

Measuring End User Satisfaction with Hospital's Mobile Health System in Korea

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Abstract

Our research seeks to measure End user satisfaction and identify the contributors of satisfaction in mobile healthcare system. We gathered data from internal end users from Hallym University hospital at the level of clinicians, such as medical doctor and nurse. We employed PLS (Partial Least Square) to analyze data and our results show that all three factors- content, accuracy, and ease of use explain the contributors of satisfaction. Moreover, our results provide the evidence that Korean Mobile Healthcare System priorities are Ease of Use and Content. Our study could contribute to mobile healthcare system developer to measure user's satisfaction with mobile system. Data collected from Hallym University Medical Center year 2012 and analyzed using PLS (Partial Least Square) Out of 1668 clinical employees, only 7% response for the survey and majorities were nurses (93).

Keywords: *End user satisfaction, Reflective measure, Formative measure, Ease of use, Partial least square, Mobile healthcare system*

1. Introduction

Mobile Healthcare service is one of the most significant emerging trends to arise in healthcare industry in Korea. Healthcare industry information system is relatively complex than that of other industries'. Huge amount of data and complicated network disturb hospital to adopt new technology that is why healthcare industry is recognized as lagged behind. However, there are more and more hospitals adopt mobile healthcare system to manage information faster and provide better service. Unlike other industry, healthcare industry consists with various types of employees: medical doctor, nurse, technician, and administrator. It is not easy to satisfy all kinds of jobs through one system. Healthcare employees can be divided by two groups- clinician and non-clinician. Clinicians include physician, nurse and technician. Non-clinicians are administrators or who has indirect relationship with patients. In this study I do not consider the administrative work force because the usage type of mobile system is different from clinician's. It is not easy to understand whose role is what and what they want. The amount of data is much larger than manufacturing industry. The suitability of service system is very important for the healthcare provider. If a service system could not make satisfaction for the end user, then there might be huge loss for IT system. In this article, I am focusing on healthcare provider user satisfaction, not on consumer. There are various types of Mobile system in healthcare, such as mobile application, wireless network, and GPS (Global positioning systems) ambulance. I investigate mobile electronic medical record (EMR) and order communication system (OCS) in hospital. EMR is the most important system for the clinicians and make them possible to provide better services to each other and patients. Through Mobile healthcare system, clinicians can get

patient information; consult requests, image and test result at anytime and anywhere. (R. Haux, 2006). Individual patient's custom health screen is possible at real-time. It was not easy to show medical image to the patient who suppose to stay in bed, mobile healthcare system increase patient care and quality of healthcare service. (E. Ammenwerth, S. Graber, G. Herrmann, T. Bu" rkle, J. Ko'nig, 2003) However, healthcare communication system is difficult to build and not easy to satisfy all end users. There are only a few previous studies how to measure mobile healthcare system satisfaction. To develop mobile healthcare system I need to find what the factors are influences to end user satisfaction. Understanding important factors determine healthcare professionals mobile healthcare system satisfaction will provide broad vision do develop strategies which make healthcare provider get more opportunity for better service. The mobile healthcare system has different screen for different group. Hallym University Medical Center (HUMC) has introduced the Mobile Health-care System (MHS) on Jun, 2010. After introduced MHS, HUMC IT office received many requests from variable employees related with contents and accuracy. HUMC IT office needs to improve the MHS service quality, so we conducted the survey of MHS for improving end-user satisfaction, and other related requirements: contents, accuracy, ease of use.

2. Theoretical Background

2.1. Definition of Mobile Healthcare Service

Mobile healthcare system is new system support end user's job with using mobile device. The function of mobile healthcare system would be very similar with the system end user use on their desk top computer. However, mobile system has limitation to support all functions which immobile provide due to security, battery, and so forth. The measurement of mobile healthcare system satisfaction will be different from that of immobile healthcare systems. There are various functions supported by mobile devices, such as game, internet and applications, but in this study we focus on mobile healthcare system only.

Traditionally healthcare information is reported through several steps. Some test results take less than one hour but some take 1or 2 days, depends on the person in charge. Even data is ready, healthcare workers are too busy to take care of patients. Unlike other industry, there are always new patients coming to hospital with different types of disease, symptom and reasons. This kind of environment cannot provide proper information to right end user.

