2012

Mhealth: a better alternative for healthcare in developing countries

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Publication Details

Motamarri, S., Akter, S., Ray, P. & Tseng, C. (2012). Mhealth: a better alternative for healthcare in developing countries. Pacific Asia Conference on Information Systems (PACIS) Vietnam: AISeL.

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Abstract
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Keywords
alternative, better, healthcare, mhealth, developing, countries

Disciplines
Business

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MHEALTH: A BETTER ALTERNATIVE FOR HEALTHCARE IN DEVELOPING COUNTRIES

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Abstract

Propelled by the continual improvements in mobile wireless communications, mobile health (mHealth) is emerging as a significant player in addition to conventional services. Health care Researchers have focused on quality which is an antecedent to service design. There is a significant gap in the literature with respect to both inter and intra health care service delivery systems. A quantitative comparison of health care services provides insights into whether service alternatives are distinguishable from each other and if so, what factors contribute to the differentiation from the patients' perspective. With this motivation, a multiple discriminant analysis is performed on various health care services including a B2C mHealth service in a developing country to unearth the patients' perceptions. The outcome of this maiden attempt can assist multiple stakeholders of health care industry. The comparative insights and House of Quality (HoQ) model can also help in services design. Ubiquity, interaction quality and value have been identified to have significant influence on the patients' attitude towards health care services. mHealth has been favourably rated than other services. Service providers and governments of developing countries can utilise these insights to enhance their services and work towards efficient delivery alternatives in achieving quality health care for all.

Keywords: mHealth, discriminant analysis, service design, patients' perception, House of Quality (HoQ).

1 Introduction

Mobile phone technology has spread across the globe at a much more rapid pace than most other technological innovations. The global mobile cellular subscriptions has topped 6 billion as per the recent International Tele-communications Union (ITU) assessment. The ITU statistics furthermore shows an interesting insight that more than three quarters of these subscriptions are in the developing world (ITU 2011). For example, in Bangladesh between 2001 to 2006 the mobile connections have rapidly grown from 660,000 to 13 Million (M Abu et al. 2007). On the contrary, the World Health Organisation's (WHO) health indicators show a large divide in health care between developed and developing nations (Ivatury et al. 2009). People in certain parts of the developing world need to travel several kilometres even to avail basic health care needs. The health care services in the developing world are dysfunctional, inaccessible, lack quality and costly for the poor (Worldbank 2004). In the similar lines of *digital divide*, the authors term this wide gap in health care service provision between developed and developing nations as *'health care divide.*' The contrasts of technology penetration on one side and the failure of basic human needs on the other side are intriguing.

The potential of mobile phones to deliver various health care services attracted researchers and facilitated the emergence of *mobile health or mHealth* (Bashshur et al. 2011). *mHealth* stacks on the ubiquitous wireless telecommunications infrastructure to deliver health care services in a mode similar to the electronic commerce model of *business to consumer or B2C*. While this has equally been feasible through the personal computer and internet, internet has not substantially impacted due to the low penetration rate of these technologies in the developing countries (ITU 2011). *mHealth* a sub-segment of *electronic health (eHealth)* is emerging as a significant contender for the delivery of health services (Ganapathy et al. 2009; Mishra et al. 2009). While there are many overlaps between these fields, the United Nations Foundation (UNF) provided a simple definition for eHealth and mHealth (Vital Wave Consulting 2009) which the current research relies on. *eHealth is defined as using Information and Communication Technologies (ICT) such as computers, mobile phones and satellite communications – for health services and information. mHealth is defined as using mobile communications such as mobile phones and PDAs for health services and information.*

mHealth by virtue of its ubiquity and reach can serve even the remotest corners of a country (Akter et al. 2010). The ability of mHealth to 'serve the un-served' makes it a viable, scalable and dependable health care delivery platform (Ivatury et al. 2009; Mechael 2009; Vital Wave Consulting 2009; Bashshur et al. 2011). All these factors and the health care divide, has motivated the authors to investigate on the potential opportunity of the mobile phone in assisting the developing world in improvising the health care services delivery. It is possible to draw a comparative analysis of existing health care services from analytical point of view. However, as the patients are the ultimate consumers of these services, the research delved into finding patients' perspective on health care services. Specifically, the research addresses the following questions from the patients' point of view:

1. Are the different health care services distinguishable from each other?
2. Is mHealth distinct from other existing services?
3. What factors contribute to the service differentiation?

