

Customer Perspective Analysis on Ubiquitous Healthcare Services

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Abstract

While ubiquitous healthcare (u-health) services were expected to propagate along with conventional healthcare services, recent progress indicated rather limited market acceptance. In this paper, we investigated the fundamental causes of why the consumer acceptance level of u-health services has been low. We draw upon innovation adoption theories to analyze the consumer readiness of the typical u-health services. The comparative analysis between innovative u-health services and conventional services was performed using analytic hierarchy process (AHP). Subsequently, policy and business implications including technological breakthrough insights were discussed based on the customer perspective comparative adoption analysis. The propositions captured through this study provide useful insight to further studies on u-health services.

Keywords:

ubiquitous healthcare; u-health services; analytic hierarchy process, innovation diffusion and adoption theory

1. Introduction

U-Healthcare is a new type of Information Technology Convergence these days. Information technology has been converged into the medical industry for diagnosis, prevention, cure and management of disease in everywhere at anytime. U-Healthcare system is an innovation of medical service under the ubiquitous environment and technology. Especially predominant infrastructure of information technology and increasing internal reform of medical industry of Korea lead a u-Healthcare system. For the technology, development of internet and mobile environment enable customer to access the network easily.

The purpose of this study is not only to investigate current status of u-Healthcare service in early stage and various cases for home and abroad but also to analyze current u-Healthcare service and conceptual u-Healthcare service in order to suggest typical service model based on innovation diffusion and adoption theory and technology acceptance model. The questionnaire is involved to obtain data for preference of u-Healthcare service from customer

and establish a basis of adequacy. This survey is analyzed through AHP (Analytic Hierarchy Process), which is widely used method to select best one. This approach is based on theory of planned behavior as a theory to explain user's behavior when they measure relative preference in the pair wise comparison. According to the result of this survey user's preference of u-Healthcare service will be derived and analyzed based on innovation diffusion and adoption theory. Also it contributes to suggest typical u-Healthcare service model and provide useful implication to the industry.

1.1 Research Scope and Method

This study focuses on u-Healthcare service served to the customer in the overall u-Healthcare area and derives typical u-Healthcare service model supported by innovation diffusion and adoption theory and technology acceptance model. Analytic Hierarchy Process is adopted to find priority for preference of u-Healthcare service. Questionnaire based on AHP consists of number of pairwise comparisons to collect data for preference from the customer. Theory of reasoned action and theory of planned behavior applied to support validity of AHP method. This approach is persuasive when we explain customer behavior in the comparison. Suggesting typical u-Healthcare service model is a meaningful effort to give implication to the industry and customer to prepare new business model and accept new service.

1.2 Research Model

Analysis of u-Healthcare service pattern and sub services
Generating classification of u-Healthcare service model and typical u-Health service
Questionnaire and AHP to analyze user acceptance service model
Suggesting implication to the u-Healthcare service business

2. Ubiquitous Healthcare System

2.1 e-Healthcare

u-Healthcare is an advanced medical care under ubiquitous environment than e-Healthcare. Here we need to understand e-Healthcare first. In fact e-Healthcare is a widely used word in the world meaning medical service which is enhanced through internet and information technology.

Developed countries including Korea have been investing in e-Healthcare since 1990s. This new business area was a common interest among the countries as a medical care merged with information technology. e-Health is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology [4].

2.2 Relations between e-Healthcare System and u-Healthcare System

e-Healthcare system is a widely used word in the world containing various services introduced in previous chapter. However u-Healthcare (ubiquitous healthcare) means e-Healthcare system under ubiquitous environment. While e-Health is an exchange of health information among the people, patients, health service provider, Information technology provider, and solution companies, u-Healthcare system is a concept connecting physical space, meaning health service provider and the people, to electronic space of medical technology as well as including functions of e-Healthcare system.

