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Drivers of eHealth Adoption: Linking eHealth Adoption to Service Concept

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ABSTRACT

Researchers and practitioners are keenly interested in understanding what drives eHealth adoption in recent years. This is largely because, while eHealth can lead to cost-effective and quality health care, the actual adoption rate of eHealth remains low across countries. In prior literature, it was clearly indicated that well-designed eHealth services are critical to eHealth adoption. In this study, our findings further show that, what may motivate patients' adoption is more strongly associated with the design of eHealth caring service, and the design of eHealth IT service is more likely to be associated with patients' continual use.

***Keywords*:** e-Health, service concept, caring service portfolio, IT service portfolio, initial adoption, continual use

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INTRODUCTION

"eHealth is the use of information and communication technologies for health" (World Health Organization, 2015). In other words, eHealth is mainly focused on the health care service and health information service that are delivered or enhanced through information and communication technologies, such as the Internet or telecommunication (Eysenbach, 2001). Convinced that eHealth may enable a quality health care with lower cost, many countries and their governments have increased their spending for promoting eHealth. However, actual adoption of eHealth is still very limited across countries. Thus, researchers and practitioners are keenly interested in understanding what drives a sustainable eHealth adoption.

Prior literature has shown that well-designed eHealth services are very crucial to eHealth adoption (Tsiknakis & Kouroubali, 2009; Goldstein *et al.*, 2002). Designing eHealth services is not a trivial task. The factors that organizations need to consider in designing eHealth offerings involve both of IT options and care options. In other words, designing eHealth services means determining an appropriate mix of IT and care service components. According to one well-established principle in service industry, people adopt a service only when they perceive the value from the consistent components in the service, i.e., the "service concept" (Goldstein *et al.*, 2002). This denotes that eHealth adoption is mainly due to the perceived value from IT, or from care service offerings. Among the studies of eHealth adoption, there are basically two parallel streams of research directions. One stream is focused on only IT components, such health IT (HIT) (Rajiv & Tan, 2016), while the other stream considers only healthcare components (Dort, 2015). In this study, we thus have the following research questions.

Research Question 1: Do customers treat IT and care service offerings equally when adopting eHealth?
Research Question 2: If not, how can eHealth organizations (i.e., eHealth service providers) make the right mix of IT and care components in their eHealth offerings?

In this study, we seek to answer such questions from a perspective of portfolio management. According to one main implication in Modern Portfolio Theory (MPT) (Markowitz, 1991) management aims to help maintain the most suitable set of investment targets, rather than a set of the best investment targets, under uncertainty (Markowitz, 1991). We thus propose to view the overall eHealth offerings by an eHealth organization (e.g., a hospital) as a portfolio. In other words, the portfolio is an aggregate management unit, referring to a set of eHealth elements which a hospital must have in order to provide healthcare services remotely and electronically. Grounded in the perspective of service concept, we further classify these elements into two sub sets: eHealth care and IT service components. Whereas *care service components* depict *what* care options are available to improve customers' health conditions, *IT service components* characterize *how* these care options should be implemented and delivered via a range of IT solutions. In this paper, we adopted a user-oriented perspective to define quality eHealth portfolio. Moreover, the constantly-optimal portfolio rarely exists in practice. Thus, for example, funding managers have to adjust their recommending portfolio compositions contingently. This denotes that, the portfolio composition of eHealth for maximally satisfying customers' needs would vary with different contexts.

RESEARCH BACKGROUNDS

The Concept of IT and Care Components in eHealth

In this study, we view the overall eHealth offerings by a hospital as a portfolio to manage. In other words, the portfolio is an aggregate management unit, referring to a set of eHealth elements which a hospital must have in order to provide healthcare services remotely and electronically. We further classify these elements into two sub sets. One is the set of eHealth care service