2 Literature Review

mHealth is transforming health care in developing countries. Though it is at its infancy, it is becoming a distinct player in developing countries due to its affordability, right time and right place availability. Lim et al. (1988) studied patients' attitudes towards four health care systems: hospitals, home health

care, nursing homes and outpatient clinics. The authors also observed that patients are increasingly influencing in the selection and decision making process of choosing service providers in the market place. They have applied *discriminant analysis (DA)* in empirically finding the attributes that form the patients' attitude towards the four health care systems. Andaleeb (2000) applied DA to model user hospital choice between public and private hospitals in Bangladesh. Siddiqui and Khandaker (2007) applied DA to distinguish public and private hospital services within Bangladesh and then between private hospitals and foreign hospitals. Both of the studies have identified sectorial weaknesses and policy changes that need to be in place to improve the health care provision. There has been some significant research in the areas of service quality measurement both from the operator and user perspective (Akter et al. 2010; Akter et al. 2010; Akter et al. 2011). Lim and Zallocco focused on inter-system comparison while Andaleeb et al. focused on intra-system comparison from the patients' perspective. However, there is scant research to distinguish mHealth from other existing health care services. This maiden research attempts to fill this research gap and addresses the aforesaid research questions.

A comparative assessment of user perceptions of various health care services provides insights and strategic input to the governmental bodies, private entrepreneurs and health care service providers. It is imperative that both the health policy makers and health service providers recognise user perceptions of health services for which either they provide governance or provision. User perceptions can alter patronage of services in a market place when captive restrictions are absent. For example, several authors have presented the dismal array of health services in Bangladesh (Andaleeb 2000; Andaleeb 2001; Andaleeb et al. 2007; Siddiqui et al. 2007). They have also noted that when opportunities present in neighbouring countries the patients started visiting the neighbouring countries, negatively impacting the foreign exchange to the economy (Andaleeb et al. 2007; Siddiqui et al. 2007).

The extant literature has identified four prominent forms of health services in developing countries, namely*: public hospitals (PH)*; *general practitioner (GP)*; *traditional medicine practitioner (TM)* and *mHealth*. The research relies on the following definition for each of these services. A GP is a medical practitioner who treats acute and chronic illnesses and provides preventive care and health education for all ages and both sexes. The GP has similar meaning across the Commonwealth countries (Leck et al. 1987). GPs provide services usually in the residential suburbs and usually establish bonding with the community they serve. The GPs may collect their fees either per consultation or may bill the patients periodically. Public hospitals (PH) are generally funded by government to serve the public, and they may collect nominal fees from the patients. PHs and GPs follows the established scientific form of medicine.

In contrast to these forms of scientific medicine, in some Asian and African countries people do depend on *traditional medicine or complementary and alternative medicine*. The World Health Organisation (WHO) defines TM as: "The health practices, approaches, knowledge and beliefs incorporating plant, animal and mineral-based medicine, spiritual therapies, manual techniques and exercises, applied singularly on in combination to treat, diagnose and prevent illnesses or maintain well-being" (WHO 2008). The PHs and GPs are in acute shortage in developing countries. Some of the rural areas are completely short of any access to PHs and GPs (Worldbank 2004). In such situations people are left with only option of TM (WHO 2008). This situation is changing with the affordable, accessible and reliable option of medical care delivered through the mobile phones.

PH, GP and TM services require a face-to-face consultation between the patient and the care provider. In contrast to these services, a care provider can as well deliver the service over a mobile phone, following the definition of mHealth by the WHO. The geographic separation of the patient and the care provider may limit the range of services a provider can offer over wireless communication. Excluding those possibilities, this paper relies on the notion that mHealth is similar to the other service alternatives: PH, GP, and TM, except that the consultation is provided over mobile phone, whereby mHealth derives its ubiquity due to the underlying delivery channel of mobile/ wireless communications.

3 Theoretical Model

House of Quality (HoQ) is a basic design tool and part of the management approach *Quality Function Deployment (QFD)*. Hauser and Clausing's (1988) classic paper on HoQ, has brought its significance to the worldwide community. With its wide spread success in bringing together various functional divisions of manufacturing, HoQ has been applied in various forms and to various degrees of sophistication in manufacturing, engineering and subsequently in the design of services (Ray 2003). HoQ inter-links customer requirements, their rankings, engineering characteristics, performance measures, competitive products/ services and thereby elicits in a single diagram the areas of improvements required to win in the market. In contrast, *Information Technology Infrastructure Library (ITIL) V3* provides a comprehensive framework for *IT Services Management (ITSM)* following the principles of Deming's PDCA Cycle which is also the underlying foundation for QFD. ITIL encompasses the complete services life cycle: *service strategy, service design, service operation, service transition and continual service improvement* (OGC 2007). HoQ essentially deals with enhancing the design stage of products and services. Figure-1 presents a typical portrayal of HoQ Matrix consisting of eight rooms, each room exemplifying a stage of service design (Ray 2003). One of the objectives of this research is to identify the characteristics of alternative health care services including mHealth and provide feedback to the service providers and planning agencies so that the quality of health services improve over time and deliver value to the society. The scope of the current paper is limited to a subset of this theme, i.e., evaluating competing services. As such, this paper focuses on the *evaluation of competing services, Stage-5* of the HoQ Matrix. The current research can also help in identifying the specific attributes that can successively be cascaded up and down through the other rooms to achieve well performing health care services.