2.3 u-Healthcare System

u-Healthcare is broadly used word related to ubiquitous along with u-City and u-Technology in Korea. However different terms such as e-Health, mobile health, telemedicine, telecare, telehealth and remote healthcare are more likely used in Europe and U.S.A than u-Healthcare. Although various terms of healthcare exist in the world the purpose of these terms focus on new healthcare system integrated with information technology.

u-Healthcare system is a type of convergence between information technology and medical industry to provide medical service to the customer under ubiquitous environment and technology. Through this system people can check their health condition by medical equipment in everywhere using wearable system or mobile tools along with wire or wireless communication. Then this measured data is transferred to the system to be analyzed by the medical doctor. As such, this system enables prevention of disease, diagnosis, medical care, and disease management.

Especially prevention of disease helps people to keep healthy. Also medical equipments in the medical institution are connected each other within network so that member of medical institution diagnose and care disease exactly under convenient environment. Therefore we can predict u-Health system will change conventional health service and this market will show remarkable growth in the future when it meet requirements such as innovative technology and regulation.

3. Theoretical Background

3.1 Innovation Diffusion Theories

Rogers defines that “diffusion is the process in which an innovation is communicated through certain channels over time among the members of a social system” [3]. He regards it as a special type of communication concerning new ideas. Also he explains that “communication is a process of convergence (or divergence) as two or more individuals exchange information in order to move toward each other in the meanings that they give to certain events” [3].

According to Rogers, diffusion involves some degree of uncertainty and social change occurs when new ideas are invented, diffused, and adopted or rejected. He introduced four main elements of the diffusion of innovations, which are innovation, communication channels, time, and the social system. The following figure shows the process of diffusion.

Rogers deals with technological innovations through his book, “Diffusion of Innovations,” regarding an innovation as a new idea, practice or object. He emphasized that characteristics of an innovation significantly influences its rate of adoption. Also he introduced five attributes of innovations, which are relative advantage, compatibility, complexity, trialability, and observability.

3.2 Technology Acceptance Model

Technology Acceptance Model is an influential extensions of the theory of reasoned action (TRA) developed by Ajzen and Fishbein. Fred Davis and Richard Bagozzi developed this theory replacing TRA’s attitude measures with two technology acceptance measures, perceived usefulness and perceived ease of use.

Fred Davis developed and validates perceived usefulness and perceived ease of use as fundamental determinants of user acceptance for information technology. He insists that when people accept or reject information technology these two determinants are especially important among the variables they may influence system use [5].

According to Davis, “perceived usefulness is defined as the degree to which a person believes that using a particular system would enhance his or her job performance” and “perceived ease of use, in contrast, refers to the degree to which a person believes that using a particular system would be free of effort” [5].

4. u-Health Service Model

4.1 Classification of Services by Types

u-Health services were investigated above along with its classification by service area, characteristics, and service subject. Here we classified u-Health services again by direct service target which are medical institution service and personal service. Personal service divided into healthcare type and wellness type by the purpose of service.

Targets of medical institution service are medical institution and other institutions for effective work of medical institution and cooperation between medical institution and other institution under ubiquitous environment. Connecting information system and ubiquitous technology enables the medical institution to work with other institutions.

The target of personal service is a person who needs health service or health information and it includes two service types, healthcare type for medical care and disease management of patient and wellness type for keeping health of normal people. Each service of two service types is introduced in a following table.

Table 1 - Classification of Services by Types

u-Health service type	u-Health Services
Medical Institution Service	OCS, HIS, EMR, PACS, Patient, medicine and property management system using RFID, Hospital patient information system, Medical information exchange for hospitals, hospital and drug store, and hospital and public health center Telematics, B2B in health portal, Medical Smart Card Service
Personal Service – Healthcare type	Mobile healthcare service, Geriatric disease service, , Mobile nursing service, Infrared emergency service. Locating Service, Health management for silver town, Mobile prescription. u-Health monitoring service, Wearable computer based health monitoring.
Personal Service – Wellness type	B2C in health portal, Online fitness service, Mobile stress management, Mobile exercise management, Mobile fatness management, Video health consultation, Online health information system.

