g., service quality)* ζ_j = error of second-order factors

7.5 An Evaluation of a PLS-based Hierarchical Model

Although PLS has established its prominence for estimating a complex hierarchical model, the study applied power analysis, predictive relevance and the GoF index to establish further rigor in empirical findings (see Chapter 8: Results and Analysis).

The study argues that *power analysis* (1-β) is necessary because "the stability of the estimates can be affected contingent on the sample size" (Chin 1998a, p. 305). In this regard, Dijkstra (1983) and Schneeweiss (1993) discussed the magnitude of standard errors for PLS-based complex models resulting from not using enough observations (consistency) and indicators for each latent variable (consistency at large). Secondly, the study argues that *predictive relevance* (Q^2) is critical to assess the predictive validity of a complex model (Chin 1998a; Fornell & Cha 1993; Geisser 1975; Geisser & Eddy 1979; Stone 1974). It refers to "a synthesis of cross validation and function fitting with the perspective that the prediction of observables is of much greater relevance than the estimation of what are often artificial construct – parameters" (cf. Chin 2010, p. 679; Geisser 1975, p. 320). Finally, the study argues that the Goodness of Fit (GoF) index is crucial to assess the global validity of a PLS-based complex model (Tenenhaus et al. 2005). It is defined as the geometric mean of the average communality and average R^2 for all endogenous constructs. Overall, the importance of these techniques has been evidenced in numerous studies; however, there is a paucity of research in the IS domain. Therefore, the study discusses the power analysis, predictive relevance and GoF index in detail in the following sections to establish further rigor in its model validation.

7.5.1 Power Analysis

Power (1-β) is defined as "the probability of rejecting H_0, when H_1 is true" (Larsen & Marx 1981). In other words, power is the probability of obtaining a statistically significant result (H_1), that is, successfully rejecting the H_0 (Cohen 1988). In positivist-quantitative IS research, the importance of power analysis lies in establishing the facts under study by successfully rejecting H_0, accepting H_1 and making decisions on IT artifacts. However, power is less understood and less explored in the IS domain (Baroudi & Orlikowski 1989; Goodhue et al. 2007; Sawyer & Ball 1981; Mazen et al.1987).

In developing and testing a complex model using PLS, this study applied power analysis to validate the implications of sample sizes. Although it is generally assumed that "sample size is less important in the overall model" (Falk & Miller 1992, p. 93), adequate sample size is important to improve overall estimates and reduce standard errors (Hui & Wold 1982; Marcoulides and Saunders 2006). Specifically, if small sample sizes (N = 20) were used in large complex models, they would not detect low-valued structural path coefficients (β = 0.20) until large sample sizes (N > 150) were used (Chin & Newsted 1999, p. 333). Besides, in the case of moderately non-normal data, "a markedly larger sample size is needed despite the inclusion of highly reliable indicators in the model" (Marcoulides & Saunders 2006, p. vi). These findings are consistent with Joreskog and Wold's observations (1982, p. 266) which highlight that, "PLS estimates are asymptotically correct in the joint sense of consistency (large number of cases) and consistency at large (large number of indicators for each latent variable)." Thus, to confirm adequacy in the sample, the study estimated power in PLS-based estimates in order to ensure rigor in complex modeling.

The power dynamics depend on three parameters: the significance level (α) of the test, the sample size (N) of the study and the effect size (ES) of the population (Cohen 1988). In order to assess the adequacy of sample size of large complex models, the power analysis should be conducted on the portion of the model with the largest number of predictors (Chin & Newsted 1999). Although early researchers used to rely on power charts (see, e.g., Scheffé 1959) and power tables (e.g., Cohen 1988), now these are supplemented by PC-based efficient, precise, and easy-to-use power analysis programs (Goldstein 1989) such as, G*Power 3.1.2 (Faul et al. 2009). The general convention is that the power of a statistical test should be at least 0.80 (Cohen 1988, p. 56). Thus, high power (> 0.80) indicates that there is high degree of probability of producing significant results when the relationship is truly significant. Thus, by applying power analysis, this study confirms its confidence in the hypothesized relationships in the research model (see Chapter 8: Analysis and Results).

7.5.2 Predictive Relevance

The present study applied the predictive sample reuse technique (Q^2) to ensure predictive relevance (Chin 2010; Fornell & Cha 1994; Geisser 1975; Stone 1974). Based on the blindfolding procedure, Q^2 evaluates the predictive validity of a large complex model using PLS. While estimating parameters for a model under the blindfolding procedure, this technique omits data for a given block of indicators and then predicts the omitted part based on the calculated parameters. Thus, it shows how well the data collected empirically can be reconstructed with the help of the model and the PLS parameters (Fornell & Cha 1994). The predictive measure for the block is based on the following parameters:

$$Q^2 = 1 - \frac{\sum_D E_D}{\sum_D O_D}$$

where:

E = the sum of squares of prediction error

O = the sum of squares error using the mean for prediction

D = omission distance

Q^2 is obtained using two different types of prediction techniques, that is, *cross-validated communality* and *cross-validated redundancy*. The former is obtained by predicting data points using a latent variable score, whereas the latter is obtained by predicting the questionable blocks using the latent variables used for prediction. Q^2 is generally estimated using an omission distance of 5-10 under existing PLS software packages. The rule of thumb indicates that a cross-validated redundancy of $Q^2 > 0$ is regarded as a predictive model (Chin 2010). The study estimates the *cross-validated redundancy* to estimate the predictive relevance of the hierarchical mHealth service quality model in the next chapter.

7.5.3 Goodness of Fit (GOF) Index

The goodness of fit (GoF) index is defined as the geometric mean of the average communality and average R^2 for all endogenous constructs (Tenenhaus et al. 2005). The study estimated the GoF index to determine the overall prediction power of the large complex model by accounting for the performance of both measurement and structural parameters. According to Chin et al. (2010, p. 680), “[t]he intent is to account for the PLS model performance at both the measurement and the structural model with a focus on overall prediction performance of the model”. Although the index is suitable for evaluating reflective indicators, it can, however, be applied for formative indicators knowing the fact that it would increase the productiveness of the inner model at the cost of the outer model (Chin 2010). As such, the GoF index is applied for both reflective and formative latent variables in a complex case as it provides a measure of overall fit (Vinzi et al. 2010). This study suggests using this index for assessing the global validity of a PLS-based complex model. As Tenenhaus et al. (2005) note (p. 173), "[a]s a matter of fact, differently from SEM-ML, PLS path modeling does not optimize any global scalar function so that it naturally lacks an index that can provide the user with a global validation of the model (as it is instead the case with χ^2 and related measures in SEM-ML). The GoF represents an operational solution to this problem as it may be meant as an index for validating the PLS model globally".

Table 7.6 GoF index and its criteria

GoF	GoF criteria
GoF = $\sqrt{\overline{communality} \times \overline{R}^2}$ Range of GoF value: GoF = (0 < GoF < 1)	Communality = 0.50 (Fornel and Larcker 1981) R^2 effect: Small = 0.02, Medium = 0.13, Large = 0.26 (Cohen 1988) Thus, $GoF_{small} = \sqrt{0.5*0.02} = 0.10$ $GoF_{medium} = \sqrt{0.5*0.13} = 0.25$ $GoF_{large} = \sqrt{0.5*0.26} = 0.36$

The GoF index is bounded between 0 and 1. Because of the descriptive nature of the GoF index, there are no inference-based criteria to assess its statistical significance (Vinzi et al. 2010). However, Wetzels et al. (2009) suggest using 0.50 as the cut-off value for communality (Fornel and Larcker 1981) and different effect sizes of R^2 (Cohen 1988) to determine GoF_{small} (0.01),

GoF_{medium} (0.25) and GoF_{large} (0.36) (see Table 7.6). These may serve as baselines for validating the PLS-based complex models globally. The study estimates the GoF index for the research model in the next chapter.

7.6 Summary

The objective of this chapter was to show how component-based SEM (or PLS) can be used to estimate the research model and establish rigor in the data analysis technique. Based on the discussion, it is evident that component-based SEM can effectively handle all complexity to provide robust solutions for a hierarchical-reflective model. The study demonstrated that PLS is suitable for estimating the third-order, reflective mHealth service quality model as the primary objective is prediction and the focus is on explaining the variance of a large number of variables (Hulland et al. 2010). The study also discussed how to establish rigor in empirical findings using power analysis, predictive relevance and the GoF index. Overall, the review in terms of conceptual, empirical and methodological beliefs and assumptions suggests that PLS is best suited for this study as the emphasis is on embracing verisimilitude/completeness (Meehl 1990), capturing reality (Cudeck & Henley 2003) or reflecting the true parameters (Chin 2010). Based on the above review in this chapter, this study discusses empirical findings in the next chapter (Chapter 8: Analysis and Results). Thus, the chapter concludes that:

"There is nothing vague or fuzzy about soft modeling;
the technical argument is entirely rigorous"
Herman Wold (1982)

Chapter 8 Analysis and Results[8]

8.1 Overview

The objective of this chapter is to present empirical findings of the study. Specifically, the chapter provides findings on the measurement model, structural model and extended model with mediating effects, moderating effects and the effects of control variables. As discussed in Chapter 5, this study applied component-based SEM, or PLS path modeling, for the confirmatory study using 283 usable responses. The study applied PLS Graph 3.0 (Chin 2001) to estimate parameters of the outer model and inner model with a path weighting scheme for the inside approximation (Chin 1998a; Tenenhaus et al. 2005; Wetzels et al. 2009). Furthermore, the study applied nonparametric bootstrapping on 283 cases (Chin 1998b; Efron & Tibshirani 1993) with 500 replications to obtain the standard errors of the estimates. In estimating the higher-order latent variables, the study used the approach of repeated indicators (Lohmoller 1989; Wold 1982) as discussed in the previous chapter. The study presents findings in terms of the first-order measurement model, higher-order measurement model and structural model with results of hypotheses testing.

[8] *Abridged versions of this chapter were published (& are under review) in the following journals:*

- Akter, S., D'Ambra, J. & Ray, P. (2010). Service Quality of mHealth Platforms: Development and Validation of a Hierarchical Model using PLS. ***Electronic Markets***, 20(3), 209-227.
- Akter, S., D'Ambra, J., Ray, P. & Hani, U. Modelling the Impact of mHealth Service Quality on Satisfaction, Continuance and Quality of Life. Second round at ***Behaviour & Information Technology (BIT)***, Manuscript ID (TBIT-2011-0090).

The chapter is designed as follows: Section 8.2 presents findings of the first-order measurement model. Section 8.3 presents findings of the higher-order measurement model. Section 8.4 presents findings of the structural model with results of the hypotheses testing. Section 8.5 presents the results of hypotheses testing for the main effects model. Section 8.6 discusses the roles of mediator and moderator in the research model. Section 8.7 discusses the roles of control variables on the research model. Section 8.8 discusses the overall results of the hypotheses testing. Section 8.9 evaluates the overall findings of the study in terms of power analysis, predictive relevance and the GoF index to establish rigor in the model validation. Finally, Section 8.10 provides the summary of the chapter.

8.2 First-Order Measurement Model

The study conducted confirmatory factor analysis (CFA) to check the properties of the first-order measurement model in terms of reliability, convergent validity and discriminant validity (Table 8.1).

The first-order model consists of 12 constructs in the research model, that is, systems reliability, systems availability, systems efficiency, systems privacy, responsiveness, assurance, empathy, functional benefit, emotional benefit, satisfaction, continuance intentions and QOL. Initially, the study calculated all the item loadings which exceeded the cut-off values of 0.7 and were significant at $p < 0.001$ (Appendix 8.E). The higher average of item loadings (> 0.80) and a narrower range of difference provide strong evidence that respective items have greater convergence in measuring the underlying construct (Chin 2010).

The study also calculated average variance extracted (AVE) and composite reliability (CR) (Chin 1998a; Fornell & Larcker 1981) to confirm reliability of all the measurement scales. AVE measures the amount of variance that a construct captures from its indicators relative to measurement error, whereas CR is a measure of internal consistency (Chin 2010). Basically, these two tests indicate the extent of association between a construct and its indicators. The study shows that the CR and AVE of all scales are either equal to or exceed respectively 0.80 and 0.50 cut-off values (Fornell & Larcker 1981). Here, the lowest AVE is 0.707 for functional benefit and the lowest CR is 0.881 for systems availability; however, all those values compellingly exceed their threshold levels. Thus, the study confirmed that all the item loadings, CRs and AVEs exceed their respective cut-off values and ensure adequate reliability and convergent validity (Chin 1998a; Fornell & Larcker 1981). Although the AVEs of all the constructs are far above the threshold level of 0.50, a few constructs (i.e., platform quality and service quality) have just met this level which is owing to the hierarchical-reflective kind of modeling (Fassnacht & Koese 2006; Wetzels et al. 2009). The AVEs of second-order platform quality is 0.50 and third-order service quality is 0.51. These values reflect the reflective nature of the higher-order model indicating high intercorrelations among manifest variables at the second-order and third-order levels which is expected (Fassnacht & Koese 2006). In other words, since manifest variables are used repeatedly in such modeling, the AVEs of reflective constructs are reduced at a higher level due to strong correlations among the indicators (Chin 2010).

Table 8.1 Psychometric properties for first-order constructs

Constructs	Items	Loadings	CR	AVE
Systems Reliability	SR1. This service platform works smoothly. SR2. This service platform performs reliably. SR3. This service platform is dependable.	0.891 0.938 0.927	0. 942	0.844
Systems Availability	SA1. This platform is always available. SA2. I can receive medical service right away.	0.876 0.899	0. 881	0.788
Systems Efficiency	SE1. It can be adapted to meet variety of needs. SE2. It can flexibly adjust to new conditions. SE3. It is versatile in addressing needs as they arise.	0.937 0.956 0.934	0.960	0.889
Systems Privacy	SP1. It protects information about my personal problems. SP2. It does not share my personal information with others.	0.977 0.976	0. 976	0.954
Responsiveness	RE1. Physicians of mHealth provide prompt service. RE2. Physicians are never too busy to respond. RE3. Physicians are willing to help me.	0.927 0.920 0.917	0.944	0.849
Assurance	AS1.The behavior of physicians instills confidence. AS2. I feel safe while consulting with physicians. AS3. Physicians have the knowledge to answer my questions.	0.899 0.903 0.841	0.913	0.777
Empathy	EM1. Physicians give me personal attention. EM2. Physicians give me individual care. EM3. Physicians understand my specific needs.	0.942 0.946 0.880	0.945	0.852
Functional Benefit	FB1. It serves my purpose very well. FB2. Having service from mHealth has been worthwhile. FB3. Overall this service is useful to me.	0.834 0.844 0.845	0.879	0.707
Emotional Benefit	EB1. I feel hopeful as a result of having this service. EB2. I feel encouraged as a result of having this service. EB3. I feel confident using this service.	0.961 0.952 0.945	0.967	0.907
Service Satisfaction (SAT)	SAT1. I am satisfied with my use of mHealth service. SAT2. I am contented with my use of mHealth service. SAT3. I am pleased with my use of mHealth service. SAT4. I am delighted with my use of mHealth service.	0.950 0.953 0.951 0.942	0.973	0.901
Intention to continue using (ICU)	ICU1. I intend to continue using mHealth to get medical information services. ICU2. My intention is to continue using this service rather than use any alternative means (e.g., going to GP). ICU3. I will not discontinue my use of this service.	0.944 0.929 0.972	0.964	0.900
Quality of life (QOL) in health	QOL1. mHealth enabled me to improve my overall health. QOL2. In most ways, my life has come closer to my ideal since I started using this service. QOL3. I have been more satisfied with my health life, thanks to this service. QOL4. So far, this service has helped me to achieve the level of health I most want in life.	0.905 0.905 0.881 0.916	0.946	0.813

In Table 8.2, the study calculated the square root of the AVEs in the diagonals of the correlation matrix. These values exceed the intercorrelations of the construct with the other constructs in the first-order model and confirm discriminant validity (Chin 1998b, 2010; Fornell & Larcker 1981). This test indicates that the constructs do not share the same type of items and they are conceptually distinct from each other (Chin 2010). In other words, each construct and its measures in the research model do a great job in discriminating themselves from other constructs and their corresponding measures. The study gains further confidence on discriminant validity by examining the cross-loadings, which indicate that items are more strongly related to their own construct than other constructs (see Appendix 8.H, pp. 356-357). In other words, each item loads more on its own construct than other constructs and, therefore, all constructs share a substantial amount of variance with their own items (Chin 1998b; Fornell & Bookstein 1982). In all cases, the item's relationship to its own construct has shared variance of more than 64% (i.e., 0.8 *0.8), which is substantial in magnitude in comparison with other constructs (Chin 2010).

Overall, the measurement model was considered satisfactory with the evidence of adequate reliability (AVE > 0.50, CR > 0.80) and convergent validity (loadings > 0.80) in Table 8.1 and discriminant validity ($\sqrt{AVE}$ > correlations) in Table 8.2. The first-order measurement model was thus confirmed satisfactory and was employed for testing the higher-order measurement model and the structural model in the next sections.

Table 8.2 Intercorrelations of the first-order constructs

Constructs	*Mean*	*Stand. Dev.*	*SR*	*SA*	*SE*	*SP*	*RE*	*AS*	*EM*	*FB*	*EB*	*SAT*	*ICU*	*QOL*
Systems Reliability (SR)	5.697	1.144	0.918*											
Systems Availability (SA)	5.926	1.031	0.456	0.887*										
Systems Efficiency (SE)	5.499	1.186	0.461	0.433	0.943*									
Systems Privacy (SP)	5.314	1.240	0.278	0.330	0.451	0.977*								
Responsiveness (RE)	5.994	1.110	0.549	0.396	0.583	0.310	0.921*							
Assurance (AS)	5.644	1.149	0.455	0.316	0.611	0.476	0.614	0.881*						
Empathy (EM)	5.837	1.170	0.453	0.280	0.580	0.429	0.660	0.745	0.923*					
Functional Benefit (FB)	5.731	1.053	0.523	0.365	0.630	0.438	0.639	0.789	0.736	0.840*				
Emotional Benefit (EB)	5.551	1.249	0.556	0.392	0.612	0.402	0.645	0.739	0.715	0.789	0.952*			
Satisfaction (SAT)	5.597	1.147	0.559	0.351	0.533	0.381	0.591	0.723	0.661	0.730	0.714	0.949*		
Intention to continue using (ICU)	5.524	1.313	0.461	0.300	0.499	0.355	0.544	0.616	0.587	0.691	*0.678*	*0.728*	0.949*	
Quality of life (QOL) in health	5.451	1.164	0.495	0.362	0.540	0.413	0.555	0.655	0.665	0.679	*0.659*	*0.746*	*0.738*	0.902*

*square root of the AVE on the diagonal

8.3 Higher-Order Measurement Model

At this stage, the study estimated measurement properties of higher-order constructs, that is, the third-order service quality construct and second-order platform quality, interaction quality and outcome quality constructs following the procedures described in the preceding chapter (see Tables 7.3 and 7.4). The third-order mHealth service quality construct consists of 25 items (10 + 9 + 6) in which 10 items (3+2+3+2) reflect platform quality, 9 items (3+3+3) reflect interaction quality and 6 items (3+3) reflect outcome quality (see Table 7.3). The study confirmed that the loadings of the first-order latent variables on the second-order factors (platform quality, interaction quality and outcome quality) are either equal to or exceed 0.70 (see Appendix 8.F). Similarly, the loadings of the second-order latent variables on the third-order service quality construct are either equal to or exceed 0.70 (see Appendix 8.G). Overall, the results confirmed that all these loadings are significant at $p < 0.001$. The results also ensured that the CRs and AVEs of the second-order and third-order model are either equal to or greater than 0.80 and 0.50 respectively, which provides evidence of reliable and valid higher-order measures (see Table 8.3).