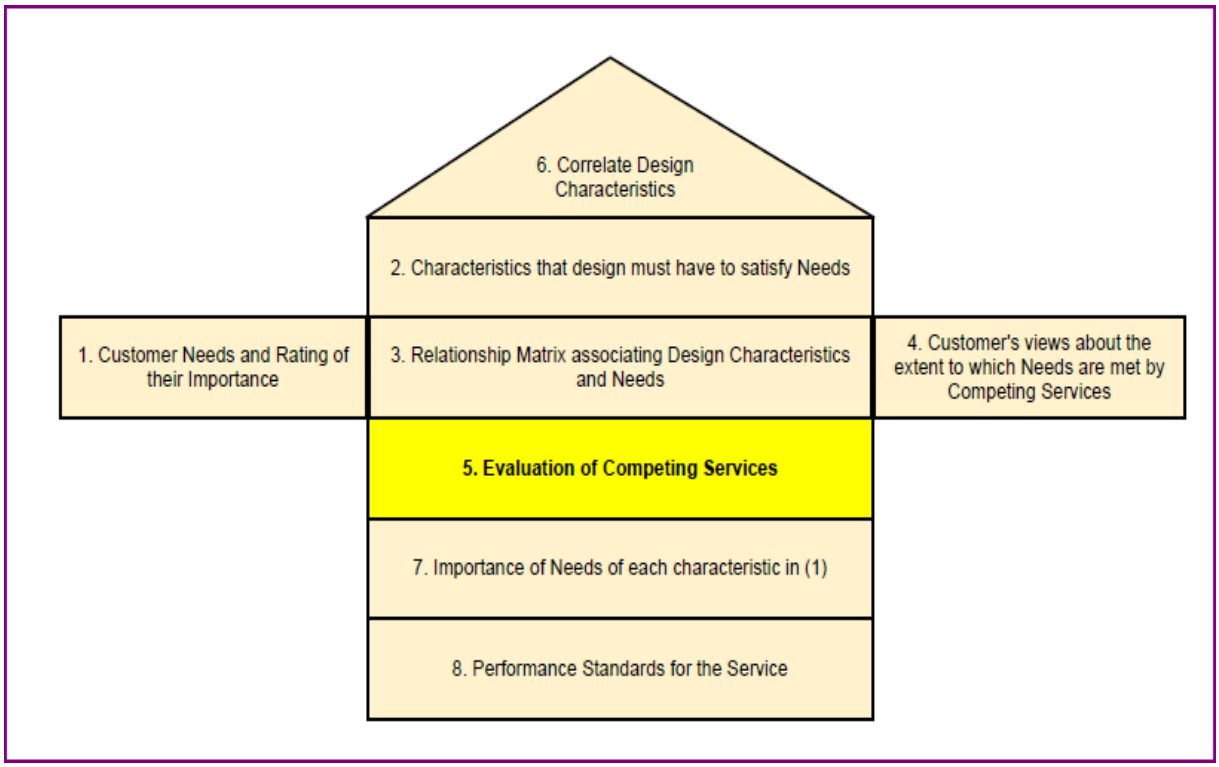

Figure 1: House of Quality (HoQ) Matrix

4 Research Methodology

4.1 Research Context

In order to establish the research objective of whether patients do differentiate mHealth from other services, it is essential to search for a market where mHealth is commercially offered and it competitively operates. Ivatury et al. (2009) have provided a comprehensive overview of mHealth services in developing countries. They have identified the *789 Service of Grameenphone* in Bangladesh as one of the significant success stories of a commercial mHealth service. This service has gained popularity in a short span. Within three years from its inception, the service on the average has handled 10,000 calls per day from patients (Ivatury et al. 2009). So Bangladesh provides a proper a research setting to gain insights to draw a comparison of various health care services including mHealth. The next sections will briefly look into a range of health care services prevailing in Bangladesh, then discusses on the data collection, analysis, research findings, discussion, and finally concludes with implications of these insights for researchers, policy makers and service providers.

4.2 Survey method

Sample survey serves as a quick and efficient method to understand the respondent's experience with a service and thereby facilitates drawing conclusions about the population (Zikmund et al. 2010). As the objective of this study was to measure patient perceptions about service characteristics and why a particular service is chosen over a competing other alternative, a *field study* was conducted in March 2010. The survey was designed to collect data from a target population only once, thus conforming to *cross sectional design* (Malhotra 2004). In order to maximise survey response rate, minimise missing data, avoid delays and improve accuracy especially, in a developing country context, the study adopted a combination of *location intercept* and *in-home survey* techniques (Andaleeb 2001; Malhotra 2004). The study focused on the most prevalent services of PH, GP and TM apart from mHealth.