4.2 u-Health Value Chain

u-Health value chain consists of part of value chains from IT, medical industry, and telecommunications. These are telecommunication meaning net providing and transmission from telecommunication value chain, IT solution provider meaning production of hardware and software from IT industry value chain, and medical intermediaries and healthcare provider from medical industry value chain. The figure of u-Health value chain shows reconfiguration from the three value chains.

Wirts indicated this kind of reconfiguration focusing on media and communication industry convergence in 2001. Wirts said that industry specific value chains will be unbundled so that the core stages of each individual chain can be extracted and rebundled to a new value chain within the market that results from the media and communication industry convergence [1]. As like media and communication industry convergence, IT and medical industry convergence is expected to rebundle in order to create u-Health value chain with core stages of each individual chain.

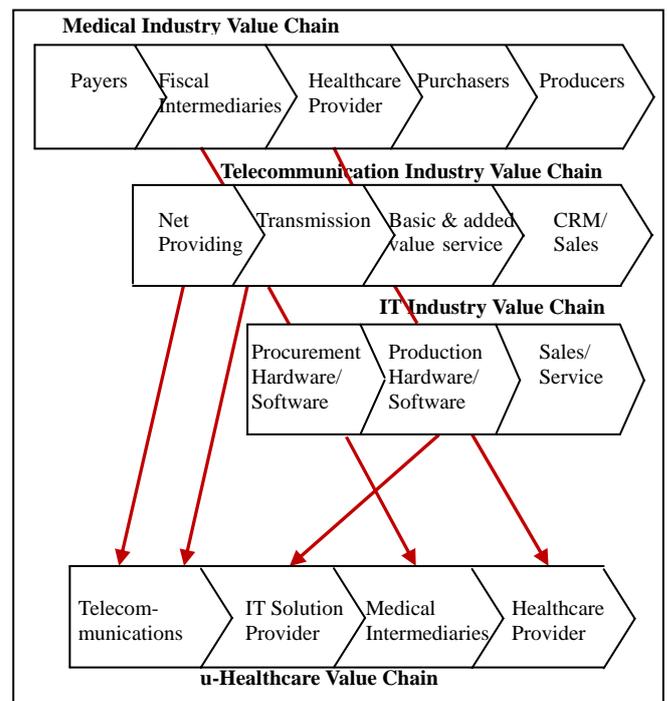


Figure 1 - Value chain reconfiguration

4.3 u-Healthcare System Diagram

The value chain which providing u-Health service composed with telecommunications, medical solution provider based on IT, medical intermediaries, and healthcare provider. And participants' cooperation is expected to be a fundamental base for innovative development of u-Health service and industries [6].

u-Health service can be feasible when the external conditions are satisfied to realize u-Health service without barriers. These external conditions are institutional support

of medial law, convergence, ubiquitous environment, and user acceptance.

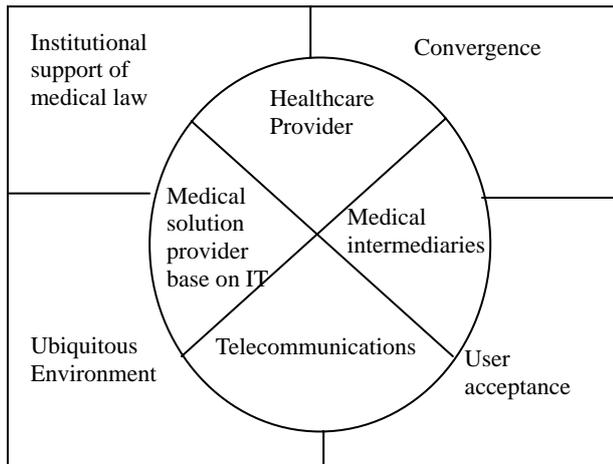


Figure 2 - u-Healthcare System Diagram

4.4 Typical u-Health Service Model

Personal Services – Healthcare Type

1) **Chronic Disease Management Service:** Customer measures blood sugar, fat, pulse, blood pressure, or respiration using remote measuring instrument by him/her and receive doctor’s advice through wire or wireless communication.

