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Analysis of user requirement on U-Healthcare system

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Abstract

The objective of this study was to explore and connect the relation between independent variables of Health Promotion Model (HPM) and customers' demand for developing ubiquitous healthcare (u-Healthcare) system and then, to suggest the methods applicable to the system design. After identifying performance levels and influence coefficients of every variables and applying them to Quality Function Deployment (QFD) to find out the relation between the requirements and customers' demand of u-Healthcare System, it sets the main goal in determining what are important system characteristics for effective quality improvement. First, it applied structural equation modeling (SEM) to search for multiple independent variables influencing user's intention. Second, with the findings, this study has also its significance in suggesting techniques applicable to the u-Healthcare system development using QFD. Concretely, by investigating u-Healthcare users' direct requirement attributes and extracting u-Healthcare system service characteristics with customer requirement reflected by using QFD model, this study figured out the order of priority in the importance of system characteristics that must be dealt with most importantly. As a result of analysis, this study proposed an application method of QFD to satisfy customer requirements for the development of u-Healthcare system. Finally, the result could give important features to improve users' requirements by using this process.

Keyword: user requirements, u-Healthcare, SEM, QFD

1. Introduction

Interest in healthcare is gradually increasing lately as the living standard is improved thanks to improvement in income level and change in social values, and needs for healthcare are also becoming diverse (Stut et al. 2006). Also, side effects caused by medical accidents and so on are further expanding the desires for healthcare (Institute of Medicine, 1999). In this respect, one of the fields of society in which ubiquitous can be most widely utilized is ubiquitous healthcare (u-healthcare) field which is most actively discussed recently. As an example, because it is shown that chronic diseases are caused by wrong living behaviors of individuals and, in case of USA, more than 50 % of death is caused by wrong living behaviors, healthy way of life is very important (Pender, 1987). Also, there are many studies which have indicated failure of health information system (HIS) informing that 70 % of such HIS have failed or have not satisfied end users (Anderson, 2000) and there are much more cases of failure than of success (Berg, 2001).

The proof is that many superior medical information systems are actually avoided by medical teams and users after materializing it by investing much expense and time. Most of studies end in making a prototype, for which it is difficult to find an actual application (Souf & Newman, 2007) and not many studies have been actually performed on needs of users (Steele et al., 2009). The core of success is to promptly grasp or predict in advance needs of customers and provide a system and service as needs of individuals ceaselessly change following development of information technology

Accordingly, the objective of this study is to explore important factors for acceptance of u-healthcare system by users and analyze user requirements of the system using diverse methodologies as a preliminary study to develop a u-healthcare system based on those factors.

2. Literature Review

2.1 User centered u-Healthcare system

Ubiquitous computing means intelligent environment composed of innumerable computer sets which can provide necessary information to the person who needs it at the right time (Weiser, 1993).

Many studies are being carried out on u-healthcare service in various aspects and Rigby (2007) proposed that, though ubiquitous technology is not yet exhibiting a value equivalent to its fame, all kinds of applications and data which can take actions against emergent situation by monitoring patients based on ubiquitous technologies will increase positive, ethical and confidential value in the future.

Especially, among many studies on benefits of health information system (HIS), there are studies carried out in relation to adaptation and acceptance model of users for systems using an acceptance model such as technology acceptance model (TAM). Pai et al. (2010) presented that, in acceptance of HIS, information quality and system quality have a significant effect on parameters, perceived usefulness, perceived ease of use and intention to use. Expense and ease of service use were selected as important factors in accepting HIS by investigating old persons through focused group interview (FGI) method (Steel et al., 2009). And, Vest (2010)

asserted that while US government much focused only on technical factors in relation to healthcare IT adaptation in studying main factors of health information exchange (HIE), in reality, many factors other than technical factors have effect on advancement of efficient HIE. Wu et al. (Wu et al., 2007) presented that compatibility in the aspect of medical team in acceptability (applicability) of mobile healthcare system (MHS) not only has an effect on perceived usefulness and perceived ease of use of MHS but also has the highest effect on intention to use. In the result of investigation carried out by Chatterjee et al. (2009) for the factors which influence satisfaction on healthcare service through a mobile terminal, portability of the terminal, system reliability and system support, which enable the user to receive healthcare service anytime anywhere, were found to be the factors which have the highest effect on user satisfaction.