4.3 Sampling

The field survey took place in Bangladesh during March, 2010 under a global mHealth assessment project. At present, more than 24 million people in Bangladesh have access to B2C mHealth services provided by the leading mobile operator *Grameen phone* (Akter et al. 2010). Under this platform, a customer (or, a patient) can access health service at any time by dialling '789' from his/her own mobile phones and receive services in the form of medical information, consultation, diagnosis, referral, treatment and counselling from registered physicians (Ivatury et al. 2009; Akter et al. 2011). In the absence of lists for drawing a random sample, 280 interviews were planned from Dhaka City using area wise cluster sampling. Areas were selected in a manner such that different socio-economic groups were represented. After a quick screening question on whether the respondent had used mHealth services in the past 12 months, then the interviewers proceeded with the survey questions. Both self-completion and interviewer filled survey techniques were used in order to receive higher valid response. A total of 212 surveys were ultimately completed, of which 200 surveys were usable.

4.4 Measurement Instrument

The questionnaire was originally developed in English, and then was translated into the local language (Bangla). The local version went through several revisions until both the English and Bangla versions were judged to be similar by a group of experts (Andaleeb 2001). Except the demographic information of the questionnaire, all the items were measured in a structured format on a seven-point Likert-type scale, ranging similar to "*strongly disagree*" to "*strongly agree*." A pre-test of over 10 samples was

conducted in order to ascertain the content, wording, sequence, layout, format, simplicity and clarity of the survey instrument (Akter et al. 2010). The pre-test was helpful in fine tuning the instrument and facilitated a smooth data collection.

A summary of the survey instrument is presented in the Appendix Table A2. Health service is a categorical variable consisting of four services: PH, GP, TM and mHealth. Patients are requested to rate the respective health care service they have used recently based on 20 factors. The questionnaire summary lists all the variables grouped as: system, provider, interaction and outcome variables.

5 Analysis

Multiple regression analysis is the most widely used multivariate technique to establish a relation between a set of IVs and DVs which are metric. MANOVA on the other hand helps in establishing a relationship between categorical IVs and metric DVs. However, *Discriminant analysis (DA)* is classification technique which helps in identifying the factors (or independent variables, IV) that help to classify the cases into individual categories of a categorical dependent variable (DV) (Malhotra 2004). For the current investigation the DV, *health care service*, is categorical and IVs are metric, thus DA is an appropriate technique to explore whether significant relationship exists between the IVs and categorical DV (Malhotra 2004; Hair et al. 2010). When there more than two categories exist for the DV, the technique is referred to as *multiple discriminant analysis (MDA)* (Hair et al. 2010). DA also has predictive abilities whereby the model constructed to explain the phenomenon can also be used to classify new cases or predict to which group they belong to. Thus DA suits the current research objectives of finding factors that differentiate services from each other and develop a predictive model so as to serve as a policy guideline for mHealth Service Design. Epistemologically and ontologically 'quantitative positivist' paradigm naturally applies to this kind of investigations (Straub et al. 2004; Gregor 2006; Bhattacherjee 2012).

DA involves the computation of a variate, usually referred to as *discriminant function (DF)*. A typical DF looks like as:

$$Z_{jk} = a + W_1 X_{1k} + W_2 X_{2k} + \ldots + W_k X_{nk}$$

Where

Z_{jk} = discriminant Z score of DF j for object k
a = intercept
W_i = discriminant weight for IV i
X_{ik} = IV i for object k.

DA is widely used in Marketing, and it is relatively new to Information Services, especially to the scale of four groups. This is a maiden attempt to formulate a DF to characterise health care services, especially mHealth. A systematic approach consisting of 6-Stage DA decision process (summarised in Table A3) as suggested by Hair et al. (2010) is followed in analysing the collected survey data. For more details on the computational steps, readers can refer to the books of Hair et al. (2010) or Malhotra (2004).

6 Results

SPSS package has been used to process the data. Important output from SPSS processing is quoted and presented in the ensuing sections. Table-1 presents a summary of the descriptive statistics and demographic profile of the respondents. There are 200 cases. There is no missing information and all the cases contain valid data. The data consists of four groups. And these four DV groups are of equal size each consisting of 50 cases or 25% of the total sample. 49% of the respondents are male and the

remaining 51% are female; 40% were between 18-25 years; and 50% of them were poor. Among the mobile health users, 60% were from poor families and 64% of them are highly educated. Overall a third of the respondents were students and close to 50% of respondents for mHealth were students.

Item	Categories	%		Item	Categories	%
Total Sample Size: 200				*Total Sample Size: 200*		
Health service	Public hospital	25.0		Age	18-25	42.0
	General practitioner	25.0			26-50+	58.0
	Traditional practitioner	25.0		Education	>= Secondary Education	80.0
	Mobile health	25.0				
Income	Below 5000	48.0		Gender	Male	49.0
	Above 5000	52.0			Female	51.0