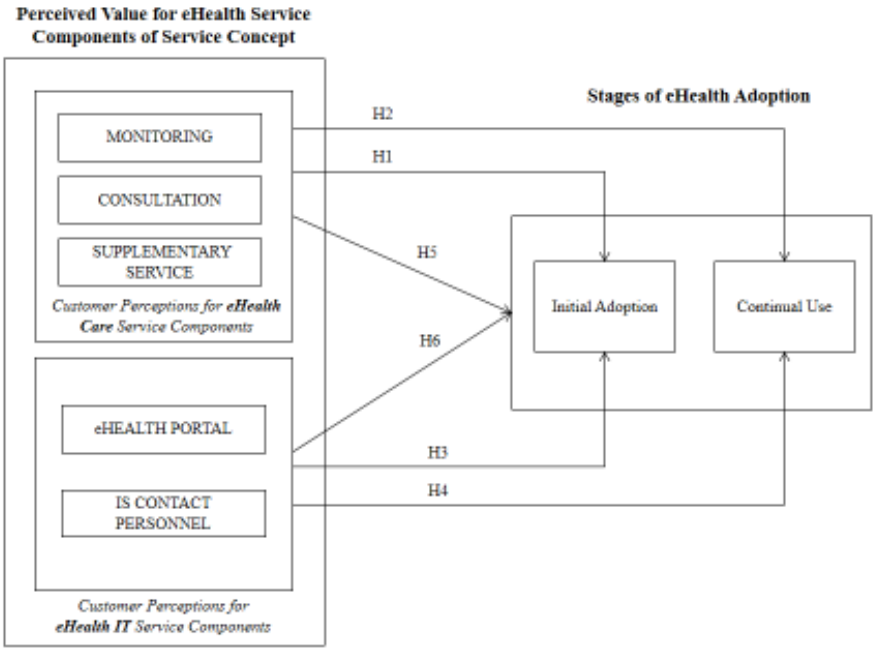
components, and the other one is eHealth care IT service components. For example, the content components may include monitoring, consultation, or other supplementary activities. The service components may contain eHealth web portal, IS supporting personnel, biotelemetry device, emergency-aiding device, and localization device. Briefly stated, an eHealth portfolio is a mix of the components of eHealth care service and IT service.

We propose that a quality eHealth portfolio can be determined by the balance of eHealth care service and IT components across pre-adoption phrase and post-adoption phrase. According to one main implication in Modern Portfolio Theory (MPT) (Markowitz, 1959), portfolio management aims to help maintain the most suitable set of investment targets, rather than a set of the best investment targets, under uncertainty.

The Service Concept

Service industry including operations and marketing generally uses two fundamental concepts to define a service: core service (what is delivered) and peripheral service (how it is delivered) (Anderson, 2008; Richard & Stewart, 1994; McDougall & Levesque, 2000). Core service is the service we think of when we name the service. Peripheral service refers to the supplementary matters for sustaining the core service. In this study, peripheral service can be subdivided further into IS Portal (Chase & Stewart, 1994; Bitner, 1990) and IS Contact Personnel (Chase & Stewart, 1994; Ken, 2003) component. Their physical attributes include environmental, mechanical, and inanimate components of the service delivery. Their interactional attributes include all of the interpersonal encounters involved in the service delivery. Prior research have indicated that both core and peripheral components are positively associated with overall service quality and customer satisfaction (Chase & Stewart, 1994; Ken , 2003; Bitner, 1990; Ken, 2005). Based on this service concept, the service components of telecare center in ChuShang Show Chwan Hospital also divided into core service component and peripheral service component.

RESEARCH FRAMEWORK



H1. Patients who perceive greater value in non-IS service components are more likely to adopt eHealth service
H2. Patients who perceive greater value in non-IS service components are more likely to adopt eHealth service
H3. Patients who perceive greater value in IS service components are more likely to continual use eHealth service
H4. Patients who perceive greater value in IS service components are more likely to continual use eHealth service
H5. Non-IS service components are more positively related to initial adoption than to continual use of eHealth service
H6. IS service components are more positively related to continual use than to initial adoption of eHealth service

REASERCH METHODOLOGY

Our main research site is Chushang Show Chwan Hospital Telecare Center. Our research data is collected by using questionnaires with Likert 5 point agree/disagree, multiple choices and some open questions. Chu Shang Show Chwan Hospital is the sole rural community hospital in Taiwan since the elderly population and mountain terrain besides its compatible medical center scale. This hospital has more than 5,000 employees and over 3,500 sickbeds. The telecare center of Chu Shang Show Chwan Hospital was established in 2007. The longitudinal physical health care aimed at developing Community-based, Home-based, Mobile-based Telecare service model which help patients develop self-health management.

Our target patient segment includes chronic disease care and cardiovascular disease care. There are five service divisions which divided into core, supplementary and peripheral service components (Table 1).