2.2 Pender's Health Promotion Model

As for the forecasting model to analysis health behavior, there are four main models; Health Belief Model, Health Promotion Model, Theory Planned Behavior and Precede model. Among these, Bandura's Society Perception Theory and Pender's Health Promotion Model drawn out from Health Belief Model are the ones that are used most frequently to explain the Health Promotion behavior (Pender, 1982).

Pender presented health protection and Health Promotion behavior as the components of Healthy life style. In particular, he suggested Health Promotion Model to explain about the Health Promotion behavior (Pender, 1987). Health Promotion Model is the model used by Pender by developing on the notion of self efficacy, a core concept of Bandura (1986)'s theory (Pender, 1982). Pender model's key assumption is that the degree of acting on the Health Promotion behavior will be greater when there is positive and resourceful emotion towards past experiences. Likewise, Health Promotion behavior in the Health Promotion Model can be considered the behavior that brings out positive health experience in the life of human beings and the final result of the behavior. Accordingly, diverse Health Promotion behaviors are explained from the behavior related to the prevention of illness and use of the Health Promotion Model is considered viable and most effective as the model that can forecast.

Among the variables that affect Health Promotion behavior of middle aged adults and senior citizens based on Pender's the 3rd Health Promotion Model(HPM), researches conducted on the society's support, self respect, self efficacy, perceived benefit and perceived pathic will be examined.

2.3 Outline of System Users' Requirements Analysis

As the users' requirements are very abstractive and non-programmed, the job of extracting and programming the requirements of system is not that easy. The requirements area document defining what functions the system should be equipped with. This is the step defining what to process rather how to process in the system design stage. Then, it moves into the design stage. As the result of requirement analysis is the basis of the design stage, there are overlapping parts between two stages (Andirole & Stephen, 1990). Moreover, the requirements include not only users' requirements but the scope of realizable possibility as objects of requirement analysis (Galletta et al, 1999).

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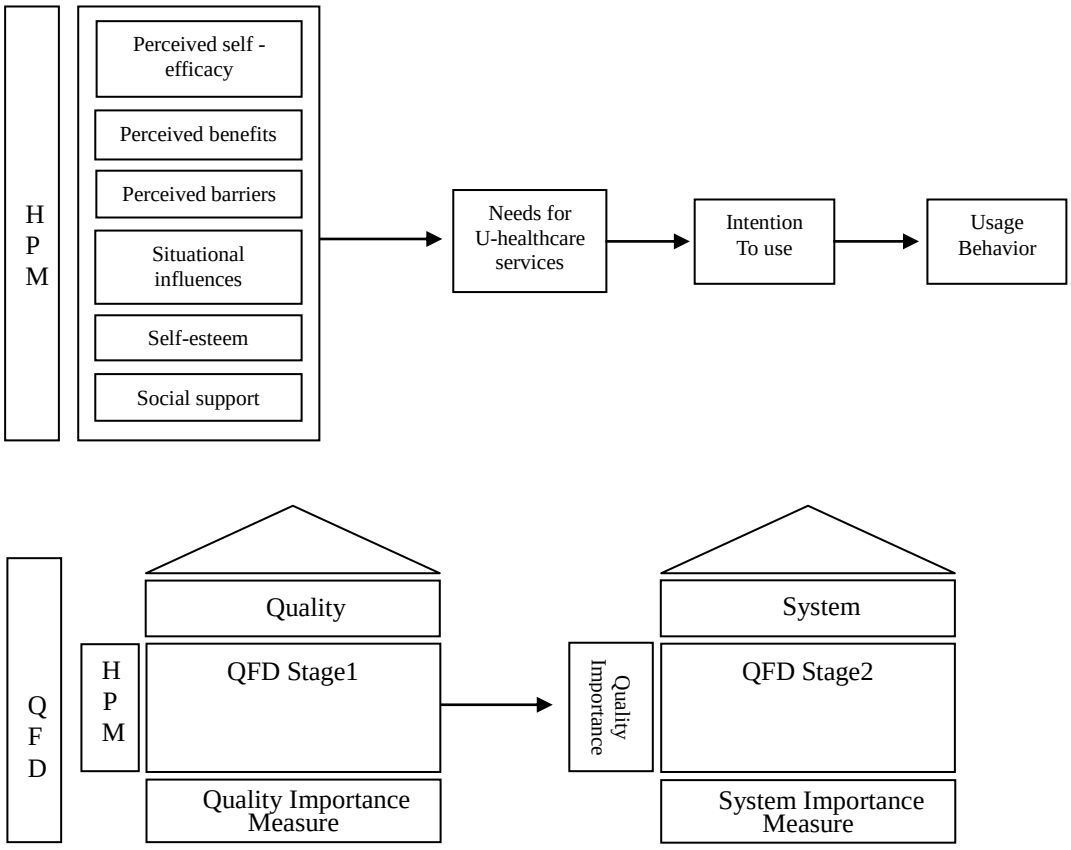
3. Research Methods