In Figure 8.1, the degree of explained variance of the third-order *mHealth service quality* construct was reflected in its second order components, that is, *platform quality* (77%), *interaction quality* (89%), and *outcome quality* (87%). Accordingly, variance of the second-order constructs was reflected in its corresponding first-order components. For example, the degree of explained variance of platform quality was reflected in systems reliability (60%), systems availability (46%), systems efficiency (71%) and systems privacy (41%). Similarly, interaction quality was reflected in responsiveness (73%), assurance (78%) and empathy (83%). And finally, outcome quality was reflected in functional benefit (87%) and emotional benefit (92%). All these path coefficients from service quality to second-order and third-order components were significant at $P < 0.001$ (Appendix 8.A).

Table 8.3 Reliability of higher-order constructs

Model	Construct	CR	AVE
Third-order	Service quality	0.96	0.51
Second-order	Platform quality	0.91	0.50
	Interaction quality	0.94	0.65
	Outcome quality	0.92	0.72

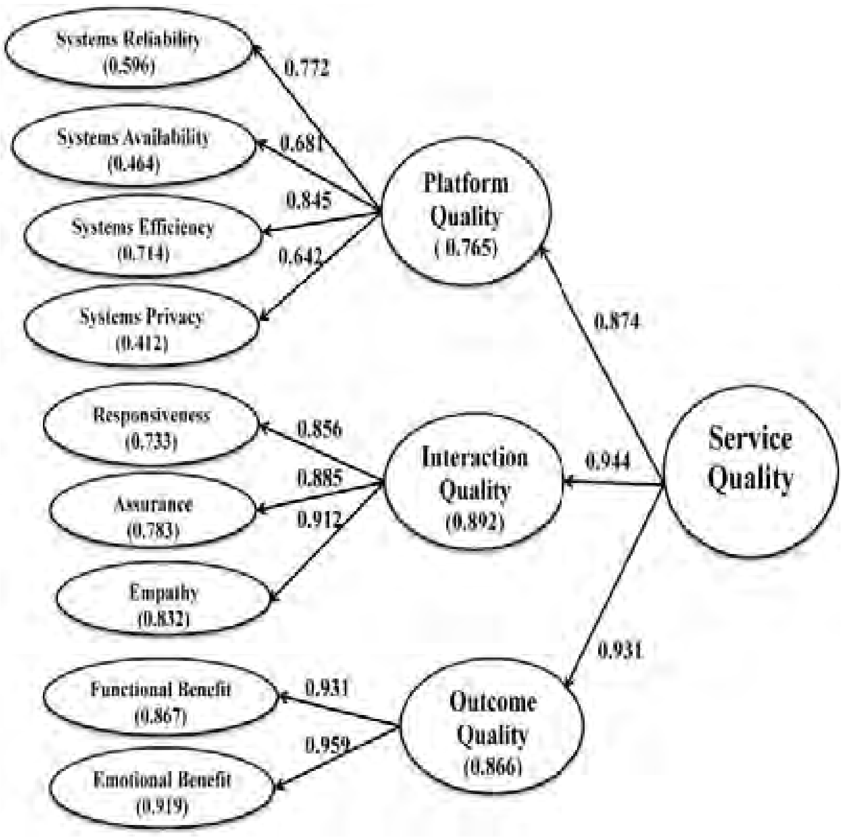


Figure 8.1 Hierarchical-reflective service quality model

8.4 Structural Model

To assess the validity of the structural model, the study estimated the relationship between higher-order service quality (SQ), satisfaction (SAT), intention to continue using (ICU) and quality of life (QOL). In Figure 8.2, the results provided a standardized beta of 0.780, 0.206 and 0.294 respectively from service quality to satisfaction, service quality to ICU and satisfaction to

ICU. All these path coefficients were significant at $p < 0.001$(see Table 8.4). Thus, the study confirmed that service quality has a significant impact on satisfaction, satisfaction has a significant impact on ICU and also, service quality has a significant impact on ICU, supporting H1, H2 and H3.

Similarly, the results confirmed that the path coefficients between service quality to QOL, satisfaction to QOL and finally, QOL to ICU were significant at $p < 0.001$ (see Table 8.4). These relationships confirmed that service quality has a significant impact on QOL, satisfaction has a significant impact on QOL and finally, QOL has a significant impact on ICU. Thus, the study found support for H4, H5 and H6.

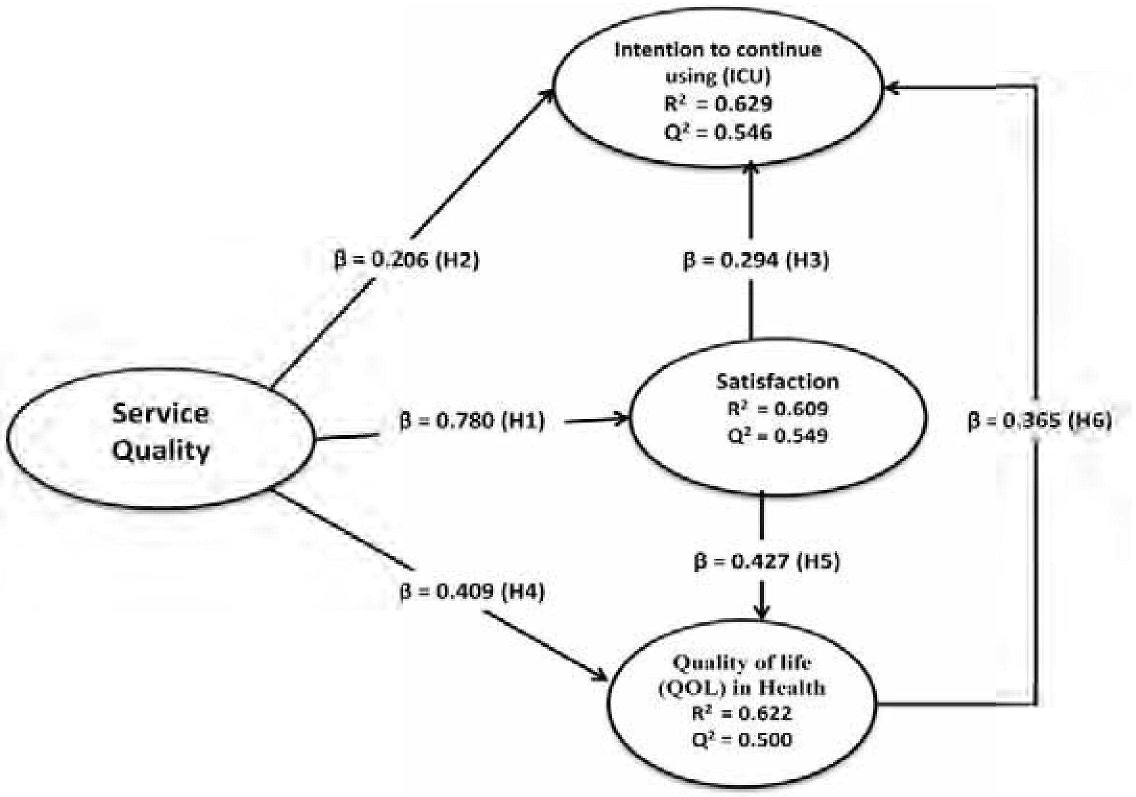


Figure 8.2 Main effects model

The overall variance explained by the model in terms of R^2 was 0.609 for satisfaction, 0.622 for QOL and 0.629 for ICU, which were significantly large ($f^2 > 0.35$) according to the effect sizes defined for R^2 by Cohen (1988). These results confirmed the impact of service quality on satisfaction, ICU and QOL, thereby ensuring nomological validity of the overall research model. Furthermore, this study applied Stone-Geisser's Q^2 to test predictive validity (Akter et al. 2011b). Using the cross-validated redundancy approach, this study obtained Q^2 of 0.549 for satisfaction, 0.500 for QOL and 0.546 for ICU (see Figure 8.2) which demonstrate predictive validity of the hierarchical mHealth service quality construct (SQ) model (Chin 2010).

Table 8.4 Results of structural model

Structural Model			Path coefficients	Standard error	*t* statistic
Service quality	→	Satisfaction	0.780	0.0356	21.9101
Service quality	→	Intention to continue using	0.206	0.0671	3.0700
Service quality	→	Quality of life	0.409	0.0580	7.0517
Satisfaction	→	Intention to continue using	0.294	0.0646	4.5510
Satisfaction	→	Quality of life	0.427	0.0594	7.1885
Quality of life	→	Intention to continue using	0.365	0.0689	5.2975

8.5 Results of Hypotheses Testing (Main Effects Model)

The six hypotheses formulated on the research model were tested simultaneously using component-based SEM, or PLS path modeling. In the research model, the path significance of hypothesized associations (beta coefficients) and variance (R^2) explained by each path were examined. The results confirmed the strong, significant impact of mHealth service quality on satisfaction, intention to continue using and quality of life, thus supporting all the hypotheses. The study synthesizes all these findings in Table 8.5.

Table 8.5 Results of hypotheses testing (main effects model)

Hypotheses	Associations	Results
H1	Service quality to satisfaction	Supported at $p < 0.001$**
H2	Service quality to ICU	Supported at $p < 0.01$**
H3	Satisfaction to ICU	Supported at $p < 0.001$*
H4	Service quality to QOL	Supported at $p < 0.001$**
H5	Satisfaction to QOL	Supported at $p < 0.001$**
H6	QOL to ICU	Supported at $p < 0.001$**
$p < 0.01 (t = 2.326)$*, $p < 0.001$ $(t = 3.090)$**		

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

The association between the higher-order service quality construct and satisfaction ($\beta = 0.780$) was significant at $p < 0.001$, which explains 61% of satisfaction variance (see Tables 8.4 and 8.5). Thus, service quality was confirmed as a significant predictor of satisfaction in the context of mHealth services in developing countries.

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

The association between the higher-order service quality construct and ICU ($\beta = 0.206$) was significant at $p < 0.01$. Thus, service quality was confirmed as a significant predictor of intention to continue using in the context of mHealth services in developing countries (see Tables 8.4 and 8.5).

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

The association between satisfaction and ICU ($\beta = 0.294$) was significant at $p < 0.001$. Thus, satisfaction was confirmed as a significant predictor of ICU in the context of mHealth services in developing countries (see Tables 8.4 and 8.5).

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

The association between higher-order service quality and QOL ($\beta = 0.409$) was significant at $p < 0.001$. Thus, service quality was confirmed as a significant predictor of QOL in the context of mHealth services in developing countries (see Tables 8.4 and 8.5).

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

The association between satisfaction and QOL ($\beta = 0.427$) was significant at $p < 0.001$. QOL was predicted both by satisfaction and service quality which jointly explained 62.20% of overall variance. Thus, satisfaction and service quality were confirmed as strong predictors of QOL in the context of mHealth services in developing countries (see Tables 8.4 and 8.5).

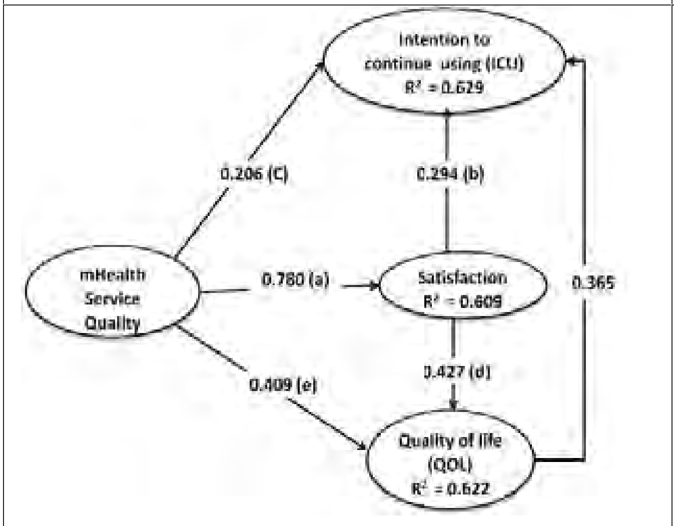
H6: Quality of health life perception has a significant positive impact on intention to continue using mHealth services.

The association between QOL and ICU ($\beta = 0.365$) was significant at $p < 0.001$. ICU was predicted jointly by service quality, satisfaction and QOL which explained 62.90% of overall variance. Thus QOL, in addition to service quality and satisfaction, were confirmed as strong predictors of ICU in the context of mHealth services in developing countries (see Tables 8.4 and 8.5).

8.6 Mediation and Moderation Analysis

The two hypotheses formulated on mediation analysis (H7.1 and H7.2) evaluating the role of ‘satisfaction’ as a mediator in the research model were tested in Figure 8.3 and the two hypotheses assessing the role of ‘service quality’ as a moderator (H8.1 and H8.2) in the research model were tested in Figure 8.4. The results and the detailed procedures of these analyses are discussed in the following sections.

Figure 8.3 Mediation analysis



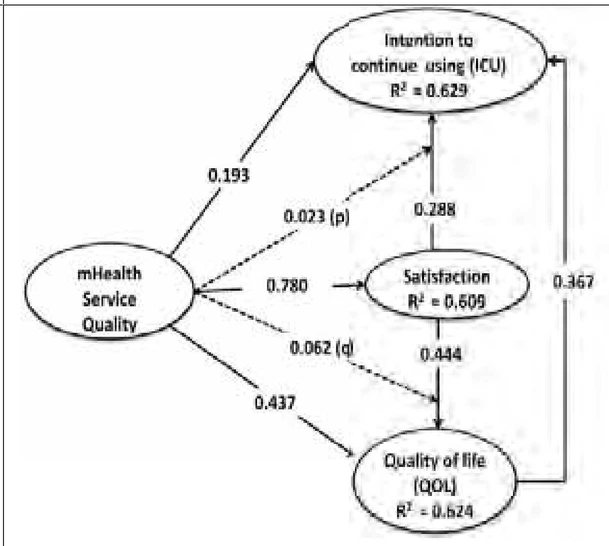
Mediating Effects:

H7.1: Service quality ⟶ satisfaction ⟶ ICU**

H7.2: Service quality ⟶ satisfaction ⟶ QOL**

***significant at P < 0.01. *not significant.*

Figure 8.4 Moderation analysis



Moderating Effects:

H8.1: Service quality × satisfaction ⟶ ICU*

H8.2: Service quality × satisfaction ⟶ QOL*

***significant at P < 0.01. *not significant.*

8.6.1 Analyzing the Role of Satisfaction as a Mediator

In Figure 8.3, this study analyzes the mediating effect of satisfaction on both the SQ-ICU link and the SQ-QOL link. Before analysis, the study adequately confirmed the criteria for mediation analysis (Baron & Kenny 1986) in the main effects model (Figure 8.2) as follows: firstly, the predictor (SQ) influenced the mediator (satisfaction); secondly, the mediator (satisfaction) influenced the criterion variables (ICU and QOL); and finally, the predictor (SQ) influenced the criterion variables in the absence of the mediator's influence. To establish the mediating effect of satisfaction, the indirect effect of a × b has to be significant for the SQ-ICU link and a × d has to be significant for the SQ-QOL link (see Figure 8.3) (Iacobucci 2008). If the *z*-value exceeds 1.96 ($p < 0.05$), the study can accept H7.1 and H7.2, because the results indicate that overall service quality has an indirect impact on both ICU and QOL through satisfaction (Sobel 1982). The study estimated the *z* value as follows (see Figure 8.3):

$$= \frac{a \times b}{\sqrt{b^2 \times s_a^2 + a^2 \times s}} \quad Z_{\text{SQ-ICU Link}}$$

$$= \frac{a \times d}{\sqrt{d^2 \times s_a^2 + a^2 \times s_d \quad s_a \quad s_d}} \quad Z_{\text{SQ-QOL Link}}$$

The *z* value for the SQ-ICU link is 4.442 and for the SQ-QOL link is 6.822 which supports the mediating effects of satisfaction (see Appendix 8.B). These findings support H7.1 and H7.2 which imply that service quality has an indirect impact on ICU and QOL through satisfaction. To estimate the size of the indirect effect, this study uses the VAF (variance accounted for) value which represents the ratio of the indirect effect to the total effect. The results indicate that indirect effects (or satisfaction) explain about 53% of the total effect of SQ on ICU and about 45% of the total effect of SQ on QOL.

$$\text{VAF}_{\text{SQ-ICU Link}} = \frac{a \times b}{a \times b + c} = \frac{0.780 \times 0.294}{0.780 \times 0.294 + 0.206} = 0.526$$

$$\text{VAF}_{\text{SQ-QOL Link}} = \frac{a \times d}{a \times d + c} = \frac{0.780 \times 0.427}{0.780 \times 0.427 + 0.409} = 0.450$$

8.6.2 Analyzing the Role of Service Quality as a Moderator

In Figure 8.4, this study presents the moderation analysis applying the PLS product-indicator approach (Chin et al. 2003; Helm et al. 2010; Henseler & Fassott 2010) to detect the moderating effect of service quality on the relationship between satisfaction-ICU and satisfaction-QOL. To test the moderating effects, firstly, this study multiplied satisfaction (predictor) and service quality (moderator) to create an interaction construct that predicts both ICU and QOL respectively. In this study, satisfaction is a simple latent construct representing four items, service quality is a third-order construct representing 25 items, thus, the interaction construct represents 100 (4 × 25**)** items. Secondly, this study estimated the influence of the predictor (satisfaction) on the criterion variables (ICU and QOL), the direct effect of the moderator (SQ) on the criterion variables and the influence of the interaction variable (satisfaction × service quality) on the criterion variables (see Figure 8.4). At this stage, the study can confirm the significance of the moderator (service quality) if the interaction effects (path p and q) are meaningful, independent of the size of the other path coefficients (Chin et al. 2003). In Figure 8.4, this study estimated the standardized path coefficients of 0.023 (p) and 0.062 (q) to predict the impact of the interaction construct on both ICU and QOL. The results confirmed that these interaction effects are not significant at $p < 0.05$ (see Appendix 8.C). The sizes of the interaction effects are as follows:

$$f^2_{ICU} = \frac{R_i^2 - R_m^2}{1 - R_i^2} = \frac{0.629 - 0.629}{1 - 0.629} = 0.000$$

$$f^2_{QOL} = \frac{R_i^2 - R_m^2}{1 - R_i^2} = \frac{0.624 - 0.622}{1 - 0.624} = 0.005$$

(Here, *i = interaction model, m = main effects model)*

The results showed that the sizes of the interaction effects were small ($f^2 < 0.02$) (Cohen 1988) and the resulting beta changes ($p = 0.023$, $q = 0.062$) were insignificant ($p < 0.05$) (Chin et al. 2003). As such, the study confirmed that service quality did not have any moderating impact on the relationship between satisfaction-ICU and satisfaction-QOL. Thus, the study failed to accept H8.1 and H8.2 (see Figure 8.4). The implications of these findings are discussed in the next chapter (Chapter 9).

8.7 Impact of Control Variables

In this section, the study models the impact of control variables (i.e, demographic and situational characteristics) on the ultimate outcome construct (i.e., ICU). Thus, the study presents the results of control hypotheses (H9.1 and H9.2) in an enquiry modeling the effects of phenomenological variables on the ultimate outcome construct in the context of mHealth in developing countries. Overall, the results confirmed that demographic factors have no impact on ICU, while situational factors have a strong significant impact on ICU (see Figure 8.5).