2) **Telemedicine Service:** Patient receives healthcare service by physician in doctor’s office for diagnosis or care. For this service physician provides healthcare service to the patient with a doctor in different hospital using medical equipments and wire or wireless communication.

3) **Emergency Service:** This is a new concept of medical service which is to rescue patient from the emergency situation by body signal monitoring system. For this case hospital and monitoring center receive body signal and find the location of patient with GPS then take patient to the hospital very quickly.

Personal Services – Wellness Type

1) **Personal Health Information Service:** This service is a free web-based platform enables patients to collect, store, and share health information with hospitals and physicians. Physician save patient’s test result and health information daily online and customer can access their health information through internet.

2) **Fitness Management Service:** Specialist provides training progress management service for losing weight and gives an advice to the customer on line based on exercise schedule check, health condition, and training menu.

3) **Health Consultation Service:** People can receive health consultation service using internet or wire and wireless communication equipment. People have conversation with a doctor or specialist as they are facing each other.

5. Research Methodology

5.1 Analytic Hierarchy Process

The Analytic Hierarchy Process developed by Thomas Saaty is a method for ranking decision alternatives and selecting the best one when the decision maker has multiple objectives, or criteria, on which to base the decision.

The AHP is about breaking a problem down and then aggregating the solutions of all the sub problems into a conclusion. It facilitates decision making by organizing perceptions, feelings, judgments, and memories into a framework that exhibits the forces that influence a decision. In the simple and most common case, the forces are arranged from the more general and less controllable to the more specific and controllable. The AHP is based on the innate human ability to make sound judgments about small problems. It has been applied a variety of decisions and planning project [2].

5.2 Criteria for Analytic Hierarchy Process

The following criteria extracted from attributes of innovation diffusion and adoption theory. We only take three attributes for AHP analysis and excluded observability and trialability from criteria since it has less weights than other criteria. And complexity (or ease of use) is also one of technology acceptance measures of Technology Acceptance Model.

1) **Relative Advantage** : is the degree to which an innovation is perceived as better than the idea it supersedes. The degree of relative advantage may be measured in economic terms, but social prestige factors, convenience, and satisfaction are also important factors [3].

2) **Compatibility** : is the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters. An idea that is incompatible with the values and norms of a social system will not be adopted as rapidly as an innovation that is compatible [3].

3) **Complexity** : is the degree to which an innovation is perceived as difficult to understand and use. Some innovations are readily comprehended by most members of a social system; others more complicated and are adopted more slowly [3].

5.3 Questionnaire

The questionnaire consisted of three parts, which are comparative explanations against present medical service and u-Health service as a future medical service, explanation of evaluation method, and evaluation. It was made on the basis of Analytical Hierarchy Process.

Questionnaires are distributed to 163 people living in Seoul and Busan including student in university and graduate school, company employee, house wife, and old people. Finally, however, 71 samples were selected with acceptable consistency ratio.

We accepted samples that its consistency ratio is under 0.1

and expanded by up to 0.2 according to Saaty's insertion. She explained that consistency ratio of 0.1 or less is positive evidence for informed judgment and consistency ratio of 0.2 is an acceptable judgment.

6. AHP Analysis

6.1 Analytical Hierarchy for Preference of u-Healthcare Service

An overall goal of this hierarchy is to find user preference of u-Healthcare service. First level represents criterions which are factors of innovation diffusion and adoption. Second level represents ubiquitous healthcare service types, which are sets with each service. While the set of Healthcare Type Service contains Chronic Disease Management, Telemedicine Service, and Emergency Service, the set of Wellness Type Service contains Personal Health Information Service, Fatness Management Service, and Health Consultation Service.