Table 1: Demographic profile of respondents

6.1 Split Sample Validation

DA can be applied on the whole sample i.e. 200 cases or partition the sample into two sets, called analysis sample and holdout sample. The validity of DA model is established through the significance of the discriminant functions and the classification performance of the DA model in re-classifying the cases. The latter part is achieved in two distinct phases: in the first mode each and every case is classified based on the DF scores and a classification matrix is built computing the total number of cases correctly classified. In the second mode, for each case holding it aside, DF scores are computed for the rest of the cases, and then it is applied to classify the held case. This is termed as *cross-validation*. In the instance where the sample is reasonably large, the researchers can divide the samples, and the DA functions are derived for the analysis sample, and it is validated as if this is the whole sample. Then as the same model is tested for the holdout sample and classification matrix is computed. Thus DA is a robust technique which not only classifies the original sample, but also acts as a predictive model. The predictive portion of DA model makes it distinctive from other multi-variate techniques, and also provides an insight on its possible generalisation for other samples (Hair et al. 2010). The total sample of 200 cases was randomly divided into 2 sets as: 1) analysis sample; and 2) holdout sample. While there is no hard-and-fast rule for the division of the sample, the authors adopted a 60-40 ratio, i.e., 60% of cases (120) for analysis sample and 40% of the cases (80) for holdout sample (Hair et al. 2010).

6.2 Validating Underlying Assumptions

6.2.1 Sample size validation

The minimum sample size criterion stipulates that the smallest group size shall be more than the number of IVs (Hair et al. 2010). The maximum sample size recommends a 1:20 ratio between IV and total sample size. The analysis sample has a total of 120 cases, with each group consisting of 30 cases. The holdout sample has a total of 80 cases, with each group consisting of 20 cases. Thus both the sample subgroups meet the minimum sample size requirement. With 20 factors and 120 cases the ratio between IV: N is 1:6, though this does not meet the 1:20 ratio for maximum sample size criteria, the sample is adequate considering the absolute size of the sample, else the sample size becomes too large (400) for a 20 factor situation (Hair et al. 2010). Thus the sample meets the minimum sample size requirement and hence the dataset is suitable for DA.

6.2.2 Variables selection

The DV, health service, is a categorical variable with four distinct categories, namely: public health, general practitioner, traditional medicine and mHealth. All IV are ratings on a 7-point Likert scale. Thus both DV and IVs meet measurement requirements for DA (Malhotra 2004; Hair et al. 2010).

6.3 Discriminant functions and their validity

One of the objectives of this research is to identify whether patients do distinguish different health care services, and if so, what factors/ dimensions contribute to this differentiation. Accordingly, a Stepwise Method for selecting variables is chosen for the computation of DFs (Malhotra 2004; Hair et al. 2010). Tables 2 and 3 present a summary of the canonical discriminant functions and Wilks' Lambda values. The Eigenvalues of Table 2 show how much of the variance in the DV, Health Service, is accounted for by each of the functions. The Wilks' Lambda as shown in Table 3, implies that each function is significant. The Chi-square statistic corresponding to Wilks' Lambda is statistically significant. It implies that there is a relationship between the DV groups and IVs.

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	1.192	66.8	66.8	.737
2	.392	22.0	88.8	.531
3	.200	11.2	100.0	.408

Table 2: Summary of Canonical Discriminant Functions – Eigenvalues

Test of Function(s)	Wilks' Lambda	Chi-square	Degrees of freedom	Significance
1 through 3	.273	147.970	18	.000
2 through 3	.599	58.485	10	.000
3	.834	20.746	4	.000

Table 3: Summary of Canonical Discriminant Functions – Wilks' Lambda

The classification accuracy of the DFs is presented in Table A1 in appendix. As the four groups of DV are of equal size, the by chance classification accuracy is 25%. In order to ascertain the validity of the model, the proportional chance criterion recommends 25% more accuracy than that by chance (Hair et al. 2010). This works out to be 31.25% (1.25 * .25 = .3125 = 31.25%) accuracy baseline. The Classification Matrix A1 shows that DFs have successfully classified 73.3% of cases accurately and achieved a cross-validation accuracy of 65.0%. These accuracies are far higher than the 31.25% accuracy baseline required by the chance criteria. Furthermore, the DF model has achieved 76.3% accuracy in classifying the holdout sample. Both these checks on classification accuracy establish not only the model's ability to achieve accuracy in classifying but also in the predictive power of the model in distinguishing new cases.

6.4 Interpretation of Discriminant Functions

The number of DFs to be interpreted is the minimum of either the number of IVs or one less than the DV categories (Hair et al. 2010). As the number of IVs is 20 and 1 less than DV categories is three (4 - 1), three DFs are extracted by DA run as shown in Tables 2 and 3. Table 4 summarises standardized Canonical DF Coefficients and Structure Matrix tables computed by the DA run. Both these statistics present relationships between the final set of factors entered into the DF model and their relationships. Out of the 20 IVs, the MDA extracted six factors *(availability, confidence, up-to-date, empathy,*

courtesy and cost) comprising three the three significant functions as shown in Tables 2 and 3. As all the three DFs are significant ($p < 0.001$) the associated six factors distinguish the IV groups, i.e., health care service. Thus MDA answers the first research question: from the patients' perspective health care services are distinguishable from each other on the three dimensions formed by the DFs. Coming to the third research question, the structure matrix provides the insight that the six factors contribute to service differentiation.