Mobile healthcare system requires high degree of security to secure patient information. The contents of mobile system are supposed to be different from immobile system, such as which level of job or group can access to the patient's test results and revise the data. Healthcare information does not allow mistake because little mistake can bring a miserable malpractice to patients. Wireless device is developing faster than any other period. Accurate information is required from healthcare employees to understand patient's condition or process next step to care. Depending on the information, patients are required to move to test room but sometimes we can observe a patient went by wayside for several hours. Even a system support high security and accurate information, we cannot enforce to use the system to healthcare employees if it is not easy to use. Unlike other country, Korea has national insurance system with low medical fees. It might look good for people using medical service often but for the hospital side, it is necessary to see patient as many as possible to sustain financial balance. Some medical doctors in Korea meet 200 out patients per a day. According to OECD report Koreans hospital visiting rate is twice higher than other countries. This environment explains why the healthcare employees do not have enough time to wrestle with difficult wireless device. There are some previous studies with employed perceived

usefulness to measure intention (Jen-her Wu *et al.*, 2007). As I mentioned above mobile system is not a totally different system. It provides same medical or patient information but without limitation of place and time. We consider that mobile system does not relate with employee's performance improvement.

According to Robert Wu *et al.*, mobile device can only improve documenting, not have significant influences on other performances. The feature of mobile system is very similar with immobile system which healthcare employees use on their work place. Training is not necessary factor. The satisfaction of end user for the mobile healthcare system can improve patient care quality. To increase usage of mobile system, finding factors with proper method which influence to satisfaction is very important. In this study we adopt Partial Least Square to analyze data and make questionnaires for both formative and reflective. The result of this study could contribute to develop better mobile healthcare system. However, the response rate for the survey is low. This survey was conducted in 2011. As time goes on there are more and more people use smart phone, therefore on next survey, we expect to get more response from various group.

2.2. Mobile Healthcare System and Constructs

Mobile healthcare system end user – generally hospital consist with several job groups, medical doctor, nurse, technician, and administrator. Bigger hospital has more job descriptions. In this study the end users are limited for physician, technician and nurse because they are most powerful and largest group of performers influence to the test. This could be one of the weak points of our study but at that period we conducted survey without mobile contents open to administrators. Davis and Olson (1985) pointing out to the primary and secondary users of IS. Primary users are responsible of entering data to the IS and working with software, but secondary users are those who make decision based on the reports provide by IS. Brancheau and Brown (1993) commenced their paper by defining end-user computing as the 'adoption and use of information technology by personnel outside the information systems department to develop software applications in support of organizational tasks'. (Sandra Baker 2007).

3. Research Model

Doll and Torkzadeh (1988) proposed five quality dimensions which influence to end user satisfaction: contents, accuracy, format, ease of use and timeliness. Our research seeks to measure End user satisfaction and identify the contributors of satisfaction. We adopt Doll's (1988) model. The original model consisted with five constructs accuracy, content, ease of use, format, timeliness, and end user satisfaction. In our study dependent variable is End user satisfaction and independent variables are content, accuracy, and perceived ease of use; we didn't use format and timeliness. The mobile system format is very similar with immobile one and nothing has been changed in documenting process. We employed partial least square to analyze the data. We observe both formative and reflective construct and their relationship and reflective questions are marked with capital 'R' and formatives are with 'F' our research model is as the next Figure 1.