Table 1 Service Category & Service Items

	Telecare Service System of Chu Shuan Show Chuan Hospital				
	Integrating life, medical, and long-term caring to offer seamless interactions with remote patients				
Service Category	Cardiovascular disease care service	Chronic disease care service	Hospice care service	Post-discharge care service	
Service Items					
Construct	**Abbrev**	**Definitions**			
Monitoring	M1	Set up community-based physical recording & monitoring system; health examiners provide continuous, automatic and remote monitoring			
	M2	Set up community-based physical recording & monitoring system; health examiners provide face to face consultation during office hour			
	M3	Set up home-based physical recording & monitoring system;health examiners provide continuer, automatic and remote monitoring			
	M4	Health examiner provide individual home visiting and physical recording			
Consultation	Con1	Set up 24hrs telecare center, provide you the 24hr telecare consultation and telephone access service			
	Con2	The health examiner call you regularly and provide remote healthcare education			
	Con3	Health examiner provide the service of pharmaceutical consultation through home visiting or audio/video consultation			
	Con4	Provide you and your family health consultation through connected assigned drugstores and clinics			
Supple-mentary	Supp1	Help hospital patients scheduling & registration			
	Supp2	Help patients hospitalization, inter-hospital transfer and transfer to another hospital			
	Supp3	Help on the emergency ambulance arrangement from hospital or 911 ambulance			
	Supp4	Health examiners visit you while you are in emergency room or during hospitalization			
IS Portal	ISP1	I think the care service platform allows me to easily record personal physiological values (blood pressure, blood sugar, etc.)			
	ISP2	I think using the care service platform makes it easier for me to control my physical condition (physiological values)			
	ISP3	I think the use of care services platform to let me know and get more information related to the disease			
	ISP4	I think using the care service platform can improve my measurement habits			
IS Contact-Personnel	InterA1	Professionalism of the health examiner service			
	InterA2	Timely response from health examiner			
	InterA3	The friendly service of the health examiner			

In Chushang Show Chwan Hospital, there are 11 community-based telecare center where physicians help patients uploading their biometric information.~ the use of RFID card (An Xin card) to read the basic information can immediately use the blood pressure, blood sugar, heart rate, body temperature and body weight of the physiological parameters of the measurement, through the network transmission to telecare center, remote care platform will directly interpret the physiological parameters of the value is abnormal, the physicians through the platform immediately phone patients give professional health education and advice, but also linked to the hospital HIS system, to provide medical reference to provide continuity and integration of the telecare services. Home-based telecare service help on greater than 65 years old people in the village, poor mobility, far from the center of the event, and suffering from multiple chronic diseases (high blood pressure, diabetes), to provide home-based physiological measurement service process: the installation of home-based physiological measurement services → teach Public use → daily measurement of blood pressure and blood glucose levels → through the GPRS transmission to the remote care service center health care and management: health management through the remote care service platform to monitor the public physiological parameters, and according to the hospital set the physiological measurement abnormalities Management SOP for health education, electric visits, home visits services (Figure 1 and 2).