	Discriminant Function Coefficients			Structure Matrix		
Function	**1 Ubiquity**	**2 Interaction Quality**	**3 Value**	**1 Ubiquity**	**2 Interaction Quality**	**3 Value**
Factor						
Availability	.758	.153	.065	.755*	.029	.058
Confidence	.166	.721	.312	.501*	-.493	-.228
Up-to-Date	.294	-.519	.271	.510	-.530*	-.194
Empathy	-.029	.207	-1.064	.462	-.054	-.752*
Courtesy	.242	.647	-.107	.375	.210	-.556*
Cost	.336	.495	.537	.349	.485	.486*

Table 4: Standardised Canonical Function Coefficients and Structure Matrix

* Largest absolute correlation between each variable and any discriminant function

The Canonical correlation coefficients measure the association between the DFs and the significant factors. The Structure Matrix provides the important information about the factors and their loading on each DF. This valuable insight of which factor has a dominant role helps in giving meaningful names for the DFs. Next section discusses on the interpretation of the DFs and their relevance for service differentiation as well as service design.

For DA, multicollinearity is indicated by SPSS by very small tolerance values for variables e.g., less than .10. Based on the '*Variables Not In Analysis'* output of SPSS, the smallest tolerance for any variable not included is .322, supporting a conclusion that multicollinearity is not a problem for this solution. Cross tabulation of the group statistics for the six significant factors and health service is presented in Table 5. Group statistics provides the average mean ratings for these dimensions as perceived by the patients. Cost has been coded from highest to lowest, meaning the higher the score the less costly the service is from patients' perspective. All the means for mHealth are higher than that of other existing services, confirming the effective role of these factors to distinguish the various health care services. Thus Table 5 answers the second research question that patients do distinguish mHealth as distinct from other health care services. Patients rated mHealth as a ubiquitous, less costly and quality service than other conventional health care services.

7 Discussion

Availability and confidence are the significant factors for DF-1 with availability being the dominant factor. mHealth, in comparison to other health care services operates on a 24x7 basis and accessible from even the remotest corners of a country. Accordingly the DF-1 can be viewed as *Ubiquity dimension*. Due to its availability and confidence of the service mHealth is positively distinguished by the patients from other services. Thus DF-1 as shown in Table 4 is referred to as *ubiquity*.

Up-to-date is the significant factor for DF-2. It signifies the quality of the interaction and information shared during the consultation process and its relevance to the patient's needs. Accordingly the DF-2 can be viewed as *Interaction Quality* dimension. On this dimension patients positively viewed mHealth as a better alternative due to the organised and systematic diagnostic process of interaction

with the service providers in comparison to the disorderly settings of other health care alternatives. Thus DF-2 as shown in Table 4 is referred to as *interaction quality*.

Empathy, courtesy and cost are the significant factors for DF-3. Empathy and courtesy signifies the provider's willingness to pay attention to and listen to the patient's concerns and provide them a valuable advice to alleviate their concerns. . As noted earlier, cost is reversely coded, implying higher the mean, the cheaper the cost. As ultimately patients as consumers of health care services, look in the market place to maximise their return for the price they pay in getting the service, these factors can be viewed as *value dimension*. Thus DF-3 as shown in Table 4 referred to as *value*.

Health Service / Factor	Public Hospital	General Practitioner	Traditional Medicine	Mobile Health	Total (120)
Availability	2.77	3.17	3.80	6.03	3.94
Confidence	3.43	4.90	3.90	6.07	4.58
Up-to-Date	3.60	5.03	3.97	6.20	4.70
Empathy	3.60	5.27	5.43	6.20	5.13
Courtesy	4.33	5.20	6.00	6.23	5.44
Cost	5.10	3.60	5.53	6.34	5.15

Table 5: Group statistics: mean values of factors vs health service

The perceptions of patients in the sub-groups formed by age, gender, income or education are found to be relatively uniform. This ascertains the fact that the conventional health care services are generally viewed as less valuable in comparison to mHealth. The group means and the three discriminant dimensions also positively support the question that the health care services are distinguishable from each other from patients' perspective. Furthermore mHealth is significantly distinguishable from the rest of the services on the identified dimensions of ubiquity, interaction quality and value.

7.1 HoQ and Health Care Service Design

HoQ Matrix is constructed with the information derived from the analysis and presented in Figure 2. The DF dimensions of ubiquity, interaction quality and value serve as the *attribute bundles*. Based on the group statistics the means are ordered in descending order, and the attribute that has the highest mean has been assigned a value '1' for importance, and the process is repeated for all the attributes. The group means for the attributes for each health service have been equated as the patients' perception. Figure 3 portrays graphically a cross-tabulation of patients' perception of health service versus significant attributes. It provides the relative positioning of various health care alternatives on the significant attribute axis. Of all the services, mHealth has been most positively viewed and the service distinctly separates from the attributes identified by DA.