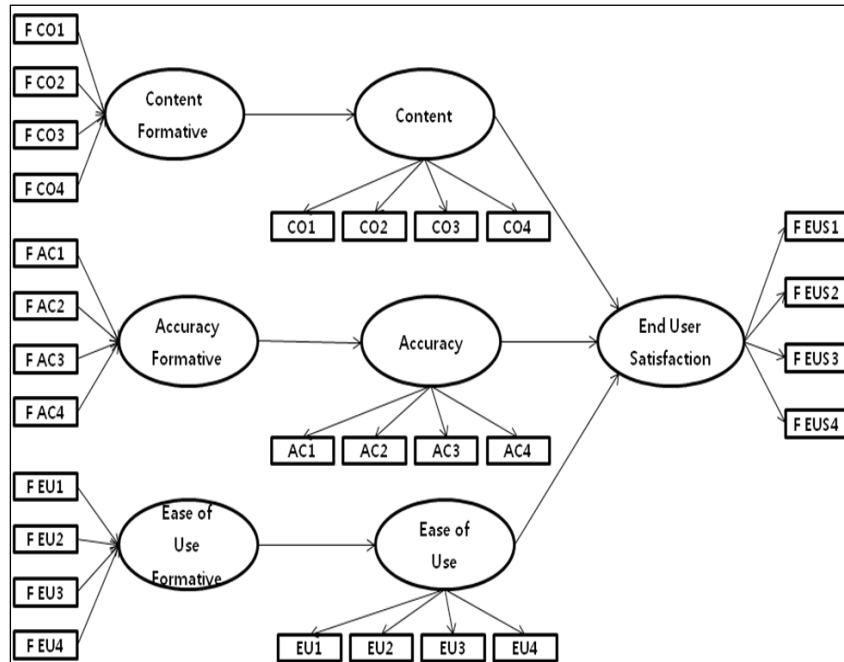


Figure 1. Research Model

4. Hypothesis

4.1. Content

There are numerous content exist in healthcare system such as EMR, such as daily charting, medication administration, physical assessment, admission nursing note, nursing care plan, referral, present complaint, past medical history, insurance, problems, finding, immunization, and demographic data. The content of electronic medical record has varied over time and we use broad concept of content in this study. Content includes documenting, reporting, information, prescription, data input, test result and patient information search functions which are supported similar by immobile system. Previous study only consider reflective constructs but for better understand what is the most important factor influence to end user satisfaction we employed formative constructs also. EMR content defined as specifications of key concepts and value sets that describe a subset of important data elements in EMR. In this study we define content as “The things that are inside MHS such as patient information, prescription and so on”.

Hypothesis 1: The satisfaction of content will have a positive effect to end-user satisfaction.

4.2. Accuracy

We measure the accuracy of mobile healthcare system with four reflective questions which are highly correlated and another four formative questions which are causal factors. In fact, using certain accuracy measures can be misleading. Our formative questions are developed to figure out what is the strongest factors influence to end user satisfaction. According to Bailey (1983) accuracy is the most important factor to measure user satisfaction. Our formative questionnaires measure the accuracy of scheduling, medical image, test result and patient

information. In this study we define accuracy as “The degree of closeness of measurement of quantity to that quantities actual/true value”.

Hypothesis 2: The satisfaction of accuracy will have a positive effect to end-user satisfaction.

4.3. Ease of Use

There are numerous previous studies which mentioned the importance of ease of use. Measures of user information satisfaction are developed continuously but current environment it is not appropriate because end users are directly interact with application software. (William J. Doll 1988) There are many previous studies exam ease of use in electronic medical record system. Electronic Medical Records are developed to support clinical activity, improve efficiency, and decrease error. Mobile healthcare system also supports similar function but more focus on process improvement. We observed how ease of use is related with mobile healthcare system satisfaction and measure the satisfaction with formative questions such user, friendly, decrease of working time, problem solving, and ease to learn. Mobile healthcare system is very similar with original healthcare system. In this study we define ease of use as “The degree to which a healthcare professional believes that the use of MHS would be free of physical and mental effort”.

Hypothesis 3: The satisfaction of ease of use will have a positive effect to end-user satisfaction.

4.4. End-User Satisfaction

In this study we define end-user satisfaction as “The degree to which an individual has a positive emotional feeling about using Mobile Health-care System (MHS)”.

5. Methodology

For better measurement, we developed 8 questionnaires for both reflective and formative. Formative questions can make use analyzing what is the most important factor which influence to physician and nurse satisfaction. All questionnaires are written in Korean and English both using proper expression. Our survey instrument is containing total 28 items, eight items for each independent variables, except dependent variable, measured by seven-point Likert scale (1=dissatisfied,4=neutral, 7=satisfied).

To collect data, we used a questionnaire method. Questionnaires (Figure 2) were distributed by IT portal system to 1168 employed medical doctors and nurses. We received 114 responses and 82% of respondents were nurses and female using smart phone to access the MHS and 18% of respondents were medical doctor and male. The users recently exposed to the mobile healthcare system in Hallym university medical center. There are five hospitals which located at different location in Seoul, Korea but using one integrated EMR and OCS. We employed Partial Least Squares (PLS) method to analyze the survey result. As I mentioned above the response rate of our survey is not high. However, it is not easy to collect data from medical organization especially from medical doctors. The advantage of using PLS is that we can analyze with small number of data. As we use reflective and formative question the number of constructs are required to minimize.