8.7.1 Measurement Properties of Control Variables

Since all the control variables are formative in nature, the study examined factor weights, instead of factor loadings, which represent the contribution of each indicator to the respective construct (Chin 2010). As shown in Table 8.6, among the demographic factors, age and income significantly contributed to the construct as they are significant at $p < 0.05$ (Chin 1998). Similarly, among the situational factors, social influence and cost significantly contributed to the corresponding construct as they are significant at $p < 0.01$ (see Appendix 8.D). Thus, demographic factors finally included age and income, and situational factors finally incorporated social influence and cost to examine their overall impact on continuance intentions.

Table 8.6 Measurement model of control variables

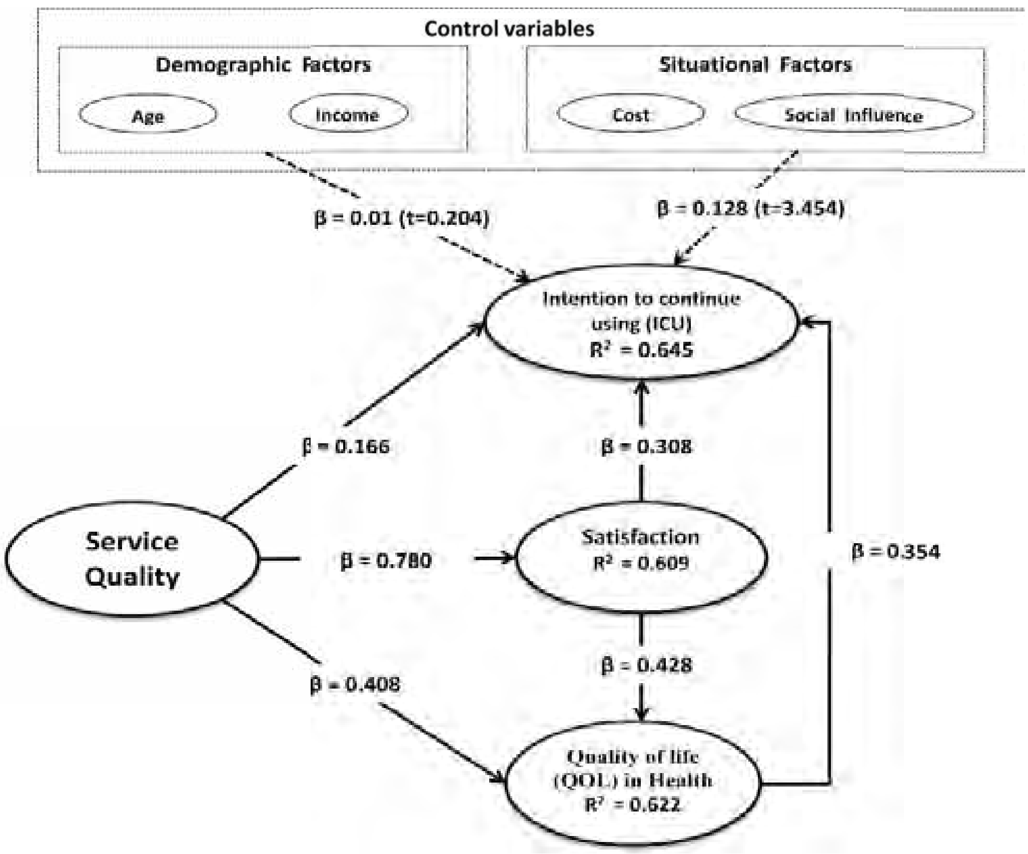
Control Variables	Formative Items	Weights	*t*-value	VIF
Demographic Factors	DF1: Age	0.324	1.823**	1.084
	DF2: Gender	0.072	0.871*	1.268
	DF3: Income	0.319	0.165**	1.342
Situational Factors	SF1. People around you influenced to use this service? (1. Yes 2. No)	0.428	3.142**	1.036
	SF2. What is your opinion about the cost of this service? (1. High 2. Medium 3. Low)	0.902	14.510**	1.045
	SF3. Experience of using this service (1. One 2. Two 3. Three 4. More than 3 times)	0.154	0.675*	1.023
** significant * not significant				

The study also conducted a collinearity test on the index and the results provided evidence of minimum collinearity among the formative items as the variance inflation factor (VIF) of all items ranged between 1.023 and 1.342, far below the common cut-off threshold of 5 to 10. Thus, the measurement properties of both demographic and situational factors were considered satisfactory with evidence of adequate reliability, convergent validity and discriminant validity, and were employed for testing hypotheses.

8.7.2 Impact of Control Variables

In Figure 8.5, the study confirmed that the hypothesized association between demographic factors and ICU is not significant at $p < 0.05$, whereas the association between situational factors and ICU is significant at $p < 0.05$. Thus, the study fails to accept H9.1, that is, demographic factors have an impact on ICU; however, the study accepts H9.2, that is, situational factors have a strong significant impact on ICU in the context of mHealth in developing countries. The implications of these findings are discussed in the next chapter (Chapter 9).

Figure 8.5 Impact of control variables



8.8 Overall Findings of Hypotheses Testing

Table 8.7 Results of hypotheses testing

	Hypotheses	Hypothesized Relationships	Hypothesized Directions	Results
Main Effects Model	**H1:** Service quality has a significant positive impact on service satisfaction.	**SQ → SAT**	(+)	**Supported**
	H2: Service quality has a significant positive impact on the intention to continue using.	**SQ → ICU**	(+)	**Supported**
	H3: Service satisfaction has a significant positive impact on the intention to continue using.	**SAT → ICU**	(+)	**Supported**
	H4: Service quality has a significant positive impact on the quality of health life perception.	**SQ → QOL**	(+)	**Supported**
	H5: Service satisfaction has a significant positive impact on the quality of health life perception.	**SAT → QOL**	(+)	**Supported**
	H6: Quality of health life perception has a significant positive impact on the intention to continue using.	**QOL → ICU**	(+)	**Supported**
Mediating Effects	**H7.1:** Satisfaction mediates the relationship between service quality and intention to continue using.	**SQ ↔ SAT ↔ ICU**	(+)	**Supported**
	H7.2: Satisfaction mediates the relationship between service quality and quality of life in health.	**SQ ↔ SAT ↔ QOL**	(+)	**Supported**
Moderating Effects	**H8.1:** Service quality moderates the relationship between satisfaction and intention to continue using.	**SQ × SAT → ICU**	(+)	**Not Supported**
	H8.2: Service quality moderates the relationship between satisfaction and quality of life in health.	**SQ × SAT → QOL**	(+)	**Not Supported**
Effects of Control Variables	**H9.1:** Demographic factors have a significant positive impact on the intention to continue using.	**DF → ICU**	(+)	**Not Supported**
	H9.2: Situational factors have a significant positive impact on the intention to continue using.	**SF → ICU**	(+)	**Supported**

8.9 An Evaluation of Overall Findings

This study applied PLS path modeling, or component-based SEM, in estimating the hierarchical research model with mediating and moderating effects. Although PLS path modeling successfully validated the research model, to establish further rigor in such modeling, this study investigated the implications of power analysis, predictive relevance and the GoF index. As discussed in the previous chapter, *power analysis* is essential to establish conjectures, *predictive relevance* is vital to measure how well observed values are reproduced by the model and finally, the *GoF index* is crucial for assessing the global validity of the research model (Akter et al. 2011b).

8.9.1 Power Analysis (1-β)

The study conducted power analysis (1-β) to validate the empirical findings of the study. The 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 - β) refers to the probability of successfully rejecting a null hypothesis (Barudi & Orlikowski 1989; Cohen 1992). The study used G*Power 3.1.3 (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 & Orlikowski 1989; Cohen 1988, 1992). The study estimated power of 0.99 for the base model with the sample size of 283 (N), 0.05 significance level (α) and 0.10 effect size (ES) (see Appendix 8.I). The size of estimated power (0.99) compellingly exceeds the cut-off value of 0.80 (Barudi & Orlikowski 1989; Cohen 1992). Thus, high power (> 0.80) confirms that the study produces significant results and the associations are truly significant. In other words, these results prove that the study has adequate confidence on the hypothesized relationships in the research model.

8.9.2 Predictive Relevance (Q^2)

Although the magnitude of R^2 is widely used as a criterion to assess the predictive validity of the PLS model, this study applied the predictive sample reuse technique (or Q^2) for the same purpose (Chin 2010; Chin 1998a; Fornell & Cha 1993; Geisser 1975; Stone 1974). This technique shows how well the data collected empirically can be reconstructed with the help of the model and the PLS parameters (Fornell & Cha 1994). Using the blindfolding procedure with the omission distance of 7, the study obtained a cross-validated redundancy Q^2 of 0.502 for service quality (SQ), 0.549 for satisfaction (SAT), 0.500 for quality of life (QOL) and 0.546 for continuance intentions (ICU) (see Appendix 8.J). All these values of Q^2 are greater than zero ($Q^2 > 0$), which is indicative of a highly predictive model (Chin 2010).

8.9.3 Goodness of Fit (GoF) Index

The study finally estimated the GOF index ($\sqrt{\overline{AVE} \times \overline{R}^2}$) for the research model, which is defined as the geometric mean of the average communality and average R^2 for all endogenous constructs. This index is suggested by Tenenhaus et al. (2005) for assessing the global validity of a PLS-based complex model. Following the guidelines of Wetzels et al. (2009), the study estimated the GoF value to ensure global validation of the research model. The study obtained a GoF value of 0.760 for the research model (see Appendix 8.K) which exceeds the cut-off value of 0.36 for large effect sizes of R^2 (Cohen 1988). As a result, the study concludes that the research model has a better prediction power in comparison with the baseline values (GoF_{small} = *0.1*, GoF_{medium} = *0.25*, GoF_{large} = *0.36)*. Thus, the findings of the study adequately validate the PLS model globally (Wetzels et al. 2009).

In addition to the above analyses, the study also conducted a non-response bias analysis following Armstrong and Overton's (1977) guidelines. As such, in the first round, the study conducted this analysis for the pilot study (n = 104) by comparing the first and last 20% of respondents for each first-order service quality construct. The results did not find any significant difference across the constructs, indicating that there were no problems with non-response bias in the pilot study. In the second round, the study conducted the same analysis for the main study (n = 283) using the first and last 10% of respondents across the same constructs. Again, the results did not find any significant deviation, suggesting no concerns with non-response bias in the main study. Finally, the study conducted a comparison test with the data of study 1 (i.e., pilot study) and study 2 (i.e., main study); the chi-squared tests did not present any significant difference ($p > 0.05$, that is, Study 1 = Study 2) in terms of demographic characteristics (e.g., gender, age, income level, profession and location).

8.10 Summary

The core objective of this chapter was to confirm the measurement and structural properties of the research model by ensuring adequate reliability and validity. The study also aimed to assess the relationships among the constructs in the model and to test six core hypotheses. Furthermore, the study aimed to examine the impact of mediator (satisfaction), moderator (service quality) and control variables (i.e., demographic and situational factors) on the research model. To serve all these objectives, the study successfully applied PLS path modeling, or component-based SEM, to estimate the parameters of the research model. The findings of the study supported six core hypotheses (H1-H6) of the main effects model, two mediating hypotheses (H7.1 and H7.2) and the impact of situational factors (H9.2) on the research model (see Table 8.7). However, the results did not support the moderating effects of higher-order service quality construct (H8.1 and H8.2) and the effects of demographic factors (H9.1). Overall, the study validated findings on hypothesized relationships among the constructs by applying power analysis, predictive relevance and the GoF index. An in-depth discussion of these results and their implications in terms of theory, methodology and practice are presented in the next chapter (Chapter 9: Discussion and Conclusions).

Chapter 9 Discussion and Conclusions[9]

9.1 Overview

This chapter aims to discuss empirical findings of the previous chapter in terms of theoretical significance, methodological rigor and practical contribution. The chapter briefly presents the entire findings addressing the two research questions of the study proposed in Chapter 1. The chapter also discusses how the results fill the existing knowledge gaps and make significant contributions in the context of mHealth service systems research in developing countries. Specifically, the contributions highlight that the study extends knowledge by reconceptualizing service quality theory, validating a hierarchical model using component-based SEM and providing practitioners with a tool for integrated analysis and design of mHealth service systems. The chapter also discusses limitations and future research directions with concluding remarks. Overall, the objective of this chapter is to elucidate contributions of the study in terms of the service quality dynamics of mHealth service systems in developing countries.

This chapter is designed as follows: Section 9.2 reviews the research objectives of the study. Section 9.3 briefly presents research findings addressing the two research questions. Section 9.4 discusses contributions of the study in terms of theory, method and practice. Next, the study

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[9] *Abridged versions of this chapter appeared in the following publications:*

- Akter, S., D'Ambra, J. & Ray, P. (2010). Service Quality of mHealth Platforms: Development and Validation of a Hierarchical Model using PLS. ***Electronic Markets***, 20(3), 209-227.

- Akter, S., D'Ambra, J., Ray, P. & Hani, U. Modelling the Impact of mHealth Service Quality on Satisfaction, Continuance and Quality of Life. Second round at ***Behaviour & Information Technology (BIT)***, Manuscript ID (TBIT-2011-0090).

discusses limitations (Section 9.5) and future research directions (Section 9.6). Finally, Section 9.7 provides concluding remarks for the entire study.

9.2 Research Objective

The key objectives of the study were to explore service quality dimensions of mHealth and to measure the impact of mHealth service quality on satisfaction, continuance intentions and quality of life in developing countries in order to fill the knowledge gaps in service systems research. To pursue these objectives, this study utilized service quality theories and related concepts from information systems, marketing and health services research in order to test the hypothetical relationships among constructs. This is a pioneering study in technology-mediated health service research exploring the dimensions of service quality and modeling the impact of overall quality on outcome constructs. The following section discusses the empirical findings that support the theoretical relationships, nature of the conceptual model and relevant hypotheses. The entire discussion addresses the two research questions proposed in Chapter 1.

9.3 Summary of Findings

This study answered two non-trivial research questions which have not been addressed nor answered satisfactorily before in the domain of service systems research. In answering these questions, the study developed and validated a context-specific, multi-dimensional, hierarchical service quality model for a new IT artifact (i.e., mHealth) and modeled its overall impact on satisfaction (SAT), intention to continue using (ICU) and quality of life (QOL). The findings of the study are synthesized in the following sections and its implications are discussed.

9.3.1 (Research Question 1): What are the dimensions of mHealth service quality in the context of developing countries?

In an effort to answer this question, this study provided an empirical illustration by developing a third-order, hierarchical-reflective service quality model using data from a developing country. The study used the approach of repeated indicators (Wetzels et al. 2009; Wold 1985) in estimating the higher-order latent variables and confirmed adequate measurement and structural properties. The study applied component-based SEM, or PLS path modeling, in developing and validating the higher-order service quality construct (Akter et al. 2010a; Akter et al. 2011b; Chin 2010; Fornell & Bookstein 1982). The study showed that service quality is a third-order construct which was adequately reflected by three second-order dimensions (i.e., platform quality, interaction quality and outcome quality) and nine first-order dimensions (i.e., systems reliability, systems availability, systems efficiency, systems privacy, responsiveness, assurance, empathy, functional benefit and emotional benefit). The findings confirmed that interaction quality had the greatest reflection of overall service quality, followed by outcome quality and platform quality. In the following sections, the relationship between service quality dimensions and subdimensions is discussed with their empirical and theoretical insights.

9.3.1.1 Platform quality

The empirical findings confirmed the role of *platform quality* as a significant dimension of mHealth service quality in capturing users' perceptions regarding the technical level of communication (Delone & McLean 1992, 2003; Nelson et al. 2005; Petter & McLean 2009). An assessment of the association indicated that 76.5% of overall variance (R^2) in platform quality was explained by service quality thus incorporating platform quality as an integral component of mHealth service quality. This association is strongly supported by the theory which highlights that a significant portion of overall service quality in mHealth is explained by platform quality in terms of systems reliability, systems availability, systems efficiency and systems privacy.

The findings of the study also provided strong evidence on the significant association between platform quality and its subdimensions. For example, firstly, *systems reliability* reflected 59.6% of platform quality variance (R^2), supporting its role as a critical component to ensure dependability and error-free service. This finding is consistent with the literature which indicates that a service system needs to be free from any disruption or interference so that patients can rely on the platform (Nelson et al. 2005; Parasuraman et al. 2005; Varshney 2005). Secondly, *systems availability* reflected 46.4% of platform quality variance (R^2), confirming the ultimate promise of mHealth, that is, ‘any-time’ and ‘anywhere’ service. This relationship is supported by the literature which documents the importance of a platform’s availability to provide quality service by ensuring network availability, network stability and reduced waiting time (e.g., Ivatury et al. 2009; Varshney 2005). Thirdly, *systems efficiency* reflected 71.4% of platform quality variance (R^2), confirming a provider’s ability to adapt to a variety of user needs and changing conditions. This association also ensured the mHealth platform’s perceived ease of use, service processing time, and the simplicity with which it meets different needs in changing situations (Chae et al. 2002; DeLone & McLean 2003; Nelson et al. 2005; Parasuraman et al. 2005). Finally, *systems privacy* reflected 41.2% of platform quality variance (R^2), confirming the importance of privacy to ensure safety and protection of patients’ information (Feder 2010; Kahn et al. 2010; Norris 2008; WHO 2011). This finding successfully addressed Kahn et al.’s concerns (2010, p. 256) that “[u]se of mHealth must ensure that patient confidentiality is not compromised”.

Overall, the findings confirm platform quality as a significant dimension of overall service quality, incorporating systems reliability, systems availability, systems efficiency and systems privacy as the critical subdimensions in the context of the mHealth (hotline) service in developing countries. These findings reflect that any improvement in any one of these subdimensions can have a significant positive impact on perceived platform quality. In other words, an mHealth service with better platform quality should be perceived as highly reliable, available, efficient and private. As such, the findings suggest mHealth providers should provide seamless service experience to patients across these four subdimensions in order to improve perception on platform quality as well as overall service quality.

9.3.1.2 Interaction quality

The empirical findings confirmed *interaction quality* as a significant dimension of mHealth service quality as it explained 89.2% of overall mHealth service quality variance (R^2). This association highlights that interaction quality is the most important component among the three second-order components. The findings indicate that the mHealth service provider has the ability to meet patients' stated or unstated needs, interests and concerns through medical consultation over a mobile platform. This finding reflects Dagger et al.'s (2007, p. 126) insights on health service research that "… [a]s services are produced, distributed, and consumed in the interaction between a service provider and a customer, the interpersonal process is crucial to the customer's ultimate perception of the service provider's performance".

The findings of the study proved a strong, significant relationship between platform quality and its subdimensions, that is, responsiveness, assurance and empathy. Firstly, *responsiveness* reflected 73.3% of interaction quality variance (R^2), supporting the provider's ability and willingness to help patients with prompt service (e.g., Parasuraman et al. 1988; Sousa & Voss 2006). This finding reflects Andaleeb's (2001, p. 1367) finding that, "… [b]eing responsive to patients and communicating openly with them are other vital components of health service delivery." Secondly, *assurance* reflected 78.3% of interaction quality variance (R^2), confirming that providers have the knowledge and courtesy to inspire trust and confidence among patients (Andaleeb 2001; Parasuraman et al. 1988). Finally, *empathy* reflects 83.2% of interaction quality variance (R^2), proving that the caring and individualized attention of the mHealth service provider is important to ensure overall service quality. This finding is consistent with the literature indicating that customers' perceptions of overall service quality are influenced to a large extent by the degree of interpersonal empathetic behavior of the provider (Andaleeb 2001; Bitner 1990; Brady & Cronin 2001; Dagger et al. 2007; Rosenbaum & Massiah 2007). It also indicates that understandability of the user's needs and the ability to provide customized attention are critical to improve interaction quality in mHealth.