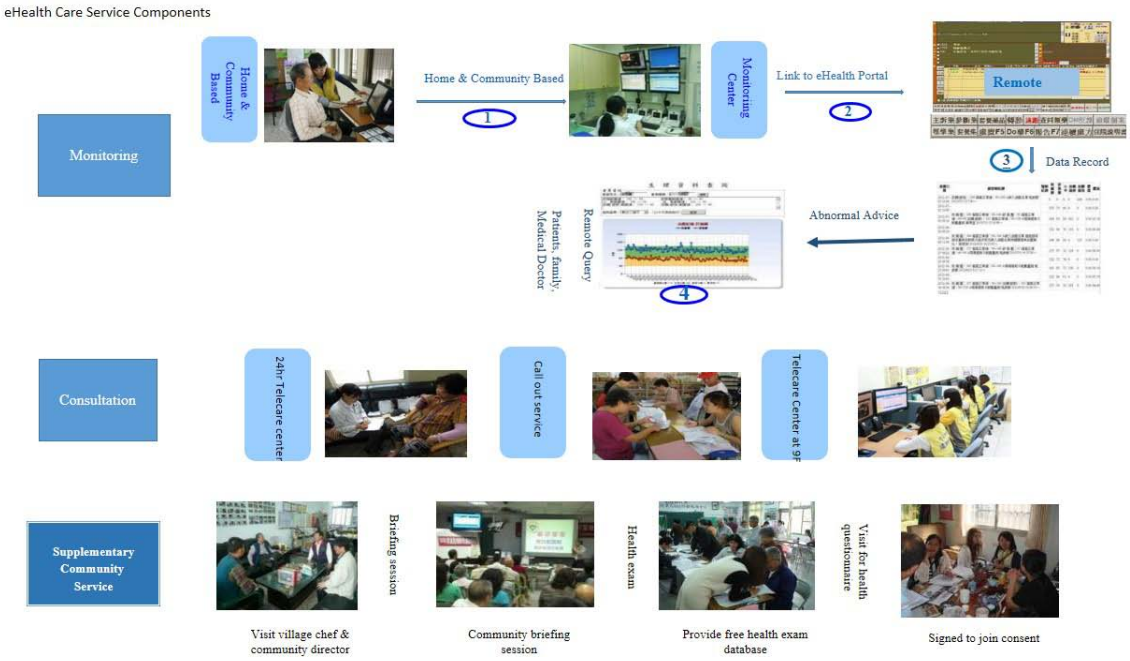


Figure 1

Figure 2

DATA ANALYSIS

To empirically assess the constructs theorized above, we conducted confirmatory factor analysis using SPSS (Statistical Product & Service Solution).A loading of 0.707 and above was considered to be desirable and 0.5 and below was to be dropped (Hulland, 1999). The result shown in Table 2 demonstrates that the loadings of all items are larger than 56%, thus indicating the variance in the item share with the latent construct is higher than error variance. We next assessed convergent and discriminant validity. Based on the suggestion of Fornell and Larcker (1981), convergent validity can be examined by Cronbach's alpha, composite reliability, and average variance extracted (AVE). The result of our findings shows that all constructs with Cronbach's alpha and composite reliability are above 0.7, which meets Nunnally's (1978) guidelines. The AVE for the constructs is also over 0.5, indicating high internal consistency (see table 2). Discriminant validity has been measured by looking at cross-loadings and AVE.

The correlation pattern shown in table 3 demonstrates that each item's correlation with its own construct is greater than its correlation other constructs. Table 4 also show that the square root of the AVE for the defined construct is greater than its correlations with other latent constructs. The collective evidence suggests that the constructs demonstrate good measurement properties.

Table 2: Item reliability analysis (n = 816)

Factors	Items	Loadings	Reliability[a] (α)[b]	AVE (%)
Monitoring	M1	0.804	0.843	54%
	M2	0.802		
	M3	0.694		
	M4	0.626		
Consultation	Con1	0.565	0.881	50%
	Con2	0.613		
	Con3	0.836		
	Con4	0.776		
Supplementary	Supp1	0.796	0.892	60%
	Supp2	0.775		
	Supp3	0.808		
	Supp4	0.718		
IT Portal	ITP1	0.829	0.924	71%
	ITP2	0.854		
	ITP3	0.860		
	ITP4	0.820		
IS Contact Personnel	InterA1	0.806	0.905	67%
	InterA2	0.802		
	InterA3	0.847		

[a] Composite Reliability

[b] Cronbach's alpha

Table 3: Factor structure matrix of loadings and cross-loadings

	eHealth Care			eHealth IT	
	Component				
	Monitoring	Consultation	Supplementary	IT Portal	IS Contact Personnel
M1	**.804** [a]	.080	.294	.268	.068
M2	**.802**	.118	.280	.277	.082
M3	**.694**	.422	.061	.042	.151
M4	**.626**	.400	.216	.030	.166
Con1	.347	**.565**	.451	.146	.153
Con2	.293	**.613**	.427	.146	.104
Con3	.196	**.836**	.269	.084	.044
Con4	.161	**.776**	.328	.166	.092

Supp1	.250	.133	**.796**	.012	.192
Supp2	.154	.342	**.775**	.098	.140
Supp3	.145	.302	**.808**	.139	.132
Supp4	.225	.311	**.718**	.225	.094
ITP1	.170	.135	.077	**.829**	.177
ITP2	.144	.115	.082	**.854**	.225
ITP3	.131	.095	.108	**.860**	.264
ITP4	.097	.068	.165	**.820**	.326
InterA1	.113	.077	.226	.365	**.806**
InterA2	.130	.142	.087	.359	**.802**
InterA3	.128	.074	.196	.297	**.847**

[a] The bold values demonstrate each item's correlation with its own construct

Table 4: Correlations of constructs

Construct	Monitoring	Consultancy	Supplementary	IT Portal	IS Contact Personnel
M	**0.735** [a]				
Con	0.63	**0.706**			
Supp	0.566	0.714	**0.775**		
ITP	0.402	0.362	0.35	**0.841**	
InterA	0.382	0.371	0.415	0.634	**0.819**

[a] The bold values are the square roots of AVE for the defined constructs

Discriminant Function Analysis

The research model and hypotheses are analyzed using the discriminant function analysis (DA), an appropriate technology for classifying cases into the values of a categorical dependent, usually a dichotomy (Hair, 1995). The interpretation and application of DA is considerably similar to that in logistic regression analysis. However, DA is preferred when the populations are normal with identical covariance matrices since the DA has greater statistical power than logistic regression (Press and Wilson, 1978). Box's M test is conduced to test the assumption of the homogeneity of covariance matrices. The result indicates that the test is not significant ($p > 0.01$). Therefore, we conclude that the groups do not differ in their covariance matrices, thus meeting an assumption of DA (Table 5).