Public hospitals have been most negatively viewed except on the cost attribute. Interestingly TM practitioners are close in the dimensions of empathy, courtesy and cost to mHealth. GPs have been favourably rated on confidence and up-to-date dimensions can be interpreted as they do provide a better interaction quality next to mHealth. These insights are very valuable for all the service providers in affecting changes to their services design and services operation.

The World Bank in their assessment of health care services in developing countries has commented that the conventional health care services are dysfunctional, inaccessible, of low quality and costly for the poor (Andaleeb 2001; Worldbank 2004; Andaleeb 2008). Our research conclusion of dismal performance of conventional services from the perspective of the patients purports to these assessments of the World Bank and other researchers.

While the generic notion is that mobile health is costlier, the patients' perception is that it is far cheaper and valuable than other alternatives. With burgeoning penetration of mobile phones, and the offering of cost-effective medical services through mobile phones has naturally been viewed positively by patients as the conventional services lack capacity and attitude to improvise the services environment (Andaleeb 2001; Ivatury et al. 2009; Mechael 2009).

Design Characteristics

Attribute Bundles	Customer Attributes	Importance	Service Measures	Customer Perceptions PH	GP	TM	mHealth
Ubiquity	Availability	6	Out of scope of current research.	2.77	3.17	3.80	6.03
	Confidence	5		3.43	4.90	3.90	6.07
Information Quality	Up-to-Date	4		3.60	5.03	3.97	6.20
Value	Empathy	3		3.60	5.27	5.43	6.20
	Courtesy	2		4.33	5.20	6.00	6.23
	Cost	1		5.10	3.60	5.53	6.34

Figure 2: House of Quality Model for mHealth Service Design

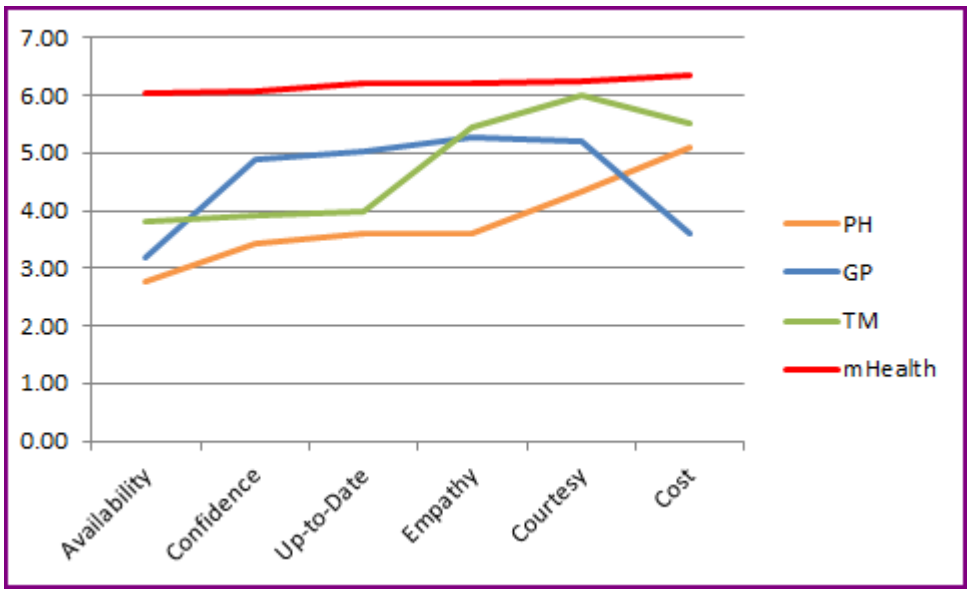

Figure 3: Customer Perceptions of Various Health Care Services

8 Future Directions

This study has some limitations. The outcomes depict the patients' perception at a point in time as the data is collected through a cross-sectional survey. Furthermore the data collection might not have covered all geographies within Bangladesh. It is possible that the patients' perceptions may change over time, due to the continual changes that happen in the market place. It is worthwhile to examine

the temporal validity of the model through on-going surveys. The model reflects that of a developing world, particularly with reference to Bangladesh. It is further worthwhile to examine the model for other countries.

ITIL is developed by the United Kingdom's Office of Government Commerce (OGC) as a response to systematically execute services management in a five phase model. ITIL is the de-facto industry standard for IT Services Management (OGC 2007). The outcome of the DA model for health care services can also be interpreted as patients' perception about how services are being operated. This implies that the study has significantly portrayed the service operation. The service providers have valuable lessons to derive from these insights and shall attend to the factors where they are poorly performing. Health care service providers, researchers and policy makers can embed the three dimensions and the associated six factors in their health sector performance measures. These lessons can be ingrained in *services design* in order to improve *services operation*. Further research is underway to incorporate the current DA Model of health care services into ITIL and HoQ frameworks to aid in the *health care services design*.