Overall, the findings support interaction quality as a significant dimension of overall mHealth service quality, incorporating responsiveness, assurance and empathy as the salient components of patient-physician interaction in the context of the mHealth (hotline) service in developing countries. These findings are consistent with the extant literature which indicate that the interpersonal interaction that takes place during service consumption hugely influences overall service quality perception (Bitner et al. 1994; Brady & Cronin 2001; Dabholkar et al. 2000; Dagger et al. 2007). The findings also suggest that these three cognitive attributes are the core components of patient-physician interaction, which deserve equal attention in the context of the mHealth (hotline) in developing countries.

9.3.1.3 Outcome quality

Results of the study supported *outcome quality* as a significant dimension of mHealth service quality by explaining 86.6% of variance (R^2). This relative importance of outcome quality in mHealth implies that "[t]echnology is a means, not an end" (Fassnacht & Koese 2006, p. 33). The findings also indicated that both functional and emotional benefits of mHealth are critical in forming overall service quality perception. These findings support WHO's (2011, p. 77) prediction that "mHealth can revolutionize health outcomes, providing virtually anyone with a mobile phone with medical expertise and knowledge in real-time".

Firstly, *functional benefit* explains 86.7% of overall outcome quality variance, confirming that it is important to serve the actual purpose of the mHealth service. Specifically, this subdimension indicates the perceived usefulness of this health care platform to consumers in terms of convenience and value (Bhattacherjee 2001; Davis 1989; Hong & Tam 2006; Kim et al. 2007; Limayem 2007; Turel et al. 2007). This finding is consistent with Akter and Ray's (2010, p. 75) assertion regarding the functional benefit of mHealth that "[i]t has dramatically improved the decision making and production processes of health and healthcare by ensuring the right information to the right person and at the right time". Secondly, *emotional benefit* explains 91.9% of overall outcome quality variance, supporting the crucial role of using the mHealth platform in arousing positive feelings and stimulating beliefs regarding overall health outcomes (Dagger et al. 2007; Fassnacht & Koese 2006). Overall, the findings confirm outcome quality as a significant dimension of overall mHealth service quality, incorporating functional and emotional benefits as critical subdimensions in the context of the mHealth (hotline) service in developing countries.

Overall, the findings suggest that three second-order dimensions (i.e., platform quality, interaction quality and outcome quality) and nine first-order subdimensions (i.e., systems reliability, systems availability, systems efficiency, systems privacy, responsiveness, assurance, empathy, functional benefit and emotional benefit) are critical components of mHealth service quality in developing countries. Although the results show varying impact of these dimensions, it is noteworthy that the differences in magnitude were small and all the components were proven significant. Thus, the results confirm that the service quality of mHealth should be based on a robust platform, vibrant interaction and meaningful outcomes to satisfy the desired health care needs of customers.

9.3.2 (Research Question 2): Is there any influence of mHealth service quality on satisfaction, continuance intentions and quality of life in the context of developing countries?

In an effort to answer this question, this study modeled the impact of overall mHealth service quality on three endogenous constructs, that is, satisfaction, continuance intentions and quality of life in health. The results of the study confirmed strong significant associations among the latent variables in the structural model and proved the six hypotheses in the base model. Furthermore, the study examined and reported critical findings on the mediating effects of satisfaction, moderating effects of service quality and the effects of control variables on the research model. In the following sections, the significance of all these findings is discussed.

9.3.2.1 Explaining satisfaction with mHealth service quality (H1)

The results of the study supported the third-order mHealth service quality construct as a strong, significant predictor of satisfaction ($\beta = 0.780$). This association between higher-order service quality (cognitive belief) and satisfaction (affect) proves the theory that service quality is an important determinant of service satisfaction in the mHealth environment. It indicates that an increase in mHealth service quality will increase the level of service satisfaction. This suggests that the higher-order service quality model is critically important for satisfaction formation in the mHealth service. In other words, an ambiguous or difficult to evaluate quality will have a negative impact on satisfaction (Andaleeb 2001; Dagger et al. 2007). Thus, the findings underscore the importance of service quality as a critical decision-making variable in order to formulate satisfaction and influence other related service outcomes in the context of the B2C mHealth (hotline) service in developing countries.

9.3.2.2 Explaining continuance intentions with mHealth service quality (H2)

The findings confirmed mHealth service quality as a significant predictor of intention to continue using ($\beta = 0.206$). This association indicates that overall service quality is one of the major drivers of continuance intentions, thus a high level of service quality perception is critically important. Besides, this association proves that patients' concern about overall service quality has a direct impact on continuance intentions in the mHealth environment. The findings suggest that the scalability of the mHealth platform in developing countries will depend on a loyal customer base and their continued usage which are key to long-term profitability (Bhattacherjee 2001; Limayem et al. 2007). Thus, in the context of B2C mHealth (hotline) services, it is necessary to assure adequate quality perceptions at every single touch point in order to influence continuance behavior.

9.3.2.3 Explaining continuance intentions with satisfaction (H3)

The results found satisfaction as a significant predictor of continuance intentions ($\beta = 0.294$). This finding indicates that a higher level of satisfaction creates a greater user dependence on mHealth service systems (Bhattacherjee 2001; Limayem et al. 2007). In other words, this association implies that the firm's future profitability depends on satisfying customers in the present. The extant literature also supports the process of satisfaction formation through overall service quality in order to create continuance intentions in health care (Akter et al. 2012; Dagger et al. 2007). Since satisfaction was a stronger predictor of continuance intentions relative to service quality in the context of mHealth services, dissatisfied patients may discontinue using mHealth services, despite having positive perceptions of its quality. The findings also suggest that mHealth service providers should utilize a patient database for information on past usage or complaints in order to create and retain loyal customers. As such, the results of the study identified satisfaction, in addition to service quality, as a necessary condition for continuing mHealth consumption. Thus, mHealth service providers should consider service quality and satisfaction as important strategic objectives in order to scale and sustain mHealth in developing countries.

9.3.2.4 Explaining quality of life with mHealth service quality (H4)

The findings confirmed the higher-order mHealth service quality construct as a significant predictor of quality of life in health ($\beta = 0.409$). This finding indicates that perceptions of overall service quality contribute to the quality of health life experienced by users in the mHealth environment. This relationship is particularly relevant in health care where the interactive nature of the medical service influences the QOL experience. This study identifies QOL as the social outcome of the mHealth service, and confirms the instrumental role of mHealth service quality in shaping this outcome in a positive manner. As IT receives enormous attention to improve QOL in health care, this study confirms that association by linking mHealth service quality with QOL in the context of a developing country (Choi et al. 2007). Most importantly, the findings prove how a technology-enabled service platform increases the quality of its users' lives (Straub & Watson 2001). Therefore, the findings confirm a richer understanding of the role of service quality in improving social outcome.

9.3.2.5 Explaining quality of life with satisfaction (H5)

The results supported satisfaction as a key predictor of quality of health life ($\beta = 0.427$). This association suggests that an increase in service satisfaction will enhance well-being: thus, this association proves the significant impact of satisfaction on the health life of an individual. This finding indicates that people in the context of developing countries have a variety of primary health care needs; the more they satisfied these needs with mHealth, the more they perceived a stronger contribution of this service to the quality of their health lives. This finding is consistent with the extant literature which supports the relationship between service satisfaction and subjective well-being (or QOL) (Choi et al. 2007; Dagger & Sweeney 2006). This finding suggests that the outcome of mHealth service experience should be viewed in terms of satisfaction and well-being derived from consumption. Thus, in addition to service satisfaction, it is necessary to incorporate the degree of perceived improvement in the quality of health life as a critical service outcome of mHealth performance evaluation in developing countries.

9.3.2.6 Explaining continuance intention with quality of life (H6)

The findings of the study examined and confirmed QOL as the strongest predictor of intention to continue using ($\beta = 0.365$). The overall results found that perceptions of overall mHealth service quality and service satisfaction affect not only continuance intentions but also QOL perceptions. While continuance intentions represent the economic outcomes of mHealth service evaluation, quality of health life represents the social outcome of such evaluation. This finding indicates that an increase in the perception of social outcome (QOL) increases the degree of continuance intentions (ICU) (Akter et al. 2010a). The finding suggests that it is important to understand how service quality evaluation affects both economic and social outcomes and, therefore, how social outcomes strengthen and deepen the relationship with economic outcomes in the context of mHealth in developing countries. Clearly, this understanding makes an important contribution to service systems theory by recognizing the impact of service quality and service satisfaction on societal welfare (i.e., QOL) and financial outcomes (i.e., ICU).

9.3.2.7 Explaining satisfaction as a mediator (H7.1, H7.2)

The findings of the study also investigated and confirmed the mediating role of satisfaction (SAT) between SQ-ICU and SQ-QOL. The findings confirmed that satisfaction explained about 53% of the total effect of service quality on continuance intentions and about 45% of the total effect of service quality on quality of life. As such, a strong mediating role of satisfaction was found between the SQ-ICU link and SQ-QOL link, confirming that it is important to measure satisfaction separately from mHealth service quality when modeling the effects of quality on outcome constructs. This relationship suggests that service satisfaction directly increases with perceived service quality, which is critically important for forming and influencing ICU and QOL perceptions. This result also supports the main effects model (or base model) which confirms that SQ has a direct impact on ICU and QOL, and an indirect impact through satisfaction. Although the mediating effects of satisfaction have been identified by prior researchers (e.g., Dabholkar et al. 2000; Dagger et al. 2007; Hightower et al. 2002), the results of this study highlight the importance of these effects in the mHealth service context using the higher-order service quality model.

9.3.2.8 Explaining service quality as a moderator (H8.1, H8.2)

The results of the study did not support the moderating effects of service quality on the SAT-ICU link (β = 0.023) and SAT-QOL link (β = 0.062). The results showed that the sizes of the interaction effects were small ($f^2 < 0.02$) and insignificant ($p > 0.05$). One plausible explanation is that continuance intentions and quality of life are more influenced by an affect (satisfaction) rather than cognitive beliefs (service quality); therefore, the moderation power of service quality as a theory is less pronounced (Dagger & Sweeney 2006). The favorable behavioral consequence of satisfaction indicates its inevitability in the research model as a separate construct and proves the cognition (SQ)-affective (SAT)-conation (ICU and QOL) chain of the theoretical framework. Overall, the findings support the baseline model which proposes that service quality has both direct and indirect effects on ICU and QOL through satisfaction; however, it has no moderating effects.

9.3.2.9 Explaining the impact of control variables (H9.1, H9.2)

The findings of the study examined and supported the significant effects of situational factors ($\beta = 0.128$) on the ultimate outcome construct (i.e., ICU); however, they failed to accept the effects of demographic factors ($\beta = 0.010$). The demographic factors included age and income, and situational factors incorporated social influence and cost to model their overall effects on continuance intentions. The demographic factors did not emerge as significant factors for continuance intentions because the mHealth service is not restricted to any specific age group or any particular gender. In other words, the insignificant effect of the demographic factors may be explained by the context of the mHealth service in developing countries. The objective of the service is to provide an accessible and reliable health care service in a low-income, developing economy. To meet these objectives, the fundamentals of the service, cost and distribution channels, are structured to ensure accessibility by low-income users thus overcoming any factors that may limit access and use.

However, the results of the study indicate that continuance intentions are strongly influenced by situational factors, that is, social influence and cost. This finding suggests that per unit cost of the mHealth service should be affordable enough to attract the vast customer base so that profit might come from large-scale consumption (Prahalad 2004). In fact, the greatest situational hurdle identified at the bottom of the pyramid (BOP) is to ensure low-cost mHealth solutions which can ultimately lead to a scalable health care platform (Ivatury et al. 2009). The results also found support for social influence to positively influence continuance intentions of mHealth in developing countries. This finding is consistent with the extant literature which argues that social influence is an important contextual factor in the early stages of technology-based service implementation (Venkatesh et al. 2003; Venkatesh & Davis 2000). These findings confirm Lin and Bhattacherjee's recent findings (2007, p. 14) that "... *[c]onstructs, new to IT usage research, helps open the 'black box' of information systems and explore specific system features and their relationships with the cognitive and affective perceptions that influence their usage … External variables may help shape user beliefs regarding usage and eventually their usage intention and behavior"*. Thus, these results underscore the critical importance of contextual factors, in addition to service quality, satisfaction and QOL, in implementing mHealth in the context of developing countries.

9.4 Contributions of the Study

The study discusses its contributions in terms of theory, methodology and practice. Theoretically, the study extends service quality research by reframing the concept as a reflective-hierarchical construct and modeling its impact on satisfaction, intention to continue using and quality of life in the context of mHealth in developing countries. Methodologically, the study proves that component-based SEM, or 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. Practically, the study provides managers with a service quality model for conducting integrated analysis and design of service delivery systems. Overall, the study makes a significant contribution to achieving patronage for firms, better health outcomes for patients and, above all, an improved quality of life for the community in developing countries.

9.4.1 Contribution to Theory

This study extends service quality research in the IS domain by developing and validating a higher-order mHealth service quality model on three primary dimensions (i.e., platform quality, interaction quality and outcome quality) and nine subdimensions (i.e., systems reliability, systems availability, systems efficiency, systems privacy, responsiveness, assurance, empathy, functional benefit and emotional benefit). By encompassing the combined explanatory power of each component, the mHealth quality model advances service quality theory in IS research while presenting a parsimonious structure. According to Whetten (1989, p. 493), "*[t]his approach adds the qualities of completeness and thoroughness to theoretical work*". Specifically, the study contributes in several ways to service quality research in the service systems domain. Firstly, the study has defined the domain of three primary service quality constructs, nine subconstructs and their associated measurement instruments against the backdrop of service quality research in mHealth. Secondly, the study has identified a comprehensive, yet parsimonious, set of dimensions that help predict the quality of an emerging IT artifact (i.e., mHealth) and their association with outcome constructs (i.e., SAT, ICU and QOL). Thirdly, the study has explored characteristics that are specific to the mobile electronic platform, which provides a solution to the new and difficult service delivery challenges of this innovative health care paradigm.

The study adds novelty to the theory by modeling the association between overall service quality (SQ) and satisfaction (SAT) with two new outcome constructs (ICU and QOL) which have not been investigated before. The study has framed *intention to continue using* (ICU) as the *economic outcome* and *quality of life* (QOL) as the *social outcome* of mHealth services. These conceptualizations and evaluations are important in understanding the role of service quality in financial benefits through ICU and in societal welfare through QOL. Firstly, given the infancy stage of mHealth, it is necessary to evaluate ICU in order to identify and replicate the best practices around the world. This evaluation can ensure acceptable economic returns to mHealth service platforms in the developing world, which is necessary for its scalability and sustainability. This assessment is a direct contribution to theory as it examines the factors that influence 'continuance behavior' in the context of mHealth services. Secondly, conceptualization and evaluation of QOL are significant because QOL is not well understood as an outcome of an IT service despite a growing focus on the relationship and the impact of service systems research on society (Alter 2010; Ostrom et al. 2010). It is apparent that B2C service providers, such as mHealth, need to move beyond traditional financial measures and embrace the social outcomes of service systems. These associations are important as the global economy is becoming characterized by services with more than a 70% contribution in GDP (Ostrom et al. 2010). This global phenomenon of significant, sustained service growth is projected to continue unabated for both developed and developing countries. In this growth, technology-mediated service providers increasingly find themselves in a world of service systems in which they evaluate their performance on both financial and social outcomes. The findings of the study thus address Ostrom et al.'s (2010, p. 32) concerns, that is, *"… service is not only about increasing revenues and profits at for-profit firms but also about how to advance service in a way that delivers higher-order, societal outcomes"*. Since service systems research is a new area, scholars still strive to frame its impact on critical financial and social outcomes. Thus, this study extends the scope of service quality research in this new domain by modeling the impact of quality-dominant logic on both ICU and QOL.

The uniqueness of the theory also lies in assessing the service quality of an innovative IT artifact in a new research setting (i.e., a developing country) based on the logical evidence of users' perceptions. Although service quality research has proven to be instrumental for the success of technology-mediated service platforms in the high-income electronic markets of the developed world, there are few studies in IS which have designed models to serve developing countries (Walsham et al. 2007). It is worth noting that developing countries represent more than four billion consumers and the concept of designing economically-viable and socially-responsible ICT platforms to serve this majority of the world's population has gained increased attention (London et al. 2009; Prahalad 2004; Prahalad & Hart 2002; Prahalad & Hammond 2002). Thus, in focusing on an innovative IT artifact in developing countries, this study developed and validated an mHealth service quality model for a new setting. 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"*. Thus, the study believes that the proposed theoretical framework makes a significant contribution to knowledge as most of its constructs and their relationships have not been the subject of prior theorizing in this context. Thus, mHealth service quality research in IS opens up a new horizon that will bring fascinating new perspectives to the field. As Straub states (2009, p. vi) *"[o]nce a theme has been introduced into the field, the resonance of the theme within the field spurs new work"*.

9.4.2 Contribution to Methodology

"Contribution is a relative term in that it also implies that the work is adding to a body of literature or methodological development…" Grover et al. (2009, p. iii)

In the same spirit as Grover et al. (2009, p. iii), this study explained in detail the methodological gestalt of hierarchical modeling using PLS in order to demonstrate why this study is a leap forward. This study is one of the earliest endeavours to conceptualize and validate a hierarchical model using PLS in the context of mHealth service quality. Using the approach of repeated indicators (Wold 1985; Wetzels et al. 2009) in estimating the higher-order latent variable, the study has confirmed adequate measurement and structural findings for the research model. The application of PLS makes it possible to extend the theoretical contribution of the study by developing and testing a third-order, reflective service quality model. The study confirms that higher-order constructs can be framed in a structural model to prove the nomological validity of the overall research model. This is a situation where PLS outperforms covariance-based SEM (CBSEM) in estimating a higher-order model. This study demonstrates the rigor of PLS path modeling in estimating a third-order, hierarchical model by successfully averting various constraints of CBSEM in terms of distributional properties (multivariate normality), measurement level, sample size, model complexity, model identification and factor indeterminacy.

This study contributes to the emerging complex modeling paradigm in social science and business research by estimating a PLS-based third-order, hierarchical-reflective model. A complex model is simply defined as a large multivariate model with many latent variables and manifest variables, such as, a third-order service quality model (Akter et al. 2011b). In the case of a large complex model, CBSEM typically results in positively-biased model fit indices as the degrees of freedom increase with the increasing number of indicators and latent variables (Mulaik et al. 1989; Chin & Newsted 1999). As such, most CBSEM studies seem to focus on simple models or less complex theoretical frameworks (Chin et al. 2008). Through our empirical demonstration, it is quite evident that PLS can effectively handle all these limitations to develop and validate a complex model by providing robust solutions. This contribution of the study 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."*

The study also illuminates the robustness of analysis by illustrating how to quantify mediating and moderating effects in a hierarchical model. Mediating effects are critical to ensure valid associations among latent variables, while moderating effects are fundamental because complex relationships are subject to contingencies. Wetzels et al. (2009, p. 190) predicted that *"PLS path modeling would be more suitable to more complex models including models with hierarchical constructs (with a total disaggregation approach), mediating effects and moderating effects"*. The study illustrated step-by-step procedures on how to integrate the mediating and moderating effects into a PLS model. The findings confirmed that PLS estimates the true effects of mediation and moderation in a nomological network by accounting for the measurement error that attenuates the estimated relationships and improves the validation of the theory. This contribution successfully addresses Chin et al.'s (2003) concerns that "… *it indeed might be the* *case that theoretical advancement of moderators has been impaired more by analytical techniques than by the lack of conceptualizing contingent factors"*.