3.1 Research Model

This study conducts a survey of consumers who have experienced or want to experience u-Healthcare service now as it aims at figure out the relation between health promotion model and not only consumers' requirements of u-Healthcare service but also system service characteristics. Korean adults tend to be greatly concerned with healthcare and suffer from some chronic diseases so that they might have a high interest in u-Healthcare service, too. Thus, this study takes Korean adults as subjects.

Though, at this point of time when the interest in u-Healthcare is on the increase, a lot of related researches are being conducted, most of them are done separately by focusing on HMP verification or QFD analysis. Thus, this study attempts to find out practical implications including a suggestion of evaluation method to assess objectively and evidently the system quality characteristics of u-Healthcare service by connecting two models of HPM and QFD. The research model based on mentioned intent is shown in figure 1.

Figure 1. Research Model



3.2 Measuring Instruments

U-Healthcare can continue to monitor patients' health information including workout time

and rapidly cope with an emergency situation by using mobile terminals and various sensors due to their development (Stut et al., 2006). Thus, this study will suggest a way to provide necessary information in building u-Healthcare systems and to plan a product with customer satisfaction taken into account. Among the constructs in this analysis, Self-esteem measurement instrument developed by Rosenberg (1965) was used. As an instrument to measure self-efficacy, the self-efficacy measure in common situations developed by Sherer & Maddux (1982) was used. In this study, the quality characteristic measurement instrument is composed of 17 items revealed by the research of Natalia et al. (2005) in order to select user requirements for efficient u-Healthcare system development with QFD.

4. Analysis Findings

4.1 Data Collection

Survey subjects of this study are users (adults) who are interested in u-Healthcare System. During August 2010, 289 questionnaires were finally used for the analysis and the analysis was carried out with SPSS 12.0 for window. Divided into genders, male subjects are 47.7% and female 52.3%. Classified into age groups, 17.2% are in their twenties, 40.5% in their thirties, 26.5% in their forties and 15.8% in their fifties. In education, it is revealed that 26.85 of them are under high school graduation, 10.7% in college, 57.7% college graduation, and 4.5% over graduate school.

The requirement chart necessary to u-Healthcare system as the horizontal axis of HOQ was conducted simultaneously with the main. In addition, 20 copies of u-Healthcare system service measurement items and difficulty survey were distributed to Healthcare-related data processing experts and 18 of them were collected. Total 14 copies among them were used for this study as 4 copies with weak response reliability were ruled out.

4.2 Application of Structural Equation Model

In this section, a reliability analysis with factor analysis and internal consistency as norms was carried out by using Cronbach's coefficient in order to analyze the validity and reliability of independent variables, dependent variables and mediating variables put into this study. The findings by exploratory factor analysis (EFA) are made up of 6 factors in total. The accumulated explanation rate is revealed as 65.5%. Factor 1 is made up of 8 social support questions, 5 self-efficacy questions, 5 self-esteem questions, 5 benefit questions, 5 disability questions and 2 situational factor questions respectively. The reliability coefficient is all as high as over 0.70 when internal consistency among items of each factor is examined. The recommended minimum Cronbach's alpha coefficient reliability of 0.70 (Nunnally, 1978) is used to verify the reliabilities of each factor.