9 Conclusions

The research has addressed the question on whether patients distinguish competing health care service alternatives. The DA Model also helped in identifying the specific dimensions and factors along which the service differentiation occurs. mHealth has been viewed by patients much more positively over the conventional services. Patients are looking for ubiquity, interaction quality and value when they consult a health care service provider. This is an important outcome, as service providers can utilise these patients' expectations in their *continual service improvement* phase of services management. In the absence of captive restrictions consumers typically opt for services that fulfil their needs at minimal cost and convenience. Unless conventional service providers start reforming their services delivery and improve the service operation, patients will tend to choose the most optimal service that maximises their utility (Keaveney 1995).

The exploding global population alongside with the continuing health care divide will pose far more challenges in ensuing years, unless a careful study is undertaken on multi-level (country, region, and world). Given its ubiquity, interaction quality and value offerings and the patients positive attitude towards its service offering, mHealth can help bridge the health care divide and assist the developing countries in achieving better health care to the under-served and unserved population groups. Even the resource rich countries are continually challenged on the escalating costs of the health care in serving their population (PC 2011). The authors view that mHealth can as well play a vital role in these countries as well in the years to come.

ACKNOWLEDGEMENTS

The work reported in this research was partly supported by the Australian Institute for Population and Ageing Research (AIPAR) and the global initiative on the assessment of mHealth led by the Asia Pacific ubiquitous Healthcare research Centre (APuHC) at the University of New South Wales, Australia.

The authors also would like to thank all the anonymous reviewers for their valuable comments, which have helped in sharpening the paper.

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Appendix

	Health Service	Total Cases		PH		GP		TM		mHealth	
		Predicted Group Membership									
		Cases	%	Cases	%	Cases	%	Cases	%	Cases	%
Original	**PH**	30	25.0	18	60.0	5	16.7	5	16.7	2	6.7
	GP	30	25.0	4	13.3	21	70.0	3	10.0	2	6.7
	TM	30	25.0	4	13.3	3	10.0	20	66.7	3	10.0
	mHealth	30	25.0	0	0.0	0	0.0	1	3.3	29	96.7
		120									
Cross validated	**PH**	30	25.0	15	50.0	7	23.3	6	20.0	2	6.7
	GP	30	25.0	6	20.0	16	53.3	4	13.3	4	13.3
	TM	30	25.0	5	16.7	3	10.0	18	60.0	4	13.3
	mHealth	30	25.0	0		0		1		29	
		120									
Holdout Sample	**PH**	20	25.0	17	85.0	1	5.0	0	0.0	2	10.0
	GP	20	25.0	3	15.0	15	75.0	0	0.0	2	10.0
	TM	20	25.0	9	45.0	0	0.0	11	55.0	0	0.0
	mHealth	20	25.0	0	0.0	1	5.0	1	5.0	18	90.0
		80									

Table A1: Classification Result: (Analysis sample: 120; Holdout sample: 80)

a. Cross validation is done only for those cases in the analysis. In cross validation, each is classified by the functions derived from all cases other than that case.
b. 73.3% of selected original grouped cases correctly classified.
c. 76.3% of unselected original grouped cases correctly classified.
d. 65.0% of selected cross-validated grouped cases correctly classified.

Section	Variable	Description	Remarks
Health Service (Categorical)	Dependent	Which health system did you use in the past one year?	1. Public Hospital (PH) 2. General Practitioner (GP) 3. Traditional medicine (TM) 4. Mobile Health or mHealth (789 of Grameenphone)
System	Independent	1. Reliability; 2. Accessibility; 3. Availability; 4. Safety; 5. Efficiency; 6. Privacy; 7. Usefulness;	Likert Scale 1-to-7
Provider	Independent	1. Helpful; 2. Promptness; 3. Courtesy; 4. Empathy	Likert Scale 1-to-7
Information	Independent	1. Completeness; 2. Accuracy; 3. Up-to-Date; 4. Orderliness	Likert Scale 1-to-7
Outcome	Independent	1. Ease; 2. Convenience; 3. Cost; 4. Confidence; 5. Enjoyable	Likert Scale 1-to-7
Demography		Gender; Age; Income; Education; Occupation; Location	Male/ Female Group selection

Table A2: Research Questionnaire - Summary

Stage	Description	Process Steps
1	Research Problem	Evaluate group differences on multivariate profile Classify observations into groups Identify dimensions of discrimination between groups
2	Research Design Issues	Selection of independent variables Sample size considerations Creation of analysis and holdout samples
3	Assumptions	Normality of independent variables Linearity of relationships Lack of multicollinearity among independent variables
4	Estimation of Discriminant Functions	Simultaneous or stepwise estimation Significance of discriminant function(s) Determine optimal cutting score Specify criterion for assessing hit ratio Statistical significance of predictive accuracy
5	Interpretation of Discriminant Functions	Discriminant weights Discriminant loadings Graphical display of group centroids
6	Validation of Discriminant Results	Split-sample or cross-validation Profiling of group differences

Table A3: Discriminant Analysis Decision Diagram (Source: Hair et al. (2010))