Finally, the study contributes to the methodological rigor by introducing power analysis, predictive relevance and the GoF index as key indicators to assess the findings of a PLS-based hierarchical model. The study demonstrated how power analysis can be used to estimate the probability of finding significant associations among the latent variables in the structural model when the relationships are there. The study also showed how to use predictive relevance (Q^2) to establish the predictive validity of a large complex model using the blindfolding procedure. Finally, the study presented the goodness of fit (GoF) index to confirm the global validity of a PLS-based hierarchical model. Through these demonstrations of assessment techniques, the study contributes to the advancement of PLS as more robust for real-world applications and more advantageous when models are complex. Thus, the study concludes its methodological contribution by citing that:

"PLS-SEM path modeling can indeed be a "silver bullet" for estimating causal models in many theoretical model and empirical data situations".

Hair et al. (2011, p. 148)

9.4.3 Contribution to Practice

The implications of this research are highly relevant to mHealth service providers, health care management and society in general. The findings indicate that customers evaluate the service quality of mHealth at an overall level, a dimensional level (platform quality, interaction quality and outcome quality) and at subdimensional level (systems reliability, systems availability, systems efficiency, systems privacy, responsiveness, assurance, empathy, functional benefit and emotional benefit). These findings clearly improve the understanding of a manager on how customers evaluate mHealth service quality. In particular, these findings suggest that managers of mHealth should focus on improving the quality of the services they provide across the three primary dimensions, which can be achieved through nine subdimensions. For example, managers could improve customers' perceptions of platform quality by improving systems reliability, systems efficiency, right-time systems availability and maintaining privacy of information services. In a similar vein, interaction quality could be improved by serving customers with sincere responses, adequate assurance and a proper empathetic attitude. Finally, outcome quality could be enhanced by informing customers about functional (utilitarian) and emotional (hedonic) service benefits (e.g., convenience, fulfillment, positive support etc.) attached to the mHealth platform.

The proposed service quality model provides managers with a tool for conducting an integrated analysis and design of service delivery systems. It underscores that only having a good technological platform (e.g., information systems and a 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 benefits associated with the service systems. 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 the dimensions of mHealth service systems have different natures, such as, platform quality deals with ‘human–technology interaction’, interaction quality deals with ‘interpersonal interaction’ and outcome quality deals with ‘service benefits’ derived from service delivery systems.

The model developed in this study offers managers an understanding of how an individual service quality dimension and overall service quality interact in the formation of satisfaction (SAT), quality of life (QOL) and intention to continue using (ICU). The findings of the study support the importance of service quality as a decision-making variable in predicting individual outcome (i.e., SAT), economic outcome (i.e., ICU) as well as social outcome (i.e., QOL). Continuance is the ultimate outcome variable, which is identified as one of the critical challenges to identify and replicate the best mHealth practices around the world. Therefore, the findings on ‘continuance’ and its antecedents (i.e., SQ, SAT and QOL) will facilitate the scalability of this new health care paradigm. Managers can now consider mHealth implementation as a success when a significant number of users will move beyond the initial adoption stage and use this service on a continued basis. In addition, through QOL assessment, the findings offer managers a tool to track the level of societal welfare caused by mHealth implementation, which is a new paradigm to ensure sustainability of the B2C mHealth model in developing countries. The findings of the study also 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 intentions. 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.

The findings of the study extend the scope of service systems research for practitioners by modeling the impact of quality-dominant logic on satisfaction, intention to continue using and quality of life through an expanded theory-based framework. As discussed above, the implications are highly relevant to practitioners as they improve the overall understanding of how service quality is linked to critical service outcomes in developing countries. The findings provide critical insights to practitioners on mediating, moderating and contextual variables which are fundamental to scale and sustain mHealth business models in a developing country. These findings will certainly create efficiencies within mHealth service systems in developing countries by positively influencing health outcomes. According to Jia et al. (2008, p. 311), “[e]quipped with a deeper understanding of the IT service quality phenomenon, IT managers will be enabled to improve customer service, increase customer satisfaction, and achieve stronger business-IT alignment”. Overall, the findings on service quality dynamics will help practitioners to improve the mHealth service systems in developing countries by facilitating service continuance, enhancing workflow and promoting evidence-based practice to make informed and effective decisions directly at the point of care.

9.4.4 Summary of Research Contributions

Although the underlying dimensions of the overall contribution to research have not been enunciated adequately for the IS scientific community, there have been numerous studies that focused on research standards in sociology, psychology, organizational behavior and the physical sciences. Among these studies, most prominent works have been conducted by Chase (1970), Wolff (1970), Price (1985), Daft (1985) and Mitchell (1985). Integrating the findings of these studies and studies conducted in IS by Straub et al. (1994, 2009) and Grover et al. (2009), this study evaluates and synthesizes the contribution in the following table:

Table 9.1 Summary of research contributions

Criteria	*Explanation*	*Contributions of the study*
Contribution to knowledge	Extended knowledge in IS research domain.	This study extended service quality research in IS by developing a hierarchical service quality model against the backdrop of an innovative IT artifact (i.e., mHealth) by examining two non-trivial research questions.
Research theme	Explored a new topic using an articulated theory in IS domain.	This study believes that mHealth service quality research is an exciting theme for knowledge extension in the service quality research of IS because of its focus on some *unique dimensions of quality parameters*, and their association with some *new outcome constructs* in IS.
Theory	Used theories from IS and reference disciplines to explain the relationships among variables in the research model.	See the conceptual model which is based on theories from IS, marketing and health care literature (Chapter 4).
Research design	Rigor in research methodology and findings.	See Research Methodology (Chapters 5, 6 and 7) and Results (Chapter 8).
Logical rigor	Established tight, logical flow of ideas with clear ties between literature review, theory and methodology.	Synthesizing the gaps and findings in the literature (Chapters 2 and 3), this study developed a higher-order, multidimensional mHealth service quality model (Chapter 4). In order to validate the model, the study designed its research methodology (Chapters 5, 6 and 7) to establish rigor in research findings (Chapter 8).
Coverage of key literature	Discussed relevant literature; explication of underlying assumptions.	See Literature Review (Chapters 2 and 3)
Contribution to practice	Linked to current technological, organizational and social problems or challenges.	See contribution to practice (Chapter 9: Discussion and Conclusions).
New methods	Established novelty in data analysis technique.	Estimated the higher-order, reflective service quality model using component-based SEM, or PLS path modeling (See Chapter 7: Estimating Hierarchical Model using PLS).
Large field sample	Findings based on large field sample for quantitative-positivist work.	104 samples analyzed for pilot study + 283 samples for main study (see sampling in Chapter 5).

9.5 Limitations

Several limitations are worth noting. Firstly, this research was conducted within the specific domain of the mHealth service and in one country. Although service quality research by its nature is context-specific, replications in other contexts would increase confidence in the research model. Secondly, the labeling of some constructs (e.g., platform quality, systems efficiency) is entirely based on the research context of the study, that is, mHealth hotline services in Bangladesh. Future research can further explore and differentiate such constructs from other related constructs (e.g., systems adaptability) or add some new constructs based on the dynamics of the research context. Thirdly, data were collected under a cross-sectional design, so the study contains typical limitations associated with this kind of research methodology. For example, the model represents the static nature of service evaluation as the findings are confined to a single point of time. To gain deeper understanding, future study could undertake a longitudinal study to evaluate users' perceptions and evaluations of mHealth service quality over time. Finally, the sample only represents consumers from a developing country (i.e., Bangladesh), thereby there is a limitation regarding the generalizability of findings to other consumers in developed countries. There might be a variation in the perceptions of the components and consequences of service quality in Eastern and Western countries, developing and developed nations, and individualistic and collectivist communities.

Methodologically, although the study applied PLS path modeling to estimate a hierarchical model, PLS path modeling needs to address some critical challenges to reap its full benefits as the ultimate technique for complex hierarchical modeling. For example, firstly, PLS path modeling should have the flexibility of imposing constraints on model coefficients (weights, loadings, path coefficients) in order to specify any information or conjectures available a priori in estimating model parameters (Vinzi et al. 2010). Secondly, this approach should allow specific treatment of categorical variables, outliers, non-linearity and mutual causality both in measurement and structural models. The study believes that these challenges represent fascinating areas for researchers to establish PLS as a predominant paradigm for complex hierarchical modeling.

9.6 Future Research Directions

"If implemented strategically and systematically, mHealth can revolutionize health outcomes, providing virtually anyone with a mobile phone with medical expertise and knowledge in real-time. This is a boon particularly to those marginalized or living in remote areas, who would otherwise not have access to this information or care" WHO (2011, p. 77). Aligned with the same spirit for better implementation of mHealth, future research could take several new directions:

- Future work can investigate the present study in cross-cultural settings by incorporating respondents from both developed and developing countries. There is always a difference between developed and developing countries with regard to the level of educational and communication systems, financial and technological sophistication, and the level of service expectation (Malhotra 1994; Raajpoot 2004; Reynolds & Smith 2010; Witkowski & Wolfinbarger 2002). Information on these differences across cultures might be of considerable interest and significance to both researchers and practitioners for critical managerial decision making (Reynolds & Smith 2010). However, some issues should be taken into account, such as, consistency in instrument development and validation, response bias with regard to measurement equivalence, demographic profile of respondents and response style.

- Although the variance explained by the research model is quite high for the study, future work should attempt to identify and test additional boundary conditions of the model with a view to present an even richer understanding of mHealth service quality and continuance behavior. This extension might be shaped in terms of additional contextual variables, moderating influences, new technology, new user groups (physicians) and other contexts (e.g., a hospital setting). Findings from such studies might enhance the overall generalizability of mHealth service quality to explain further variance in usage behavior.
- Future work could adopt a dyadic approach in which perceptions of service providers and consumers will be taken into account. This approach might reveal some interesting findings by evaluating perceptions of different groups in one study.
- Subsequent studies need to assess the impact of service quality on other consequential latent variables (i.e., value co-creation) and on other quality-of-life domains (e.g., other technology-mediated health services).
- Future studies can extend the present research model by adding the “service recovery dimension” in order to address the concern of frequent service failures. It would be interesting to compare the results of such an approach with other established service quality models in e-service domains, such as, E-S-QUAL (Parasuraman et al. 2005) that have tried to incorporate recovery as a separate dimension.

- Methodologically, 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.

9.7 Conclusions

The objective of this study was to identify the dimensions of mHealth service quality and model the impact of overall quality on satisfaction, continuance intentions and quality of life in the context of developing countries. In order to serve the objective, a systematic literature review of IS, services marketing and health services was undertaken. Using the literature on service quality, satisfaction, continuance intentions and quality of life, a conceptual framework and a set of hypotheses were developed. The research model was specified as a hierarchical-reflective model which was then tested in the context of a B2C mHealth service in Bangladesh. A total of 104 samples were analyzed to develop and validate an instrument and 283 samples were analyzed to test the conceptual model. The study applied PLS path modeling to estimate the hierarchical model and test the relationships among constructs. The findings of the study confirmed adequate measurement and structural properties of the research model, proving six core hypotheses. In addition, the study confirmed the significant impact of satisfaction as a mediator and situational factors as a contextual variable; however, the study did not support the hierarchical service quality construct as a moderator and demographic factors as a contextual influencer.

The most significant contribution of the study lies in providing critical insights in service quality research in mHealth service systems by reframing service quality as a third-order, hierarchical-reflective construct and modeling its overall effects on individual (i.e., satisfaction), organizational (i.e., intention to continue using) and social (i.e., quality of life) outcomes. These relationships of the research model are based on adequate logical (i.e., theory is internally consistent), epistemological (i.e., rigor in research design) and empirical (i.e., robust findings) evidence. The findings of the study are highly valuable to managers to capture users' service quality perceptions which have been evidenced as hierarchical, multidimensional and context-specific. This knowledge provides an important step on the path to providing conceptual clarity and practical solutions to the service quality challenges of mHealth service systems in developing countries. Although proposed in the context of mHealth services, this model may be of interest to any service system which deals with providing a vast network of customers with right-time services. The study hopes that this research will serve as a catalyst for action by encouraging both researchers and practitioners to embrace service quality as a core concept in service systems research.

Overall, the findings make it evident that mHealth will be the ultimate societal application in developing countries to address the pressing health care needs. However, the overall development of this ubiquitous health care platform will be driven by service quality perception and its effects on service satisfaction, continuance intentions and quality of health life. As such, the findings of the study suggest an integrated quality assessment approach in order to create an enabling environment for mHealth in developing countries. In this regard, the mHealth service quality model will play an instrumental role in evaluating service satisfaction, quality of health life perception and service continuance in developing countries. Overall, the study believes that the findings will help transform the mHealth service systems in developing countries by serving the majority of unserved people and opening novel opportunities for global access to health services and medical knowledge.

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Appendix 6. A: Analysis of selected responses from focus group discussions (FGD) and depth interviews (DI): Findings on qualitative themes to support dimensions and subdimensions

Dimension	Subdimensions	Supporting quotes from FGD/DIs	Comments on Themes
Systems Quality	**Systems Reliability**	• “………‘7-8-9’ has become very familiar digits for healthcare in my community because this service platform is nuisance free and works smoothly”. (FGD 1) • “…I have been using this service since 2006 for various primary health issues of my family members and every time I have experienced the service without any disruption.” (FGD 2) • “……I have used this service several times in the last 6 months and each time I talked with the physician for about 5 minutes….I never experienced any call drops.” (FGD 3) • “……….I always depend on this service as I have never faced any trouble in services consumption……..” (DI 1) • “……….I have been living in a girls’ hostel for 1 year and we all live far away from our family. Therefore, if any member in our hostel faces any health trouble, she quickly dials number ‘7-8-9’, because of its reliable performance.” (FGD 2) • “…………A country like Bangladesh where no one can rely on traditional health service because of the lengthy procedure and long time waiting for public healthcare. This service brings a new horizon where anyone can depend on this service just in one dial.” (FGD 1)	An analysis of these quotes indicates the theme ‘systems reliability’ which is defined as the degree to which the mHealth platform is dependable over time. The following items were developed subsequently with the support of these responses and the literature to measure this theme: • mHealth platform works smoothly. • mHealth platform performs reliably. • mHealth platform is dependable.

Systems Quality	**Systems Availability**	• "……………...once at mid night my daughter had high temperature, and called to this service at 3am and the availability of the services gave me a great relief."(DI 1) • "……For my son's case, I made the call at mid night and for my dad, I made the call early in the morning, in both cases, I could access and use the service to solve my problems……" (FGD 3) • "…….I live in a rural place in Northern Bangladesh where we do not have telephone in every home and people need to go to kiosk for mobile phone services and I never had to wait for long time in order to access this service." (FGD2) • "……...Last year I went to holiday at *Cox's Bazar* which is the very end of my country. Suddenly my 3 months old daughter starts vomiting because of dehydration. I was frightened, dialed 7-8-9 and was able to contact with a doctor without any waiting. Thanks to '7-8-9' which saved my child's life." (DI 1) • "………The poor people in Bangladesh usually do not get the on hand health service. This service is available at any time at any place for all kind of people. As a result the quality of health is improving in our country." (FGD 2) • "……….I am a sales representative in a local company. My job is to move all around the country and sell the product. I find this service always available at any part of my country." (FGD 1)	These quotes indicate the theme 'systems availability' which is defined as the degree to which the mHealth platform is available on an 'anytime' and 'anywhere' basis. The following items were developed subsequently with the support of these responses and the literature to measure this theme: • This platform is always available. • I can receive medical service right away. • It does not have long waiting time.

Dimension	Sub-dimensions	Supporting quotes from FGD/DIs	Comments
Systems Quality	**Systems Efficiency**	• "……….From pressing '7-8-9' to the end of services consumption, this platform manages entire operations in an organized manner by handling all the queries relating to my health problem." (DI 2) • "…….Once my 1 year daughter was seriously affected by diarrhea, this service not only provided me the initial suggestions but also gave me the names of specialists and recommended nearby hospitals for this type of disease." (FGD 3) • "……..My 65 years' old grandfather has arthritis problem and he uses this services several times in a month for consulting his different problems, this is only possible for him because of the flexibility of these services." (DI 3) • "………I am a busy working mother with 4 kids. Whenever any of my family members gets sick, the first thing which comes to my mind is to dial the number '789' because this service provides quick service in an efficient manner." (FGD 1) • "………I always use this service because it always gives me the right solution for my health problems. As I am a rickshaw puller, cheaper service is important to me. I do not need to visit doctors repeatedly for a simple health complexity." (DI 7) • "………..One day I was away from my home because of working purpose. I left my 5 year old son to his grandmother's care. At that night my son had terrible fever and my old mother-in-law used this service because of its simplicity and easy use." (FGD 2)	An assessment of these quotes refer to the theme 'systems efficiency' which is defined as the degree to which the mHealth platform can be adapted to a variety of user needs and changing conditions The following items were developed to measure this theme: • This service platform can be adapted to meet variety of needs. • This service platform can flexibly adjust to new conditions. • This service platform is versatile in addressing needs as they arise. • This service platform is well organized.

Systems Quality	**Systems Privacy**	• "…………I am 16 years old, I used this service many times regarding feminine problems which I cannot share with my family members in a conservative society like Bangladesh and I find this service quite reliable and trustworthy."(DI 4) • "………I recently got married and I am facing difficulties while sexual intercourse. I use this service to consult with doctor. I find this platform safe because the provider is committed not to share personal information." (DI 5) • "…...I have never heard of any leaking information from this platform since 2006 , which is really good." (DI 6) • "……In a conservative society in Bangladesh, patients rely on this service a lot as they do not need to go through face to face consultation anymore for sensitive issues." (FGD 1) • "…….This service is secured to me because I am using this service for a long time and never compromised patients' confidentiality..." (DI 6) • "………My mother and mother-in-law use this service when they do not want to share personal health problems because they think that it is safe and secured." (DI 2)	An evaluation of these quotes represent the theme 'systems privacy' which is defined as the degree to which the mHealth platform provides the security of protecting health information services provided by patients. The following items were developed to measure this theme: • This platform protects information about my personal problems. • This platform does not share my personal information with others. • This platform offers me a meaningful guarantee.

Dimension	Subdimensions	Supporting quotes from FGD/DIs	Comments
Interaction Quality	**Responsiveness**	• "……I used this service for various problems and the physicians were really quick to provide solutions." (FGD 2) • "……I have been using this service for the last 4 years and I never had to wait long to get the service from the physicians."(FGD 3) • "……..Once I had terrible tummy ache and I used that platform. The Physician was very cooperative and patient to listen to my problem." (DI 7) • "…. I am a student and I have no time to visit GP; I use this service because it provides better solutions within a very short time which costs me less." (FGD 1) • "……My 18 year old daughter never wants to visit any GP because she thinks that it is time consuming and always uses this service because of its fast service." (DI 3) • "……..I work 7 days in a week and I always use this service because it provides speedy solution in no time." (FGD 2)	An analysis of these quotes represent the theme 'responsiveness' which is defined as the willingness of the service provider to help users and deliver prompt service The following items were developed subsequently with the support of these responses and the literature to measure this theme: • Physicians of mHealth platform provide prompt service. • Physicians are never too busy to respond to my requests. • Physicians are willing to help me. • They provide the service by a certain time.