In this case participant needs judgment in the pairwise comparisons for each level. These tasks include the evaluation of criterions against overall objectives, healthcare service type against each criterion, u-healthcare services against healthcare type. When the eigenvalue of lowest level(u-healthcare service level) appears this process is completed only if consistency for each level is appropriate and this value represent the intensity of the participant's judgmental perception of the relative importance. Through this process we will obtain weight of Healthcare type and Wellness type, local and global weight of service for each type.

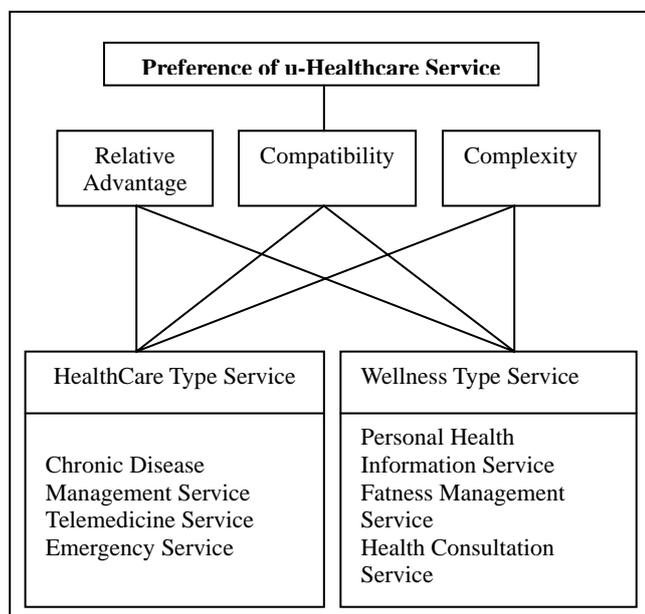


Figure 3 - Analytical Hierarchy for Preference of u-Healthcare Service

7. Findings

7.1 Customer Preference of u-Healthcare Service

According to the result from AHP analysis people prefer Wellness type services rather than Healthcare type service. The table of overall result illustrates each local weight and global weight of u-Health service type and services as well as preference of u-Health service type and services. From this result we can explain that many people hesitate to approach new medical service of Healthcare type but people can easily approach health service of Wellness type. The table of overall ranking shows that Emergency service has a high preference among the Healthcare type services and Health Consultation service has a high preference among the Wellness type services. Also Health Consultation service placed first among the entire services. In addition the table of comparison among the Criterions shows that people regard complexity as a most important factor of u-Health services.

Table 2 - Overall Result of AHP

Health Service Type	Service	Local weight	Local Service Ranking	Global weight	Global Service Ranking
Healthcare Type	Chronic Disease	0.320	2	0.130	5
	Telemedicine	0.251	3	0.111	6
	Emergency	0.432	1	0.205	3
Wellness Type	Health Information	0.367	2	0.207	2
	Fatness	0.243	3	0.134	4
	Consultation	0.396	1	0.216	1

Table 3 - Comparison among the Criterions

Criterion	Weight	Consistency ratio
Relative Advantage	0.22	0.085
Compatibility	0.37	
Complexity	0.41	

Table 4 - Comparison between Healthcare Type and Wellness Type against attributes of Innovation Adoption and Diffusion

u-Health Type	Relative Advantage	Compatibility	Complexity
Healthcare Type	0.552	0.493	0.438
Wellness Type	0.448	0.507	0.562

7.2 Result Analysis

As we observed the result above, Health Consultation service placed first among the entire services and Telemedicine services placed last. This result was contrary to our expectations. The technology of Healthcare type is

relatively higher than Wellness type and Healthcare type is more beneficial for our health than Wellness type. However people more likely prefer Wellness type service and the most favorite service is Health Consultation service. Why they prefer Wellness type more? The table of comparison among the criterions tells us the clue that compatibility and complexity are more important than relative advantage.