This analysis aims at finding out questions hurting reliability by identifying Squared Multiple Correlation (SMC) that explains whether significant causal relationship exists between potential variable and observation variables or not and potential variables by observation variables(Bollen, 1989). Various criteria of SEM analysis using AMOS 19.0 in this study were satisfied. Finally, the variables having a significant effect on necessity are 3 factors such as self-efficacy, perceived benefit and social support ($p<0.05$).On the other hand, situational factor, perceived disability and self-esteem do not have a significant effect

(p>0.05). That is, it is found out that as self-efficacy is higher, benefit of u-Healthcare service is highly recognized, and the degree of social support is higher, necessity of u-Healthcare is highly recognized. In addition, necessity has a significant positive (+) effect on attitude and in turn, attitude on intention. As attitude is positive, it affects behavioral intention. The result of verifying path significance between potential variables examined in the final model is as follows.

Table 1. Path Significance in model

Paths	standardization	β	S.E.	C.R.	p
PSE → Needs	0.19	0.19	0.07	2.79	0.005
PB → Needs	0.47	0.40	0.07	5.96	0.000
SS → Needs	0.17	0.18	0.07	2.79	0.005
Needs → Attitude	0.49	0.64	0.09	7.37	0.000
Attitude → Intention	0.83	0.92	0.07	13.33	0.000

4.3 Analysis for the QFD Application

QFD is a technique to determine how to satisfy customers' needs with limited resources by listening to customers 'opinion and finding out what they want. QFD turns customer-experienced quality factors revealed in customer satisfaction into technological quality and analyzes them, selects quality improvement tasks according to importance and priority of customers and make customer-oriented products through quality improvement (Hauser & Clausing, 1988; Sullivan, 1986). The intention of this paper is to apply HPM to QFD. That is, HPM, u-Healthcare service quality characteristics and system service characteristics are built into a causal relationship, a center of HOQ. Finally, chief result of HOQ is the priority of system service characteristics. By using this, this paper determines important system service characteristics for the effective quality improvement.

This paper identified three pivotal factors of self-efficacy, perceived benefit and social support through confirmatory factor analysis in order to select an effective u-Healthcare system development using QFD. Contents of each factor are shown in table 2.

Table 2. Contents of significant factors in SEM

Factors	Contents
PSE1	Using u-Healthcare Service, I can carry out necessary health acts to improve my health.
PSE2	Using u-Healthcare Service, I can maintain a balanced diet.
PSE3	Using u-Healthcare Service, I feel confident to overcome difficulties in healthcare.
PSE4	Using u-Healthcare Service, I can exercise regularly.
PB1	Ubiquitous Healthcare will be effective to cope with emergency immediately.
PB2	Ubiquitous Healthcare will be helpful to save time for health care.
PB3	Ubiquitous Healthcare will be convenient as it is possible to measure and manage it.
SS1	I have people to have a good time with me.
SS2	I have people to help me to the hospital when sick.

SS3	I have people to tell me right and wrong without hesitation.
SS4	My relatives and friends think that I am helpful for them.
SS5	I feel satisfied with my life more than others do.

In order to calculate importance measure of individual variables of each factor applicable to HOQ, This paper divided necessity of u-Healthcare with a mean into upper and lower groups and extracted important elements in judging upper and lower groups of self-efficacy, perceived benefit and social support and then, conducted discriminant analysis to figure out order of importance priority (Hyejung Chang& Dohoon Kim, 2010). This paper made up of a measuring instrument for quality characteristics with 17 items revealed by Natalia et al. (2005).

Table 3. Quality characteristics for QFD step 1 analysis

	Feature	Description
NETWORK	Mobility	Ability to operated in mobile environment
	Security	Ability to protect users' personal information
	Accessibility	Ability to be easily accessed
	Scalability	Ability to provide stable and scalable work even if the system is overloaded
	Interoperability	Connects various kinds of devices
DEVICE	Invisibility	Ability to provide service calmly, namely, without users' recognition
	Durability	Ability to maintain 'Power-on' status all the time
	Embeddedness	Ability to be embedded into physical environment and be unseen
	Portability	Ability of being used hands-free or with one hand
USER INTERFACE	Customizability	Ability to provide information to users according to their profile and preferences
	Nomadicity	Ability to be used while a user moves from place to place
	Usability	Ability to underpin input and output with by various user interfaces
	Versatility	Ability to be operated as a user moves from place to place and be manipulated using different physical objects
OPERATING SYSTEM	Context inference	Ability to provide users with service fairly correlated with their current context
	Agility	Ability to complete operations on real-time basis
	Personalization	Ability to remember users' common patterns and use them later
	Pro-activeness	Ability to provide users with the service they are likely to require in the nearest future depending on their current situation