Content	CO1. I am pleased with information MHS provide. CO2. I am satisfies with contents MHS provide. CO3. I am happy with information MHS provide. CO4. I am satisfied with report MHS provide. Here is the list of contents, MHS provide. How satisfy with each of this? I am satisfied with. CO5. Capability of patient prescription through MHS CO6. Capability of Patient data input through HMS CO7. Capability of test result confirm through MHS. CO8. Capability of patient information search through MHS.
Accuracy	AC1. Overall, I am satisfied with accuracy of Information of MHS. AC2. Overall, I am satisfied with fidelity of information of MHS. AC3. In general, I am satisfied with level of reliability of output MHS. AC4. Overall, I am satisfied with how precise the MHS is. We want you to tell us how satisfied are you in terms of the accuracy of parts of MHS AC5. I am satisfied with accurate appointment schedule of MHS. AC6. I am satisfied with MHS accurate medical image of MHS. AC7. I am satisfied with accurate test result of MHS. AC8. I am satisfied with accurate patient information of MHS.
Ease of Use	EU1. How do you satisfy with user friendliness of MHS. EU2. How do you satisfy with ease of use of MHS ? EU3. How do you satisfy with comfortableness of MHS ? EU4. How do you satisfy with ease to access ? EU5. MHS provides user-friendly interface. EU6. MHS decrease my work time. EU7. I can solve problem easily using MHS EU8. MHS is easy to learn.
End user satisfaction	EUS1. Overall, I am satisfied with MHS. EUS2. In general, I am please to use MHS. EUS3. I am positive to use MHS. EUS4. Overall, I am comfortable to use MHS.

Figure 2. Survey Questionnaire

6. Measurement Model Estimation

Figure 3 shows that coefficient value of content to End User Satisfaction is 0.300, Accuracy to End User Satisfaction is 0.187, and Ease of Use to End User Satisfaction is 0.482. R-square value of Accuracy is 0.588, Ease of Use is 0.757, and End User Satisfaction is 0.746. Correlation of CO6, AC6 and EU6 shows very low. According to our cross loadings discriminant validity for the reflective constructs based on the loadings and cross loadings are good. We can observe seven dimensions are higher than 0.7 except CO6, EU6 and EU8, so the results are considered reliable (Nunnally 1978). Table 1 show that EU6 and EU8 may not measure "Ease of Use". So, we examined the model after removed Eu6 and EU8. The correlation of latent variables is significant. We conducted the bootstrapping with 1000 times and 500 times both.

In the original model the correlation value for CO6, AC6 and EU6 were lower than other values. After bootstrapping, correlation values are increased, but CO8 and EU5 are decreased.

Paths between formative and reflective constructs are all significant. T-value for content is 14.111, accuracy is 19.837 and ease of use is 28.037.

According to the original model there were two items (EU6, EU8) which are greater than AVE. Also we removed CO6 and AC6 for negative gamma coefficient value. In the modified model (Figure 4) we removed four items from the original model and conducted same process. Coefficient value from content to End User Satisfaction is 0.300, Accuracy to End User Satisfaction is 0.186, and Ease of Use to End User Satisfaction is 0.482.

In the Table 1, R-square value of End User Satisfaction is 0.746, Content is 0.462, Accuracy is 0.586, and Ease of Use is 0.727. In the modified model, CO8, AC7 and EU5 are most significant contributors to form the constructs.