Relative Advantage

In the comparison between Healthcare type and Wellness type against Relative Advantage, a weight of Healthcare type is higher than Wellness type. Indeed Healthcare type has more benefit and advantage than conventional service. Although Healthcare type has relatively higher advantage, overall result shows people more prefer Wellness type. It means people think that compatibility and complexity are more important than relative advantage as the table of comparison among the criterions tells us. In addition to increase degree of relative advantage, telecommunications needs to extend bandwidth for safe and fast data transmission along with compact network security. And u-Health service solution provider needs to concentrate on user friendly design and simple and easy operation.

Compatibility

In the comparison between Healthcare type and Wellness type against compatibility, a weight of Wellness type is little more higher than Healthcare type. It means Wellness type services are more harmonious service for our daily life. Since Wellness type almost keeps conventional service style with high technological equipment, people may have less aversion for new service. In the case of Healthcare type, because it is more innovative service for both service process and medical equipment people may have more aversion. To increase degree of compatibility, government policy and medical law need to support u-Health service to be utilized to people. Also government needs to provide u-Health service, especially Healthcare service, to old people and low-income in order to people naturally accept innovative health service. Then the company who prepares u-Health business needs to develop and provide Wellness type service.

Complexity

In the comparison between Healthcare type and Wellness type against complexity, a weight of Wellness type is more higher than Healthcare type. It means people feel Wellness type is more easier and simple than Healthcare type. Indeed Healthcare type is more complex for both service process and operation. And it is required for people to know how to operate system. For increasing degree of complexity, healthcare provider needs to simplify service method and procedure to prevent confusion from the system. In addition health service solution provider base on IT needs effort to make easy and simple system.

Healthcare Type

In the result of comparison between Healthcare type and Wellness type against three attributes of innovation diffusion

and adoption theory, Healthcare type has more relative advantage but weights of compatibility and complexity are relatively low. It is analyzed that Healthcare type is more complex and innovative for both service method and procedure than conventional service and it brought relatively low compatibility and complexity. For the individual Healthcare type service, chronic disease management service is more convenient than conventional service but it requires installation of complex system at home and knowledge about new system. That is why it placed second in the local ranking, fifth in the global ranking. Telemedicine service is more innovative medical service than conventional face-to-face service process. People can receive diagnosis and care from the physicians who is in distant site through high technological medical equipment. As a result, however, people are reluctant to accept telemedicine service. It placed third in the local ranking, sixth in the global ranking. For emergency service, it is safe and fast medical service to rescue patient with high technological equipment. That is why it placed first in the local ranking, third in the global ranking.

Wellness Type

In the result of comparison between Healthcare type and Wellness type against three attributes of innovation diffusion and adoption theory, Wellness type has less relative advantage but weights of compatibility and complexity are relatively higher than Healthcare type. And overall result shows that people more likely prefer Wellness type. We analyze that since people regard compatibility and complexity as more important factor for accepting new health service than relative advantage it brought this result. For the individual service of Wellness type, health information service is very convenient and useful inquiry system for health information but it is not legally admitted yet. It may affect customer preference. It placed second in the local ranking, also second in the global ranking. Fitness service is a harmonious system with easy approach but the demand of customer looks low. It placed third in the local ranking, fourth in the global ranking. For health consultation service it placed first in the local ranking, also first in the global ranking. It is analyzed that the method of health consultation and the operation of equipment are easier than other services and it has similar style to conventional way as well as less limitation compare with other service.

7.3 Implication

Here we analyze u-Healthcare service model based on drivers of industry convergence by Wirtz [1] which are deregulation of markets, technological innovations, and change of user preference. Through overall analysis various propositions are captured from the result of AHP analysis and various literatures related to u-Healthcare. We expect that these propositions will contribute to provide useful insight for further research.