In order to find out how much systematic correlation exists between HPM and u-Healthcare service quality characteristics, this paper conducted a correlation analysis. By using this, this paper can build first House of Quality (HOQ). Correlation is marked below 0.01(**) and 0.05(*) in significant level between all the variables. As the result of correlation analysis, all showed consistent correlation except ‘portability. This means that most quality characteristics have high correlation with variables of HPM. And this fact is the foundation to compose HOQ 1 quality chart (Hyejung Chang & Dohoon Kim, 2010).

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The method of calculating importance to determine order of priority in practicing service quality characteristics for each customer requirement in QFD is to use importance of HPM and correlation coefficients between HPM and service quality characteristics that customers evaluated. According to the size obtained from the calculation of order of priority in service quality characteristics is determined (Wasserman, 1993).

Technical characteristic is one of the two main elements of QFD. One of the essential objectives of QFD is to determine how to cope with customer needs technically. QFD is the process to transform qualitative customer needs into quantitative technical characteristics. One of these methods is to fill in required quality deployment chart that transforms customer needs into concrete requirements. And then, you can extract technical characteristics by drawing up technical characteristic chart. Finally, calculation of quality chart reflects opinions of technical characteristic experts and judges the degree of relationship between customer requirements and technical characteristics.

In this study, the multiplied values in the relation of importance of required quality and technical characteristics by using simple weighted sum method are calculated, and then, the value of technical characteristics is calculated by adding them vertically. When relative importance of required quality as a line of HOQ is and the value indicating the degree of relevance is, absolute weight is expressed like the following equation.

As the degree of Difficulty on Service Platform and External Interface is 2.6~4.0, the gap is rather wide. The highest degree of difficulty is the construction of "Treatment Decision Support System Management" and "Emergency Situation Management" system as 4.0. "Biometric Information Collection/Storage/Management" and "Biometric Information Analysis" is the next as 3.6 degree of difficulty. That is, to build these systems is recognized as very hard.

In the rank of Service Platform and External Interface, "Emergency Situation Management" is the highest as the first and "Biometric Information Collection/Storage/Management" is the next. And "Treatment Decision Support System Management", "Individual Health Information Management", "Biometric Information Monitoring Management", "Contents Management" and "Biometric Information Analysis" are placed in the following order respectively. "Network Telemanagement" is the lowest in order.

4. Conclusion

For this study, survey was carried out on the basis of quality model extracted from the previous research. From the survey findings, both consumer requirements and degree of difficulty as well as importance measure in building service system are drawn out. And, by using QFD technique, system characteristics of high correlation with quality characteristics and consumer requirements are extracted and by evaluating these characteristics with degree of difficulty added as suitable or not in real system development, much time and effort can be saved and efficient evaluation procedures are suggested.

Concretely, this study first introduced main evaluation factors of Pender's HPM in order to draw out consumers' objective requirements about u-Healthcare for u-Healthcare system development. In addition, it suggested structural equation model for the purpose of examining

evaluation methods to accommodate multiple dependency causal relationship between evaluation factors and finding out optimal causality between them. Second, this paper examined structural equation model with the validity in composing potential variables and observation variables of HPM through confirmatory factor analysis and evaluates its goodness of fit. Third, in order to consider the correlation between evaluation norms and factors of service quality characteristics for the satisfaction of u-Healthcare system users, this paper figured out the influence of multiple dependency causality. In addition, this paper rated significant HPMs on the basis of the standardization discriminant function and applied it to the evaluation norms as a weighted value. Using this, this paper suggested an evaluation model to determine the order of priority in consumer quality characteristics.

Through this study, by applying QFD techniques in order to find out service system characteristics according to u-Healthcare service types, this paper attempted to provide more improved system environment to u-Healthcare users.

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