Interaction Quality	**Assurance**	• "………In the last summer, I was in a remote village with my one year old daughter and that time she caught cold and flu. I was very worried but solutions of mHealth physicians really relieved me from all anxiety."(FGD 2) • "………I used this platform once while I was terribly suffering from food poisoning; the physicians asked me all the symptoms and identified my problem which proved that they are knowledgeable in their service."(FGD 3) • "………My grandmother is very old and we often face problems because of her unstable physical condition. In that case, we use this service because every time they assure us with right solution."(DI 2) • "……the way mHealth physicians talk with me is really assuring". (FGD 1) • "……….My father is a diabetic patient. One day, suddenly his sugar level went down and he collapsed. I immediately dialed the number '789' and the way they suggested to me and assured me was amazing." (FGD 2) • "………..I live with my aunt. One day my aunt became very sick. At that moment I used this service and explained the situation. They not only identified the problem but also gave me the advice for that particular problem. Moreover, they provide the name of the nearest specialist for further treatment." (FGD1)	These quotes illuminate the theme 'assurance' which is defined as the degree to which the mHealth platform is safe. It is an important dimension to inspire trust and confidence. The following items were developed to measure this theme: • The behavior of physicians instills confidence in me. • I feel safe while consulting with physicians. • Physicians have the knowledge to answer my questions. • Physicians are competent in providing service.

Dimension	Sub-dimensions	Supporting quotes from FGD/DIs	Comments
Interaction Quality	**Empathy**	• "……Generally in public hospitals or in nearby pharmacy, the physicians provide a pre-set solution to a problem. They have no time to listen to the specific nature of my problem. However, mHealth physicians understand my specific needs and provide customized solutions which is really appreciated " (FGD 1) • "……Once you talk with mHealth physicians, you can understand their level of professionalism. Their queries to know the root cause indicate their best interests to solve my problem". (FGD 3) • "……..mHealth physicians provide solutions for solving problems, not for the sake of earning money. I like their caring attitude to understand my needs. " (FGD 2) • "……...My aunt is a diabetic patient who uses this service for her physical problem. She cannot express all her problems but this service is always supportive to her and never showed any impatience."(FGD 1) • "……….One of my relatives was recently diagnosed with heart problems. We were really worried because we live in a rural place and do not know which hospital provides the best service for heart disease. We dialed 789 and they provided us with the name of the hospital and specialist for heart treatment. It was really beneficial for us." (FGD 2)	An analysis of these quotes reflects the theme 'empathy' which is defined as 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. The following items were developed using these responses and literature to measure this theme: • Physicians give me personal attention. • Physicians give me individual care. • Physicians understand my specific needs. • Physicians have my best interests at heart.

Outcome Quality	**Functional Benefit**	• "…….I am a mother of four children, I often face frequent medical problems for my kids. Every time visiting a GP is very expensive for me. So I use this service which is not only economic but also gives me the right solution for my kids' problem." (FGD 1) • "…….I work as a sales representative in a company, the nature of my job is to move all around the country, I always use this service because it is very convenient and it always serves my purpose." (FGD 2) • "…….I am a taxi driver, I run a big family with my limited income. Whenever, any of my family members get sick, this service came to my mind because it is useful for me in all aspects." (DI 7). • "………Teaching is my profession; hence I need this service in order to inform the vaccination information to parents." (FGD3) • "………I prefer this service because it is quick and efficient." (DI 8) • "………I like this service because it provided better service at low cost." (DI 9)	An assessment of the quotes reflects the theme 'functional benefit' which is defined as the degree to which the mHealth service serves its actual purpose. The following items were developed using these responses and the literature to measure this theme: • It serves my purpose very well. • I believe having service from this platform has been worthwhile. • It is convenient to use this health service. • Overall this service is useful to me.

Dimension	Sub-dimensions	Supporting quotes from FGD/DIs	Comments
Outcome Quality	**Emotional Benefit**	• "……..I am a rice grower. Couple of years before I never thought of visiting a doctor for simple health problems. Because of this platform, now I feel encouraged to use health service always." (DI 10) • "…..During my pregnancy, I had different problems such as acidity, increased body temperature and so on, this service not only suggested to me the solution but also advised me what is good for the unborn baby. All these suggestions created a sort of confidence in my vulnerable mind at that time"(DI 8) • "…….My son is very fussy about food and it keeps worrying me seriously but with the help of this service I always get information about how can I give him balanced intake. I am pretty hopeful that it will work because the suggestions seemed very rational to me "(DI 9) • "…………I feel very positive when I use this platform." (FGD1) • "………….I always feel relaxed and relieved whenever I use this service." (FGD 3) • "…………It removes my mental agony regarding my health problem." (FGD 2)	An evaluation of these quotes indicates the theme 'emotional benefit' which is defined as the degree to which the mHealth service arouses positive feelings. The following items were developed subsequently with the support of these responses and the literature to measure this theme: • I feel positive using this health service. • I feel hopeful as a result of having this service. • I feel encouraged as a result of having this service. • I feel confident using this service.

Appendix 6. B: Placement ratio, inter-judge raw agreement scores & associated kappa scores

Placement Ratios	Round 1	Round 2	Avg. (2 Rounds)
Systems Reliability	0.82	0.84	0.83
Systems Availability	0.80	0.84	0.82
Systems Efficiency	0.74	0.78	0.76
Systems Privacy	0.86	0.92	0.89
Responsiveness	0.82	0.76	0.79
Assurance	0.84	0.88	0.86
Empathy	0.72	0.84	0.78
Functional Benefit	0.82	0.88	0.85
Emotional Benefit	0.75	0.81	0.78
Average	0.80	0.84	**0.82**
Raw Agreement	0.86	0.82	0.84
	0.84	0.86	0.85
	0.88	0.94	0.91
	0.84	0.92	0.88
	0.86	0.86	0.86
	0.78	0.92	0.85
	0.85	0.88	0.87
	0.82	0.86	0.84
Average	0.84	0.88	**0.86**
Cohen's Kappa $K = \frac{pr(a) - pr(e)}{1 - pr(e)}$ ** Pr (a) = The observed percentage agreement, Pr (e) = The probability of random agreement.*	0.83	0.79	0.81
	0.81	0.82	0.82
	0.84	0.91	0.88
	0.8	0.89	0.84
	0.82	0.82	0.82
	0.75	0.82	0.79
	0.83	0.86	0.84
	0.79	0.82	0.81
Average	0.81	0.84	**0.83**

Appendix 6. C: Factor analysis (Round 1)

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.803
Bartlett's Test of Sphericity	Approx. Chi-Square	2514.764
	df	528
	Sig.	.000

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	10.344	31.345	31.345	10.344	31.345	31.345	4.192	12.702	12.702
2	2.928	8.873	40.218	2.928	8.873	40.218	3.350	10.151	22.853
3	2.599	7.875	48.093	2.599	7.875	48.093	2.939	8.906	31.759
4	2.103	6.374	54.467	2.103	6.374	54.467	2.877	8.717	40.476
5	1.854	5.617	60.084	1.854	5.617	60.084	2.569	7.785	48.261
6	1.555	4.714	64.798	1.555	4.714	64.798	2.386	7.230	55.491
7	1.460	4.424	69.222	1.460	4.424	69.222	2.379	7.208	62.699
8	1.321	4.003	73.225	1.321	4.003	73.225	2.310	7.001	69.700
9	1.018	3.086	76.312	1.018	3.086	76.312	2.182	6.612	76.312
10	.917	2.780	79.091						
11	.819	2.483	81.574						
12	.712	2.156	83.731						
13	.544	1.650	85.381						
14	.514	1.558	86.938						
15	.512	1.553	88.491						

16	.482	1.462	89.953						
17	.425	1.287	91.240						
18	.404	1.223	92.463						
19	.336	1.019	93.482						
20	.311	.943	94.425						
21	.285	.863	95.288						
22	.256	.776	96.064						
23	.215	.653	96.716						
24	.178	.540	97.256						
25	.170	.514	97.770						
26	.136	.413	98.183						
27	.122	.369	98.552						
28	.104	.315	98.867						
29	.099	.300	99.167						
30	.083	.252	99.419						
31	.073	.220	99.639						
32	.070	.211	99.851						
33	.049	.149	100.000						

Extraction Method: Principal Component Analysis.

Rotated Component Matrix[a]

	Component								
	1	2	3	4	5	6	7	8	9
SQ1						.688			
SQ2						.899			
SQ3						.838			
SQ4								.888	
SQ5								.831	
SQ6*								.368	
SQ7				.835					
SQ8				.853					
SQ9				.791					
SQ10*				.331					
SQ11									.928
SQ12									.906
SQ13*								.421	.451
SQ14*	.425	.410					.493		
SQ15			.828						
SQ16			.890						
SQ17			.885						
SQ18							.596		
SQ19							.520		
SQ20*	.439								
SQ21							.600		
SQ22	.817								
SQ23	.839								
SQ24	.713								
SQ25*	.323								
SQ26*							.660		
SQ27					.773				
SQ28					.682				
SQ29					.640				
SQ30*		.346							
SQ31		.848							
SQ32		.823							
SQ33		.820							

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 8 iterations.

Appendix 6. D: Factor analysis (Round 2)

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.764
Bartlett's Test of Sphericity	Approx. Chi-Square	1828.879
	df	300
	Sig.	.000

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.824	31.297	31.297	7.824	31.297	31.297	2.765	11.061	11.061
2	2.644	10.575	41.873	2.644	10.575	41.873	2.765	11.060	22.121
3	2.070	8.279	50.151	2.070	8.279	50.151	2.757	11.026	33.148
4	1.864	7.457	57.609	1.864	7.457	57.609	2.502	10.006	43.154
5	1.722	6.890	64.498	1.722	6.890	64.498	2.298	9.193	52.347
6	1.473	5.890	70.389	1.473	5.890	70.389	2.090	8.360	60.707
7	1.118	4.472	74.861	1.118	4.472	74.861	2.032	8.129	68.836
8	1.076	4.304	79.164	1.076	4.304	79.164	1.779	7.116	75.952
9	1.024	3.297	82.462	1.024	3.297	82.462	1.627	6.509	82.462
10	.674	2.697	85.158						
11	.575	2.299	87.457						
12	.498	1.990	89.447						
13	.468	1.873	91.320						
14	.380	1.520	92.840						

15	.333	1.331	94.170						
16	.261	1.042	95.213						
17	.225	.899	96.112						
18	.203	.812	96.923						
19	.173	.694	97.617						
20	.142	.569	98.186						
21	.123	.493	98.678						
22	.105	.419	99.098						
23	.090	.361	99.458						
24	.082	.326	99.785						
25	.054	.215	100.000						

Extraction Method: Principal Component Analysis.

Rotated Component Matrix[a]

	Component								
	1	2	3	4	5	6	7	8	9
SQ1					.700				
SQ2					.905				
SQ3					.851				
SQ4								.908	
SQ5								.896	
SQ7			.854						
SQ8			.866						
SQ9			.807						
SQ11							.946		
SQ12							.932		
SQ15	.868								
SQ16	.907								
SQ17	.892								
SQ18									.731
SQ19									.662
SQ21									.628
SQ22				.831					
SQ23				.861					
SQ24				.738					
SQ27						.805			
SQ28						.719			
SQ29						.680			
SQ31		.851							
SQ32		.859							
SQ33		.890							

Appendix 6. E: Factor analysis (Outcome constructs)

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.861
Bartlett's Test of Sphericity	Approx. Chi-Square	835.993
	df	55
	Sig.	.000

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.409	58.266	58.266	6.409	58.266	58.266	3.625	32.955	32.955
2	1.186	10.783	69.049	1.186	10.783	69.049	2.484	22.584	55.539
3	1.032	7.568	76.616	1.032	7.568	76.616	2.319	21.078	76.616
4	.587	5.335	81.951						
5	.496	4.508	86.460						
6	.405	3.685	90.145						
7	.347	3.158	93.303						
8	.284	2.585	95.888						
9	.191	1.735	97.623						
10	.180	1.639	99.261						
11	.081	.739	100.000						

Extraction Method: Principal Component Analysis.

Rotated Component Matrix[a]

	Component		
	1	2	3
SA1	.845		
SA2	.881		
SA3	.796		
SA4	.787		
IC1			.881
IC2			.656
IC3			.743
QL1		.644	
QL2		.680	
QL4		.711	
QL5		.879	

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 5 iterations.

Appendix 6. F: English Questionnaire

THE UNIVERSITY OF NEW SOUTH WALES
SYDNEY · AUSTRALIA

Approval No (09703)

THE UNIVERSITY OF NEW SOUTH WALES

PARTICIPANT INFORMATION STATEMENT AND CONSENT FORM

User Perceived Service Quality of mHealth Services in Developing Countries: A study in Bangladesh

You are invited to participate in a study of your perceptions regarding service quality of mobile health services. The objective of this study is to explore the dimensions of service quality of mHealth services and their impact on user satisfaction, intention to continue using and quality of life in Bangladesh. Here, we define mHealth services as a personalized and interactive service whose main goal is to provide ubiquitous and universal access to medical advice and information to patients over mobile phone, such as, mobile health line service (789) provided by Grameen phone in your country. You have been selected as a possible participant in this study because you are one of the users of such services in Bangladesh.

If you decide to participate, I will provide you with a copy of a questionnaire to be completed which will take approximately 15 minutes. There are no foreseeable discomforts and inconveniences associated with the procedure and I cannot and do not guarantee or promise that you will receive benefits from participating in this study.

It may be noted that completion and return of the questionnaire will be regarded as your consent to participate in the survey. Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission, except as required by law. I plan to publish the results in my PhD thesis that will be submitted to The University of New South Wales. In any publication, information will be provided in such a way that you cannot be identified.

If you would like feedback on the study, please provide your preferred contact address at the end of the questionnaire.

Your decision whether or not to participate will not prejudice your future relations with the University of New South Wales. If you decide to participate, you are free to withdraw your consent and to discontinue participation at any time without prejudice. If you have any questions, please feel free to ask me. If you have any additional questions subsequently, A/P John D'Ambra, (Tel: + 61 2 93854854, email: j.dambra@unsw.edu.au) will be happy to answer them.

You will be given a copy of this form to keep. Your assistance is greatly appreciated. Thank you for participating in this study.

Regards,

Md. Shahriar Akter
phD student
School of Information Systems, Technology and Management
Australian School of Business
The University of New South Wales

Screening Questions

1. Are you aware of health services through your mobile phone?

   Yes **No**

2. Do you use mobile health services?

   Yes **No**

3. Did you use mobile health services in the last one year?

   Yes **No**

If your answer is 'NO' to any of the above mentioned questions, you are NOT required to fill the the questions in the following pages. Please return the questionnaire back to instructor. Otherwise, please continue.

Instructions: *Please rate the following statements under 1-7 point scale where '1' refers to the lowest degree of agreement and '7' refers to the highest degree of agreement.*

SECTION A	Strongly Disagree			Neither Agree Nor Disagree			Strongly Agree
SQ1. This service platform works smoothly.	1	2	3	4	5	6	7
SQ2. This service platform performs reliably.	1	2	3	4	5	6	7
SQ3. This service platform is dependable.	1	2	3	4	5	6	7
SQ4. This platform is always available.	1	2	3	4	5	6	7
SQ5. I can receive medical service right away.	1	2	3	4	5	6	7
SQ6. It does not have long waiting time.	1	2	3	4	5	6	7
SQ7. This service platform can be adapted to meet variety of needs.	1	2	3	4	5	6	7
SQ8. This service platform can flexibly adjust to new conditions.	1	2	3	4	5	6	7
SQ9.This service platform is versatile in addressing needs as they arise.	1	2	3	4	5	6	7
SQ10: This service platform is well organized.	1	2	3	4	5	6	7
SQ11.This platform protects information about my personal problems.	1	2	3	4	5	6	7
SQ12.This platform does not share my personal information with others.	1	2	3	4	5	6	7
SQ13. This platform offers me a meaningful guarantee.	1	2	3	4	5	6	7
SQ14. Physicians of mHealth platform provide prompt service.	1	2	3	4	5	6	7
SQ15. Physicians are never too busy to respond to my requests.	1	2	3	4	5	6	7
SQ16. Physicians are willing to help me	1	2	3	4	5	6	7
SQ17. They provide the service by a certain time.	1	2	3	4	5	6	7
SQ18.The behavior of physicians instills confidence in me.	1	2	3	4	5	6	7
SQ19. I feel safe while consulting with Physicians.	1	2	3	4	5	6	7

SQ20. Physicians have the knowledge to answer to my questions.	1	2	3	4	5	6	7
SQ21. Physicians are competent in providing service.	1	2	3	4	5	6	7
SQ22. Physicians give me personal attention.	1	2	3	4	5	6	7
SQ23. Physicians give me individual care.	1	2	3	4	5	6	7
SQ24. Physicians understand my specific needs.	1	2	3	4	5	6	7
SQ25: Physicians have my best interests at heart.	1	2	3	4	5	6	7
SQ26. It serves my purpose very well.	1	2	3	4	5	6	7
SQ27. I believe having service from this platform has been worthwhile.	1	2	3	4	5	6	7
SQ28: It is convenient to use this health service.	1	2	3	4	5	6	7
SQ29. Overall this service is useful to me.	1	2	3	4	5	6	7
SQ30: I feel positive using this health service.	1	2	3	4	5	6	7
SQ31. I feel hopeful as a result of having this service.	1	2	3	4	5	6	7
SQ32. I feel encouraged as a result of having this service.	1	2	3	4	5	6	7
SQ33. I feel confident using this service.	1	2	3	4	5	6	7

SECTION B

(SA1-SA4)	Very dissatisfied 1	2	3	4	5	6	Very Satisfied 7
I am -----------with my use of mobile health for primary medical information service.	Very frustrated	2	3	4	5	6	Very contented 7
	Very Displeased 1	2	3	4	5	6	Very Pleased 7
	Absolutely terrible 1	2	3	4	5	6	Absolutely delighted 7

SECTION C	Strongly Disagree			Neither Agree Nor Disagree			Strongly Agree
IC1. I intend to continue using mobile health service to get medical information services.	1	2	3	4	5	6	7
IC2. My intention is to continue using this service rather than use any alternative means (e.g., going to local clinics)	1	2	3	4	5	6	7
IC3. I will not discontinue my use of this service.	1	2	3	4	5	6	7
SECTION D	Strongly Disagree			Neither Agree Nor Disagree			Strongly Agree
QL1. Getting services from this platform have enabled me to improve my overall health.	1	2	3	4	5	6	7
QL2. In most ways, my life has come closer to my ideal since I started using this service.	1	2	3	4	5	6	7
QL3. I have been more satisfied with my health life, thanks to this service.	1	2	3	4	5	6	7
QL4. So far, this service has helped me to achieve the level of health I most want in life.	1	2	3	4	5	6	7
SECTION E *Please provide your degree of importance with regard to the following mHealth service. Here '1' refers to 'not important at all' and '7' refers to 'very important'.*	Not important at all			Neutral			Very Important
TM1. Help and advice during medical emergency	1	2	3	4	5	6	7
TM2. Information on medicine	1	2	3	4	5	6	7
TM3. Medical consultation with physicians	1	2	3	4	5	6	7
TM4. Information on specialized physicians	1	2	3	4	5	6	7
TM5. Information on medical facilities	1	2	3	4	5	6	7