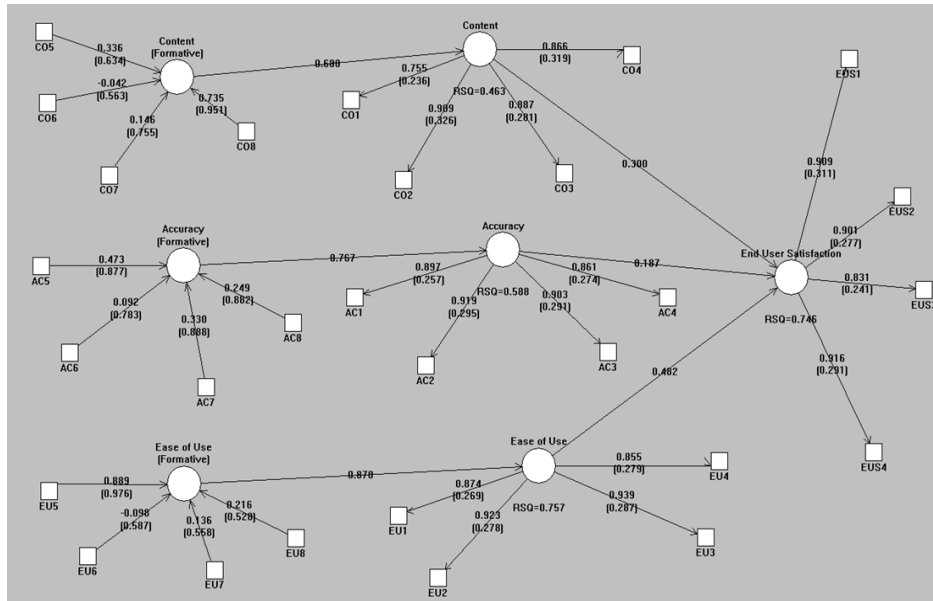


Figure 3. Original Model

Table 1. Statics of the Measurement Model

CR	Sq AVE	Latent Variables	EUS	CO	AC	EU	COF	ACF	EU F
0.9383919	0.8900839	EUS	1						
52	77		0.7640880						
0.9163254	0.8563856	CO		1					
96	84		0.7257415	0.8070515					
0.9415896	0.8951459	AC			1				
53	48		0.7921432	0.6513553					
0.9435722	0.8984419	EU			0.617123916	1			
39	88		0.6659930	0.6799861		0.6065518			
0.8302700	0.7914297	COF					1		
03	16		0.7367132	0.6913510		0.6083745	0.6358544		
0.9150896	0.8844501	ACF						1	
1	95		0.7412552	0.6199313		0.8526008	0.5922377		1
0.7815809	0.8110496	EU F						0.5466310	
19	13		0.7412552	0.6199313	0.583946923	0.8526008	0.5922377	0.5466310	1
			55	06	0.583946923	25	18		

CR	AVE	Latent Variables	EUS	CO	AC	EU	COF	ACFF	EU F
0.9383919	0.7922494	EUS	1						
52	87		0.5838305						
0.9163254	0.7333964	CO		1					
96	4		0.5267007	0.6513322					
0.9415896	0.8012862	AC			1				
53	68		0.6274909	0.4242638					
0.9435722	0.8071980	EU			0.380841928	1			
39	06		0.4435467	0.4623811		0.3679051			
0.8302700	0.6263609	COF					1		
03	95		0.5427464	0.4779662		0.3701195	0.4043109		
0.9150896	0.7822521	ACF						1	
1	48		0.5494593	0.3843148		0.7269281	0.3507455		1
0.7815809	0.6578014	EU F						0.2988054	
19	75		0.5494593	0.3843148	0.340994009	0.7269281	0.3507455	0.2988054	1
			52	25	0.340994009	67	15	63	

We conducted the bootstrapping with 1000 times and it shows that t-value from content to End User Satisfaction is 3.327(3.291 at 99.99%), Accuracy to End User Satisfaction is 1.480(1.645 at 90%), and Ease of Use to End User Satisfaction is 3.551 (3.291 at 99.99%). Only two paths are significant at level 0.01%

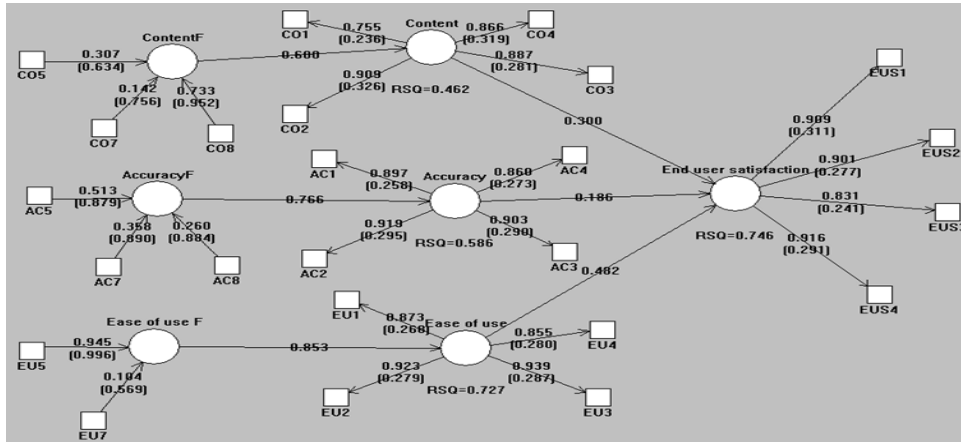


Figure 4. Modified Model

7. Conclusion

The hypotheses were tested by examining the structural model. The test of the structural model includes estimating the path coefficients, which indicate the strength of the relationships between two variables. Results of structural model are provided in Figure 5.