Deregulation of markets

Proposition 1: Business using medical information or

medical service needs to be legally admitted so that physicians can perform in the diverse fields and medical expert can be cultivated.

Proposition 2: Medical information standardization will create synergy effect between subjects of value chain enabling harmonious communication.

Proposition 3: Construction of standard u-Health service platform will contribute to develop related technology together and promote enterprise participation.

Proposition 4: Government needs to absorb Healthcare type services into public health insurance to provide u-Health service to people who is an old, low-income, and living in distant site.

Technological innovations

Proposition 5: Creating effective medical equipment needs to consider user's experience with computer or related technology, as well as their health literacy and limited capability.

Proposition 6: Considering technology acceptance, ease of use affects customer's acceptance and perceived usefulness affects physician's acceptance.

Proposition 7: The role of telecommunications is very important since it connects health service provider and customer. Also this is a main subject to realize u-Health service.

Change of user preference

Proposition 8: Strategy of u-Health service should be different by customer's characteristics.

Proposition 9: The companies preparing u-Health service business needs to create and develop new Wellness type services for customer who want to keep healthy.

Proposition 10: After Wellness type services diffused to our society, it will be easy for customer to accept Healthcare type services.

8. Conclusion

As we discussed in this paper, u-Health service derived from convergence between information technology industry and medical industry along with ubiquitous environment. Although different terms of u-Healthcare like e-Health, mobile health, telemedicine, telecare, telehealth, and remote healthcare are more likely used in Europe and U.S.A than u-Healthcare, we distinguish u-Healthcare from these terms. We insist u-Healthcare is a connecting physical space, meaning health service provider and patients, and electronic space, meaning high quality medical technology, under ubiquitous environment including functions of these terms.

We investigated current status of u-Health service and classified current u-Health service and conceptual u-Health service through extant literatures in order to suggest typical u-Health service model. Also survey was involved to research customer preference and acceptance using Analytical Hierarchy Process with the theory of planned behavior. Criteria of AHP, which are relative advantage, Compatibility, and Complexity (or ease of use)

extracted from attributes of innovation diffusion and adoption theory and Technology Acceptance Model. These were used for AHP pairwise comparison as criteria to select favorite u-Health service which is innovative and acceptable.

The result showed that people prefer Wellness type service more than Healthcare type service although relative advantage and benefit of Healthcare type are higher than Wellness type. Also favorite service was a Health consultation service and least favorite was a Telemedicine service. It means people are reluctant to try risky and unsafe new health service. On the contrary people have an intention to receive Wellness type services, which have good compatibility and complexity. Here we suggest to government and IT industry that the Healthcare type services like chronic, telemedicine and emergency service need to be operated by public health insurance for social welfare and IT industry needs to create and develop new Wellness type services for customer.

Recomposed value chain of u-Healthcare was extracted from each value chain of IT industry, telecommunications, and medical industry. And these are telecommunications, medical solution provider based on IT, medical intermediaries, and healthcare provider, which are core stages of each individual chain. The role of telecommunications, especially, became predominant factor of u-Healthcare service since it connects health service provider and patients and supports data transmission among the subjects of value chain. We suggest when the supports from subjects of value chain is sufficient and external conditions, which are institutional support of medial law, convergence, ubiquitous environment, and user acceptance, are satisfied, u-Health service can be feasible to realize u-Health service without barriers.

Additionally, we captured 10 propositions through this study related to government policy, medical law, ubiquitous technology, and user acceptance. We expect that it will give meaningful implication to the industry and useful insight for further research.

In conclusion there is one thing we need to concern. Ubiquitous environment should be healthy environment. However it is not clear that u-Health equipments including RFID or wire and wireless communication are not harmful for human and nature. We propose that further studies need to verify harmless of ubiquitous technology and environment before real ubiquitous age comes.

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