SECTION F	
SF1. Media influenced you to use mHealth service?	1. Yes 2. No
SF2. People around you influenced to use this service?	1. Yes 2. No
SF3. What is your opinion about the cost of this service?	1. High 2. Medium 3. Low
SF4. How many times did you use this service in the last one year?	1. One 2. Two 3. Three 4. More than 3 times

Respondent's Profile

Gender: 1. Male 2. Female

Age

1. 18-25
2. 26-33
3. 34-41
4. 42-49
5. 50+

Income (in Taka)

1. Below 5000
2. 5001-10000
3. 10001-15000
4. 15001-20000
5. 20001-25000
6. 25001 -30000
7. 30000 +

Occupation

1. Education, Teaching & Research
2. Domestic workers / Housewife
3. Personal business
4. Public organization
5. Private organization
6. Others

Location:

1. Urban
2. Rural

Time of Service:

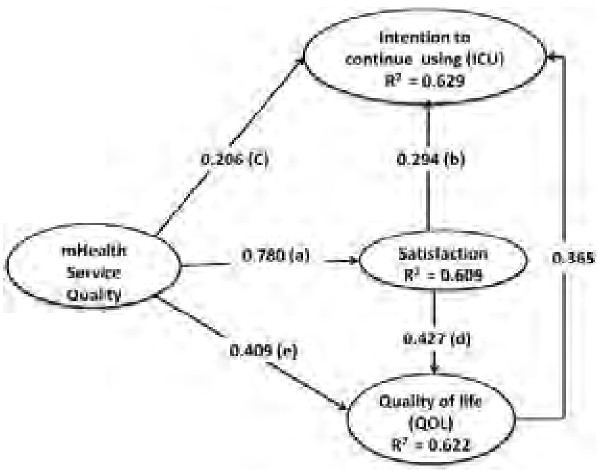
1. 9:01 AM – 5: 00 PM (Day)
2. 5:01 PM – 10:00 PM (Evening)
3. 10:01 PM - 5:00 AM (Night)
4. 5:01 AM- 09:00 AM (Morning)

Appendix 8. A: Path coefficients, STDER, *t*-values of the research model

Hierarchical Model			Path coefficients	Standard error	*t* statistic
Platform quality	→	System Reliability	0.772	0.0388	19.8969
Platform quality	→	System Availability	0.681	0.0379	17.9683
Platform quality	→	System Efficiency	0.845	0.0190	44.4736
Platform quality	→	System Privacy	0.642	0.0583	11.0120
Interaction quality	→	Responsiveness	0.856	0.0271	31.5867
Interaction quality	→	Assurance	0.885	0.0196	45.1530
Interaction quality	→	Empathy	0.912	0.0133	68.5714
Outcome quality	→	Functional Benefit	0.931	0.0108	86.2037
Outcome quality	→	Emotional Benefit	0.959	0.0054	177. 5925
Service quality	→	Interaction quality	0.874	0.0188	46.4893
Outcome quality	→	Functional Benefit	0.944	0.0090	104.8888
Service quality	→	Platform quality	0.931	0.0093	100.1075
Structural Model					
Service quality	→	Satisfaction	0.780	0.0356	21.9101
Service quality	→	Intention to continue using	0.206	0.0671	3.0700
Service quality	→	Quality of life	0.409	0.0580	7. 0517
Satisfaction	→	Intention to continue using	0.294	0.0646	4.5510
Satisfaction	→	Quality of life	0.427	0.0594	7.1885
Quality of life	→	Intention to continue using	0.365	0.0689	5.2975

Appendix 8. B: Calculating Z value for mediation analysis

Structural Model			Path coefficients	Standard error	T statistic
Service quality	→	**Satisfaction**	**0.780**	**0.0356**	**21.9101**
Service quality	→	**Intention to continue using**	**0.206**	**0.0671**	**3.0700**
Service quality	→	**Quality of life**	**0.409**	**0.0580**	**7. 0517**
Satisfaction	→	**Intention to continue using**	**0.294**	**0.0646**	**4.5510**
Satisfaction	→	**Quality of life**	**0.427**	**0.0594**	**7.1885**
Quality of life	→	**Intention to continue using**	**0.365**	**0.0689**	**5.2975**



$$= \frac{a \times b}{\sqrt{b^2 \times s_a^2 + \quad {}^2 \quad {}^2 \cdot \quad {}^2 \quad {}^2}}$$

$Z_{\text{SQ-ICU Link}}$

= 0.780*0.294/ 0.0864 * 0.0013 + 0.6084*0.0042

= 0.22932/ 0.00011232 + 0.0025552

= 0.22932/ 0.05165

= 4.442

$$= \frac{a \times d}{\sqrt{d^2 \times \quad \quad \quad + s_a^2 \times s_d^2}}$$

$Z_{\text{SQ-QOL Link}}$

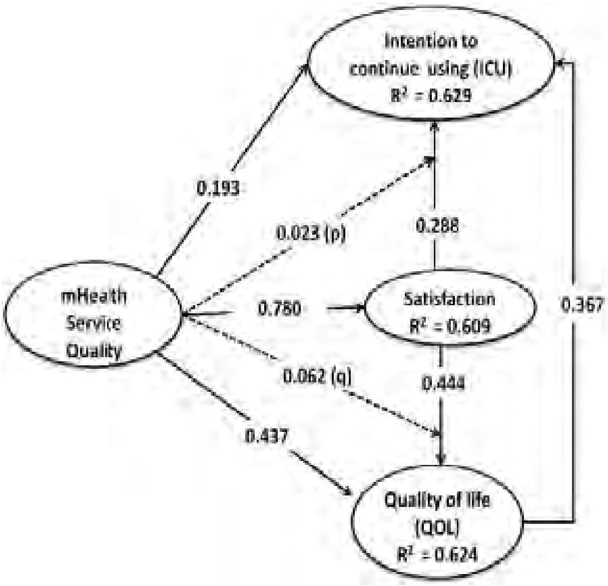
= 0.33306/ 0.182329 * 0.0013 + 0.6084*0.003528

= 0.33306/ 0.000237+ 0.002146

= 0.33306/ 0.04882

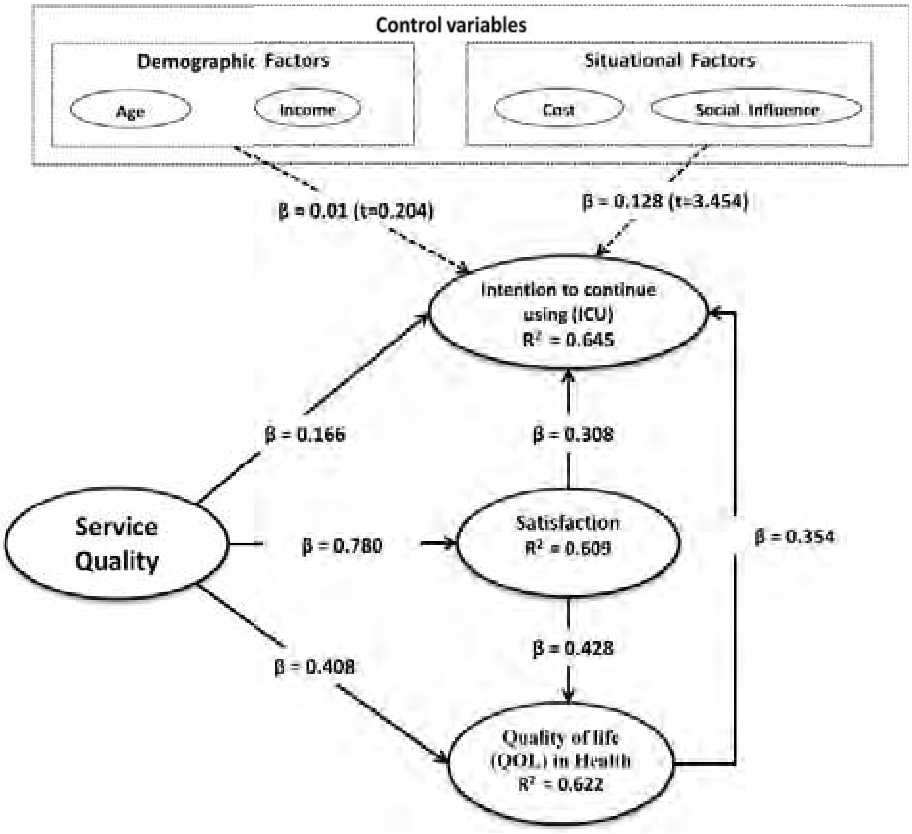
= 6.822

Appendix 8. C: Moderation analysis



Structural Model			Path coefficients	Standard error	T statistic
Service quality	→	Satisfaction	0.780	0.0348	22. 3901
Service quality	→	Intention to continue using	0.193	0.0694	2.7862
Service quality	→	Quality of life	0.437	0.0606	7. 2005
Satisfaction	→	Intention to continue using	0.288	0.0608	4.0617
Satisfaction	→	Quality of life	0.444	0.0661	6.7148
Quality of life	→	Intention to continue using	0.367	0.0657	4.8541
SAT * SQ	→	Intention to continue using	0.023	0.0641	0.3797
SAT * SQ	→	Quality of life	0.062	0.0932	0.6614

Appendix 8. D: Impact of control variables



Structural Model			Path coefficients	Standard error	T statistic
Service quality	⟶	Satisfaction	0.780	0.0340	22.8956
Service quality	⟶	Intention to continue using	0.166	0.0704	2.3828
Service quality	⟶	Quality of life	0.408	0.0573	7. 1141
Satisfaction	⟶	Intention to continue using	0.308	0.0666	4.5859
Satisfaction	⟶	Quality of life	0.428	0.0599	7.1402
Quality of life	⟶	Intention to continue using	0.354	0.0740	4.7867

Appendix 8. E: Significance of loadings (First-order model)

Constructs	Items	Loadings	t-stat
System Reliability	SR1. This service platform works smoothly. SR2. This service platform performs reliably. SR3. This service platform is dependable.	0.891 0.938 0.927	41.946 81.434 66.690
System Availability	SA1. This platform is always available. SA2. I can receive medical service right away.	0.876 0.899	53.722 70.460
System Efficiency	SE1. This service platform can be adapted to meet variety of needs. SE2. This service platform can flexibly adjust to new conditions. SE3.This service platform is versatile in addressing needs as they arise.	0.937 0.956 0.934	94.582 141.687 83.202
System Privacy	SP1.This platform protects information about my personal problems. SP2.This platform does not share my personal information with others.	0.977 0.976	254.519 240.609
Responsiveness	RE1. Physicians of mHealth provide prompt service. RE2. Physicians are never too busy to respond. RE3. Physicians are willing to help me.	0.927 0.920 0.917	61.479 64.397 56.823
Assurance	AS1.The behavior of physicians instills confidence. AS2. I feel safe while consulting with Physicians. AS3. Physicians have the knowledge to answer to my questions.	0.899 0.903 0. 841	61.470 61.254 32.964
Empathy	EM1. Physicians give me personal attention. EM2. Physicians give me individual care. EM3. Physicians understand my specific needs.	0.942 0.946 0.880	94.197 90.911 39.322
Functional Benefits	FB1. It serves my purpose very well. FB2. Having service from mHealth has been worthwhile. FB3. Overall this service is useful to me.	0.834 0.844 0.845	39.067 30.043 29.579
Emotional Benefits	EB1. I feel hopeful as a result of having this service. EB2. I feel encouraged as a result of having this service. EB3. I feel confident using this service.	0.961 0.952 0.945	120.091 115.590 94.146
Service satisfaction	SAT1. I am satisfied with my use of mHealth service. SAT2. I am contented with my use of mHealth service. SAT3. I am pleased with my use of mHealth service. SAT4. I am delighted with my use of mHealth service.	0.950 0.953 0.951 0.942	111.984 117.084 123.048 99.171
Intention to continue using	ICU1. I intend to continue using mHealth. ICU2. My intention is to continue using this service. ICU3. I will not discontinue my use of this service.	0.944 0.929 0.972	87.781 66.298 202.870
Quality of health life	QOL1. mHealth enabled me to improve my overall health. QOL2. In most ways, my life has come closer to my ideal. QOL3. I have been more satisfied with my health life. QOL4. So far, this service has helped me to achieve the level of health I most want in life.	0.905 0.905 0.881 0.916	63.012 61.362 76.660 43.107

Appendix 8. F: Significance of loadings (Second-order model)

Second order constructs	First order Constructs	Items	Loadings	t-stat
Platform Quality (10 items)	System Reliability	SR1	0.792	16.272
		SR2	0.831	15.003
		SR3	0.828	17.203
	System Availability	SA1	0.770	11.982
		SA2	0.781	11.546
	System Efficiency	SE1	0.857	30.673
		SE2	0.830	35.209
		SE3	0.820	35.045
	System Privacy	SP1	0.864	11.534
		SP2	0.853	11.763
Interaction Quality (9 items)	Responsiveness	RE1	0.821	21.022
		RE2	0.824	22.659
		RE3	0.818	28.213
	Assurance	AS1	0.800	24.847
		AS2	0.776	21.760
		AS3	0. 761	19.087
	Empathy	EM1	0.848	40.149
		EM2	0.860	38.461
		EM3	0.816	28.575
Outcome Quality (6 items)	Functional Benefit	FB1	0.787	22.823
		FB2	0.771	25.801
		FB3	0.780	20.690
	Emotional Benefit	EB1	0.917	66.337
		EB2	0.910	70.784
		EB3	0.915	70.881

Appendix 8. G: Significance of loadings (Third-order model)

Third order construct	Second order constructs	First order Constructs	Items	Loadings	t-stat
Service Quality (25 items)	Platform Quality (10 items)	System Reliability	SR1 SR2 SR3	0.722 0.761 0.758	11.133 10.870 13.331
		System Availability	SA1 SA2	0.710 0.720	07.467 06.661
		System Efficiency	SE1 SE2 SE3	0.767 0.770 0.751	22.224 21.958 21.202
		System Privacy	SP1 SP2	0.793 0.753	10.102 11.133
	Interaction Quality (9 items)	Responsiveness	RE1 RE2 RE3	0.714 0.735 0.768	16.499 19.664 21.514
		Assurance	AS1 AS2 AS3	0.788 0.772 0. 711	24.612 26.301 14.614
		Empathy	EM1 EM2 EM3	0.792 0.789 0.760	25.149 26.987 20.604
	Outcome Quality (6 items)	Functional Benefits	FB1 FB2 FB3	0.746 0.716 0.760	19.227 19.923 06.661
		Emotional Benefits	EB1 EB2 EB3	0.846 0.832 0.838	34.285 33.575 35.599

Appendix 8. H: Cross loadings of the measurement model

	Assurance	Intention to Continue Using (ICU)	Emotional Benefit (EB)	Empathy
ICU1	0.492873	**0.943698**	0.469314	0.587120
ICU2	0.434707	**0.929000**	0.486034	0.495029
ICU3	0.419853	**0.972264**	0.469952	0.584105
EM1	0.400555	0.568048	0.455058	**0.941635**
EM2	0.450863	0.542357	0.467657	**0.945512**
EM3	0.412448	0.514494	0.456258	**0.879906**
AS1	**0.899377**	0.557085	0.588721	0.544428
AS2	**0.902617**	0.586737	0.660302	0.440335
AS3	**0.840691**	0.482172	0.601652	0.586167
EB1	0.511035	0.446828	**0.960912**	0.579787
EB2	0.481118	0.425032	**0.951506**	0.481146
EB3	0.418331	0.466035	**0.945212**	0.481523

	Quality of Life (QOL)	Responsiveness (RE)	Systems Availability (SA)	Satisfaction (SAT)
RE1	0.506952	**0.927499**	0.314789	0.527944
RE2	0.476074	**0.919649**	0.403210	0.509352
RE3	0.547352	**0.916629**	0.302966	0.592548
SA1	0.308836	0.335521	**0.911798**	0.287688
SA2	0.283542	0.334112	**0.906549**	0.289340
QOL1	**0.904641**	0.458781	0.239014	0.581957
Q0L2	**0.904722**	0.473485	0.279836	0.544852
QOL3	**0.881095**	0.540271	0.321122	0.490143
QOL4	**0.915789**	0.526012	0.333752	0.572798
SAT1	0.414159	0.575007	0.298593	**0.949643**
SAT2	0.358128	0.581207	0.290605	**0.952962**
SAT3	0.310229	0.541276	0.302124	**0.951126**
SAT4	0.499776	0.546550	0.313154	**0.942096**

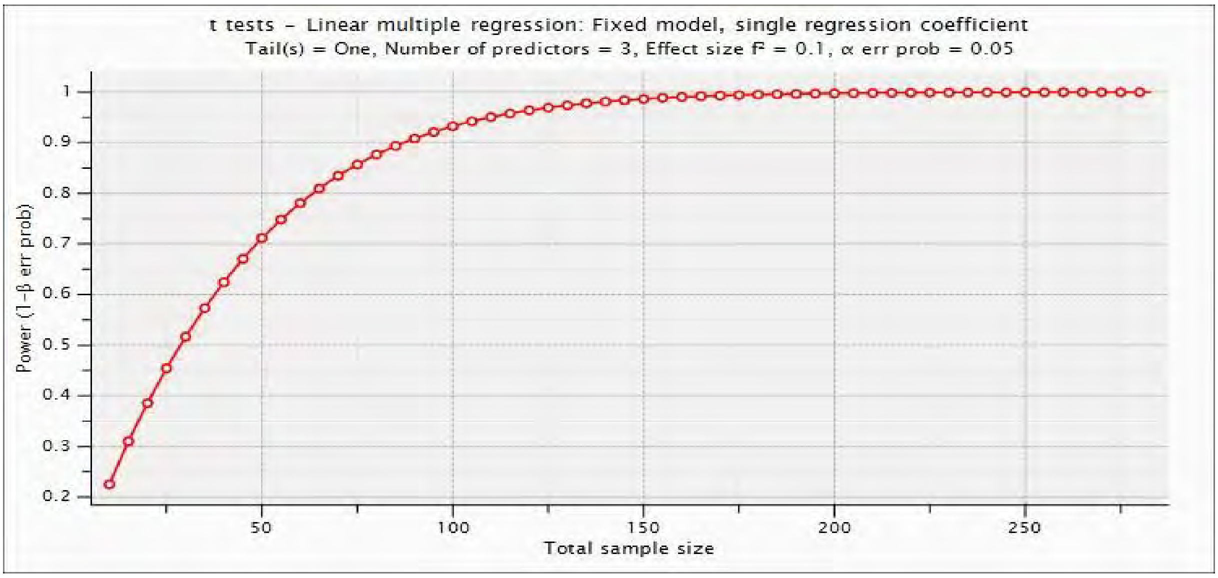
	Systems Efficiency (SE)	Systems Privacy (SP)	Systems Reliability (SR)	Functional Benefit (FB)
SE1	**0.937188**	0.395978	0.434997	0.414159
SE2	**0.956329**	0.418843	0.445152	0.358128
SE3	**0.934199**	0.460984	0.423225	0.310229
SP1	0.435471	**0.977096**	0.289238	0.499776
SP2	0.446226	**0.976231**	0.253907	0.298593
SR1	0.440260	0.249724	**0.890143**	0.290605
SR2	0.401454	0.256019	**0.927021**	0.302124
SR3	0.427867	0.321122	**0.937816**	0.313154
FB1	0.335521	0.333752	0.414159	**0.834355**
FB2	0.334112	0.298593	0.358128	**0.843777**
FB3	0.458781	0.321122	0.310229	**0.844660**