First, the satisfaction of content has a significant positive effect on End-User Satisfaction ($\beta=0.300$, $p<0.001$), thus H1 is supported.

Second, the satisfaction of accuracy was not found to have a significant positive effect on End-User Satisfaction ($\beta=0.187$, $p<0.001$), thus H2 is not supported.

Third, the satisfaction of ease of use has a significant positive effect on End-User Satisfaction ($\beta=0.482$, $p<0.001$), thus H3 is supported.

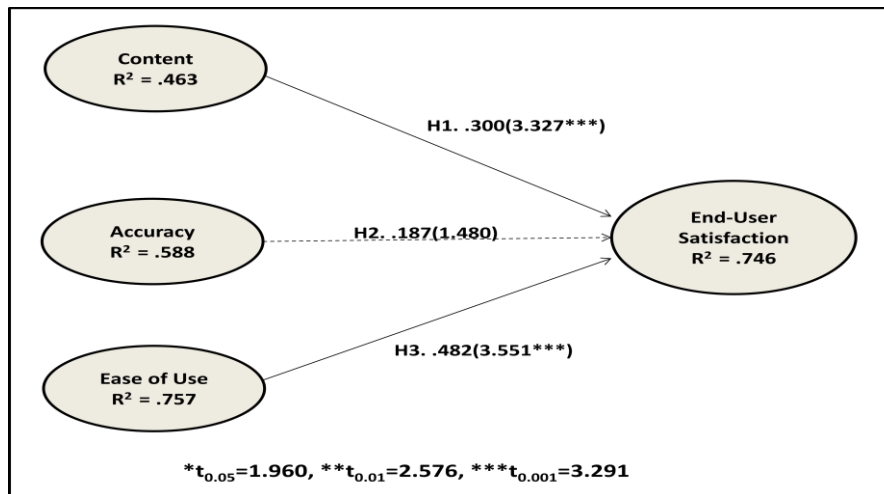


Figure 5. Results of Structural Model

Table 2. Results of Hypotheses Test

Hypotheses	Std. Estimate	Std. Error	t-value	Results
H1 Content → End User Satisfaction	0.300	0.103	3.327***	Support
H2 Accuracy → End User Satisfaction	0.187	0.089	1.480	Not Support
H3 Ease of Use → End User Satisfaction	0.482	0.105	3.551***	Support

‡ $t_{0.1}=1.645$, * $t_{0.05}=1.960$, ** $t_{0.01}=2.576$, *** $t_{0.001}=3.291$

In Table 2, H1 and H3 are supported. It means that the satisfaction of content and ease of use are important to end users to use mobile health system. Mobile health system offer unique ability compare to original health system, mobility. According to this study mobility is very important factor to the end users. Healthcare industry deals very complicate data compare to any other industries and those are controlled strictly by lots of organization or regulations. As I mentioned above mobile health system is a different way to view original healthcare system in the hospital thus accuracy didn't show positive relationship with end user satisfaction. Even end users can see the information through different device with different format all medical or clinical information is same as desk top showing. Ease of use is important factor to the end users to adopt innovation. In the study we made four different formative questions about ease of use and employed those to the survey. The result shows that ease of use is very important factor to the end users to adopt the mobile health system. In the future study we need more discussion on how to add formative indicators would be helpful.

8. Limitation of this Study

Through this research, we found that there are three limitations. Firstly, the sample size was 114 out of over 1000. Secondly, the survey was conducted only for medical doctor and nurses without clinical technician and administrative. Thirdly, our study had considered only end-users from specific hospital environment. Most of these end-users were themselves responsible for driving the mobile system implementation in respective lead agencies. Although the respondent's participation in the research was voluntary, their evaluations of the Mobile Health systems could have been motivated by their own personal needs to demonstrate to themselves, their superiors or other agencies that they had delivered positive results.

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