Appendix 8. I: Power analysis (using the program G*Power 3.3.3)

T tests - Linear multiple regression: Fixed model, single regression coefficient

Analysis: Post hoc: Compute achieved power

Input:	Tail(s)	=	One
	Effect size f^2	=	0.10
	α err prob	=	0.05
	Total sample size	=	283
	Number of predictors	=	3 (SQ, SAT, QOL)
	Criterion Variable	=	1 (ICU)
Output:	Noncentrality parameter δ	=	6.5153665
	Critical t	=	1.6503335
	Df	=	279
	Power (1-β err prob)	=	0.9999994



Appendix 8. J: Predictive relevance (using the program PLS Graph 3.0)

Constructs	**CV Redundancy**	**CV Communality**
Service Quality (SQ)	0.502	0.502
Satisfaction (SAT)	0.549	0.871
Quality of Life (QOL)	0.500	0.792
Continuance Intentions (ICU)	0.546	0.745

Appendix 8. K: GoF index estimation

Endogenous Constructs	AVE	R^2
Systems reliability	0.844	0.596
Systems availability	0.788	0.464
Systems efficiency	0.889	0.714
Systems privacy	0.954	0.412
Responsiveness	0.849	0.733
Assurance	0.777	0.783
Empathy	0.852	0.832
Functional Benefit	0.707	0.867
Emotional Benefit	0.907	0.919
Satisfaction	0.901	0.609
Intention to continue using	0.900	0.629
Quality of life	0.813	0.622
Average	0.848	0.682
$GOF = \sqrt{0.848 \times 0.682}$	0.760	

Appendix 8. L: Bangla Questionnaire

THE UNIVERSITY OF NEW SOUTH WALES

SYDNEY · AUSTRALIA

অনুমোদন নং (**০৯১০৩**)

দি ইউনিভার্সিটি অফ নিউ সাউথ ওয়েলস

অংশগ্রহণকারীর তথ্য বিবৃতি ও সম্মতি পত্র

উন্নয়নশীল দেশে মোবাইল স্বাস্থ্য সেবার ব্যাবহারকারী অনুভূত সেবার মানঃ প্রেক্ষিত বাংলাদেশ

আপনার অনুভূত মোবাইল স্বাস্থ্য সেবার মান নিয়ে করা গবেষণায় আপনাকে আমন্ত্রন জানানো হচ্ছে। এই গবেষণার উদ্দেশ্য হল মোবাইল স্বাস্থ্য সেবার মাত্রা নিয়ে গবেষণা করা এবং ব্যবহারকারীদের উপর তার সন্তুষ্টির প্রভাব, ভবিষ্যতে এর ব্যবহার চালু রাখার মানুষিকতা ও বাংলাদেশে জীবনযাত্রার মান। এখানে মোবাইল স্বাস্থ্য সেবা বলতে আমরা যোগাযোগ, ব্যক্তিগতকৃত ও উত্তরপ্রদানসূচক সেবা যার মূল উদ্দেশ্য হল সর্বব্যাপী ও সার্বজনীন স্বাস্থ্য পরামর্শ ও তথ্য মোবাইলের মাধ্যমে রোগীকে পৌঁছে দেয়া, যেমন, আপনাদের দেশে গ্রামীণ ফোনের মাধ্যমে মোবাইল স্বাস্থ্য লাইন সেবা (৭৮৯)। এই গবেষণায় আপনাকে একজন সম্ভাব্য অংশগ্রহণকারী হিসেবে মনোনীত করা হয়েছে কারণ আপনি বাংলাদেশে এই ধরনের সেবা ব্যাবহারকারীদের একজন।

আপনি যদি অংশ নেওয়ার ব্যাপারে সিদ্ধান্ত নেন, তাহলে আমি আপনাকে পূরণ করার জন্য এই প্রশ্নপত্রের একটা কপি দেবো যেটা প্রায় ১৫ মিনিট সময় নেবে। এই প্রক্রিয়ায় দূরবর্তী সময়ের জন্য কোনরকমের অস্বস্তি ও অসুবিধা নেই এবং আমি আপনাকে কোন সুবিধা পাওয়ার ব্যাপারে কোন নিশ্চয়তা বা কথা দিতে পারছি না।

এটা বলা যায় যে, প্রশ্নপত্র পুরোপুরি পূরণ করা ও তা ফেরত দেওয়ার এই জরিপে অংশগ্রহণের ব্যাপারে আপনার সম্মতি প্রকাশ করবে। এই গবেষণার সাথে সম্পর্কিত সংগৃহীত যে কোন তথ্য এবং যা আপনার পরিচয় সনাক্ত করে তা গোপন রাখা হবে এবং তা শুধুমাত্র আপনার অনুমতি নিয়ে প্রকাশ করা হবে, যদি না আইনগত ভাবে তা প্রয়োজন হয়। আমি এর ফলাফল আমার পি,এইচ,ডি গবেষণা পত্রে প্রকাশ করতে চাই যা ইউনিভার্সিটি অফ নিউ সাউথ ওয়েলসে জমা দেওয়া হবে। আমার যে কোন প্রকাশনায় তথ্য এমনভাবে দেওয়া হবে যাতে আপনাকে আলাদাভাবে চিহ্নিত করা না যায়।

আপনি যদি এই গবেষণার ফলাফল সম্পর্কে জানতে চান তাহলে দয়া করে আপনার যোগাযোগের ঠিকানা এই প্রশ্নপত্রের শেষে প্রদান করুন।
আপনি অংশ নেন বা না নেন অংশগ্রহনের ব্যাপারে আপনার সিদ্ধান্ত ইউনিভার্সিটি অফ নিউ সাউথ ওয়েলসের সাথে ভবিষ্যৎ সম্ কের্র ব্যাপারে কোন ভূমিকা রাখবে না। আপনি যদি অংশগ্রহনের বাপারে সিদ্ধান্ত নেন, তাহলে যে কোন সময় নিরপেক্ষ ভাবে আপনি আপনার সম্মতি তুলে নিতে পারেন এবং উত্তর প্রদান স্থগিত করতে পারেন। আপনার কিছু জানার থাকলে আমাকে বিনা দ্বিধায় জিজ্ঞাসা করুন। আপনার যদি আরও কিছু জানার থাকে এ/পি জন ডি'আমব্রা (ফোনঃ+ ৬১ ২ ৯৩৮৫৪৮৫৪, ই-মেইলঃ j.dambra@unsw.edu.au) আপনার প্রশ্নের উত্তর দেবেন।

আপনাকে এই ফরমের একটা কপি দেয়া হবে রাখার জন্যে। আপনার সহযোগিতা একান্ত ভাবে কাম্য। জরিপে অংশগ্রহন করার জন্য আপনাকে ধন্যবাদ।

শুভেচ্ছান্তে,
মোঃ শাহরিয়ার আক্তার
পি,এইচ,ডি ছাত্র
স্কুল অফ ইনফর্মেশন সিস্টেমস, টেকনোলজি অ্যান্ড ম্যানেজমেন্ট
অস্ট্রেলিয়ান স্কুল অফ বিজনেস
দি ইউনিভার্সিটি অফ নিউ সাউথ ওয়েলস

বাছাই প্রঃ

১. আপনি কি মোবাইলে স্বাস্থ্য সেবার ব্যাপারে জানেন?

হ্যাঁ **না**

২. আপনি কি মোবাইল স্বাস্থ্য সেবা ব্যাবহার করেন?

হ্যাঁ **না**

৩. গত এক বছরে আপনি কি মোবাইল স্বাস্থ্য সেবা ব্যাবহার করেছেন?

হ্যাঁ **না**

উপরের কোন একটি প্রশ্নের উত্তর যদি 'না' হয় তাহলে আপনার পরবর্তী পৃষ্ঠার প্রশ্নের উত্তর দেওয়ার প্রয়োজন নেই। দয়া করে এই প্রশ্নপত্রটি এটা প্রদানকারী ব্যক্তিকে ফেরত দিন। তা না হলে দয়া করে পরের পৃষ্ঠাগুলোতে যান।

নির্দেশনা: *দয়া করে নিচের বিবৃতিগুলোকে ১-৭ পয়েন্ট স্কেলের মধ্যে রেটিং করুন, যেখানে '১' সবচেয়ে কম সম্মতি বোঝায় আর '৭' সবচেয়ে বেশি সম্মতি বোঝায়।*

বিভাগ ক	পুরোপুরি ভিন্নমত			একমতও না, ভিন্নমতও না			পুরোপুরি একমত
SQ1. সেবার এই প্ল্যাটফর্ম সবসময় ঠিকভাবে কাজ করে।	১	২	৩	৪	৫	৬	৭
SQ2. সেবার এই প্ল্যাটফর্ম নির্ভরযোগ্য।	১	২	৩	৪	৫	৬	৭
SQ3. সেবার এই প্ল্যাটফর্ম আস্থার সাথে কাজ করে।	১	২	৩	৪	৫	৬	৭
SQ4. সেবার এই প্ল্যাটফর্ম সবসময় পাওয়া যায়।	১	২	৩	৪	৫	৬	৭
SQ5. আমার যখন দরকার তখন আমি মোবাইল স্বাস্থ্য সেবার এই প্ল্যাটফর্মে ঢুকতে পারি।	১	২	৩	৪	৫	৬	৭
SQ6. সেবার এই প্ল্যাটফর্মে বেশি সময় অপেক্ষা করতে হয় না।	১	২	৩	৪	৫	৬	৭
SQ7. সেবার এই প্ল্যাটফর্ম অনেক রকমের প্রয়োজন মেটাতে পারে।	১	২	৩	৪	৫	৬	৭
SQ8. সেবার এই প্ল্যাটফর্ম নতুন পরিস্থিতির সাথে খাপ খাইয়ে নিতে পারে।	১	২	৩	৪	৫	৬	৭
SQ9. সেবার এই প্ল্যাটফর্ম যখন যা প্রয়োজন সে অনুযায়ী বহুমুখী সেবা দিতে পারে।	১	২	৩	৪	৫	৬	৭
SQ10. এই সেবা প্রদানের পদ্ধতি গোছানো।							
SQ11. সেবার এই প্ল্যাটফর্ম আমার ব্যক্তিগত সমস্যার তথ্য নিরাপদ রাখে।	১	২	৩	৪	৫	৬	৭
PQ12. সেবার এই প্ল্যাটফর্ম আমার ব্যক্তিগত তথ্য অন্যের কাছে দেয় না।	১	২	৩	৪	৫	৬	৭
SQ13. সেবার এই প্ল্যাটফর্ম আমাকে অর্থপূর্ণ নিশ্চয়তা দেয় যে তাঁরা আমার ব্যক্তিগত তথ্য অন্য কাউকে জানাবে না।	১	২	৩	৪	৫	৬	৭
SQ14. চিকিৎসকরা দ্রুত সেবা প্রদান করেছে।	১	২	৩	৪	৫	৬	৭
SQ15. চিকিৎসকরা কখনই আপনার অনুরোধের উত্তরে ব্যস্ততা দেখায়নি।							
SQ16. চিকিৎসকরা আপনাকে সাহায্য করার ব্যাপারে আগ্রহী।	১	২	৩	৪	৫	৬	৭
SQ17. চিকিৎসকরা নির্দিষ্ট সময়ের মধ্যেই সেবা প্রদান করেছে।	১	২	৩	৪	৫	৬	৭
SQ18. চিকিৎসকদের আচরণে আপনার মধ্যে ভরসা পেয়েছেন।							
SQ19. চিকিৎসকদের সাথে কথা বলার সময় আপনি নিরাপদ বোধ করেছেন।	১	২	৩	৪	৫	৬	৭
SQ20. আপনার প্রশ্নের উত্তর দেওয়ার মত জ্ঞান চিকিৎসকদের আছে।	১	২	৩	৪	৫	৬	৭

SQ21. চিকিৎসকরা স্বাস্থ্য তথ্য সেবা দেওয়ার ক্ষেত্রে উপযুক্ত।	১	২	৩	৪	৫	৬	৭
SQ22. চিকিৎসকরা আপনাকে ব্যক্তিগতভাবে গুরুত্ব দিয়েছে।	১	২	৩	৪	৫	৬	৭
SQ23. চিকিৎসকরা আপনাকে আলাদাভাবে গুরুত্ব দিয়েছে।							
SQ24. চিকিৎসকরা আপনার প্রয়োজনটা সঠিকভাবে বুঝতে পেরেছেন।	১	২	৩	৪	৫	৬	৭
SQ25. চিকিৎসকরা আপনার সবচেয়ে ভাল যাতে হয় সেটাই চায়।	১	২	৩	৪	৫	৬	৭
SQ26. আমার কাজটি ঠিকভাবে হয়েছে।	১	২	৩	৪	৫	৬	৭
SQ27. আমি বিশ্বাস করি এই প্ল্যাটফর্ম থেকে পাওয়া সেবা আমার উপযুক্ত।							
SQ28. স্বাস্থ্য সেবা পাওয়ার ক্ষেত্রে অন্যান্য উপায়ের তুলনায় এই পদ্ধতিটি বেশি সুবিধাজনক।							
OQ29. সার্বিক ভাবে এই সেবা আমার জন্যে প্রয়োজনীয়।	১	২	৩	৪	৫	৬	৭
SQ30. আমি এই সেবা ব্যবহার করে নিঃসংশয় বোধ করছি।	১	২	৩	৪	৫	৬	৭
SQ31. আমি এই সেবা ব্যবহার করে আমার সমস্যা সমাধানের ব্যাপারে আশাবাদী।	১	২	৩	৪	৫	৬	৭
SQ32. আমি এই সেবা ব্যবহার করে আমার সমস্যা সমাধানের ব্যাপারে উৎসাহিত বোধ করছি।	১	২	৩	৪	৫	৬	৭
SQ33. আমি এই সেবা ব্যবহার করে আমার সমস্যা সমাধানের ব্যাপারে আমার বিশ্বাস আছে।	১	২	৩	৪	৫	৬	৭

বিভাগ **থ**

(SA1-SA4) প্রাথমিক স্বাস্থ্য তথ্য সেবা নেয়ার ক্ষেত্রে, মোবাইল স্বাস্থ্য সেবা ব্যবহার করে আমি ------।	খুব অসন্তুষ্ট ১	২	৩	৪	৫	৬	খুব সন্তুষ্ট ৭
	খুব হতাশ ১	২	৩	৪	৫	৬	খুব পরিতুষ্ট ৭
	খুব অতৃপ্ত ১	২	৩	৪	৫	৬	খুব তৃপ্ত ৭
	খুব শোচনীয় ১	২	৩	৪	৫	৬	খুব পুলকিত ৭

বিভাগ-গ	পুরোপুরি ভিন্নমত			একমত ও না, ভিন্নমতও না			পুরোপুরি একমত
IC1. (আমি মোবাইল স্বাস্থ্য সেবা ব্যবহার করে মেডিকেল তথ্য সেবা নেওয়ার কাজটি আগামীতে চালু রাখব।	১	২	৩	৪	৫	৬	৭
IC2. আমার ইচ্ছা হল, অন্যান্য বিকল্প ব্যবস্থায় না গিয়ে মোবাইল স্বাস্থ্য সেবা ব্যবহার করে মেডিকেল তথ্য সেবা নেওয়ার কাজটি আগামীতে চালু রাখব (যেমন: স্থানীয় ক্লিনিকে যাওয়া)।	১	২	৩	৪	৫	৬	৭
IC3. আমি এই সেবা ব্যবহার করা থেকে বিরত থাকব না।	১	২	৩	৪	৫	৬	৭
বিভাগ-ঘ	পুরোপুরি ভিন্নমত			একমত ও না, ভিন্নমতও না			পুরোপুরি একমত
QL1. এই প্ল্যাটফর্ম থেকে সেবা পাওয়ার পর আমার সার্বিক স্বাস্থ্যের উন্নতি হয়েছে।	১	২	৩	৪	৫	৬	৭
QL2. জীবনে যেমনটা চাই তার কাছাকাছি মানে পৌঁছাতে পেরেছি যেদিন থেকে আমি এই সেবা ব্যবহার করছি।	১	২	৩	৪	৫	৬	৭
QL3. আমি আমার স্বাস্থ্য জীবন নিয়ে আরও বেশি সন্তুষ্ট, এই সেবাকে ধন্যবাদ।	১	২	৩	৪	৫	৬	৭
QL4. জীবনে যে মানের স্বাস্থ্য আমি চেয়েছি, তার কাছাকাছি পৌঁছাতে এই সেবা আমাকে সাহায্য করেছে।	১	২	৩	৪	৫	৬	৭
বিভাগ-ঙ দয়া করে মোবাইল স্বাস্থ্য সেবার ব্যাপারে আপনার গুরুত্বের মাত্রা প্রদান করুন। এখানে, '১' অর্থ 'তেমন গুরুত্বপূর্ণ না' এবং '৭' অর্থ 'খুব গুরুত্বপূর্ণ।'	তেমন গুরুত্বপূর্ণ না			নিরপেক্ষ			খুব গুরুত্বপূর্ণ
TM1. জরুরি মেডিকেল সেবার সময় সাহায্য পরামর্শ	১	২	৩	৪	৫	৬	৭
TM2. ঔষধ বিষয়ক তথ্য	১	২	৩	৪	৫	৬	৭
TM3. চিকিৎসকদের সাথে মেডিকেল পরামর্শ	১	২	৩	৪	৫	৬	৭
TM4. বিশেষায়িত চিকিৎসকদের তথ্য	১	২	৩	৪	৫	৬	৭
TM5. চিকিৎসা সুবিধা বিষয়ক তথ্য	১	২	৩	৪	৫	৬	৭

বিভাগ-চ	
SF1. মিডিয়া কি আপনাকে মোবাইল স্বাস্থ্য সেবা ব্যাবহারের জন্য প্রভাবিত করেছে?	১.হ্যাঁ ২.না
SF2. আশেপাশের কেউ কি আপনাকে মোবাইল স্বাস্থ্য সেবা ব্যাবহারের জন্য প্রভাবিত করেছে?	১.হ্যাঁ ২.না
SF3. এই সেবার খরচের ব্যাপারে আপনার অভিমত কি?	১.বেশি ২.মাঝারি ৩.কম
SF4. গত এক বছরে কতবার আপনি এই সেবা ব্যবহার করেছেন?	১.এক ২.দুই ৩.তিন ৪.তিনবারের বেশি

উত্তরদাতার প্রোফাইল

লিঙ্গ: ১. ছেলে ২. মেয়ে

আয় (টাকায়)

1. ৫০০০-এর চেয়ে কম
2. ৫০০১-১০০০০
3. ১০০০১-১৫০০০
4. ১৫০০১-২০০০০
5. ২০০০১-২৫০০০
6. ২৫০০১ -৩০০০০

বয়স

1. ১৮-২৫
2. ২৬-৩৩
3. ৩৪-৪১
4. ৪২-৪৯
5. ৫০+

পেশা

1. ছাত্র
2. গৃহিণী
3. ব্যবসায়
4. সরকারি চাকরি
5. বেসরকারি সংস্থা
6. অন্যান্য

স্থান

1. শহর
2. মফস্বল
3. গ্রাম

সেবার সময়

1. সকাল ৯:০১ –বিকাল ৫:০০
2. সকাল ৫:০১ –রাত ১০:০০
3. রাত ১০:০১ –ভোর ৫:০০
4. ভোর ৫:০১ - সকাল ০৯:০০