Discriminant analysis involves the following two steps: (1) an F test (Wilks' lambda) is used to test whether the discriminant model as a whole is significant, and (2) if the F test shows significance, independent variables are assessed to point our those that contribute significantly to the model. To analyze the data, two discriminant models are formed. The first model (i.e., Model 1) is to test hypotheses relating core, core-supplementary and peripheral elements to the symbolic adoption of eHealth service. The sample include eHealth client that have symbolically reject (SJ status; n = 216) and symbolically accept (SA status; n = 442 eHealth service. The total sample size is 653. The second model (i.e., Model 2) is to determine which service elements are important in discriminating adopters and continual user. The samples include clients that have adopted. However, this is working in progress paper, we are still linking to explore more.

Table 5: Summary of discriminant analysis

Independent variable	Model 1 : (dependable variable : adoption reject and adoption)				
	Standardized	Discriminant		Univariate	*P* level
	coefficient	loadings		*F* ratio	
	Value	Value	Rank	Value	Value
Monitoring	0.853	0.924	1	64.887	0.000
Consultancy	0.237	0.707	2	37.988	0.000
Supplementary	0.157	0.609	3	28.13	0.000
IT Portal	-0.147	0.150	4	1.719	0.190
IS Contact	-0.255	0.119	5	1.071	0.301
	Wilks' Lambda = 0.896; p = 0.000; Canonical R^2 = 0.104,				
	Chi-square = 71.571 ; df = 5 Box's M = 4.645 (p=0.031)				
Independent variable	Model 2 : (dependable variable : usage and continue used)				
	Standardized	Discriminant		Univariate	*P* level
	coefficient	loadings		*F* ratio	
	Value	Value	Rank	Value	Value
Monitoring	0.567	0.873	1	26.974	0.000
Consultancy	-0.112	0.655	4	15.180	0.000
Supplementary	0.463	0.792	2	22.217	0.000
IT Portal	-0.041	0.541	5	10.378	0.001
IS Contact	0.348	0.673	3	16.035	0.000
	Wilks' Lambda = 0.943; p = 0.000; Canonical R^2 = 0.057,				
	Chi-square = 34.241 ; df = 5 Box's M = 6.536 (p=0.011)				

RESEARCH CONTRIBUTIONS AND CONCLUDING REMARKS

In this study, our contributions are twofold. Based upon our assessment in extant IS literature, this study is one of the first to analyze eHealth service offerings at the portfolio level. In particular, we look into patients' ex-ante and post adoption phrases, and distinguish caring components from IT components in eHealth service. We are thus able to ascertain that which eHealth service components may weigh more at which adoption phrase. In prior literature, while several studies have provided great insight into electronic service design, most of them pertain to IT artifact or system design, such as the desired functionality in electronic government websites and electronic health records (Tan *et al.*, 2013; Rajiv & Tan, 2016). In addition, their focused outcomes were either in the pre-adoption phrase only or the post-adoption phrase only, instead of the comparison between the

two phrases. In this study, we show that, while either IT service or caring service components can both influence patients' adoption of eHealth service, their relative impacts differ. Specifically, what may motivate patients' adoption is more strongly associated with the design of eHealth caring service components. As for patients' continuous use of eHealth service, it is more likely to be associated with the design of IT service components. Therefore, this study is very complementary to prior literature and able to offer a solid foundation for future research in eHealth service design.

Relatedly, this study is complementary to a stream of telemedicine research by highlighting the importance of managing telemedicine offerings as an eHealth service portfolio. In prior literature, it was already implicitly suggested that there is no best telemedicine but only most suitable telemedicine, depending on patients' contexts or backgrounds (Miscione, 2007; Srivastava & Shainesh, 2015). In this study, we further suggest that telemedicine offerings can be further managed and classified as IT service components and caring service components. Telemedicine patients can be further managed and classified as pre-adoption users and post-adoptions users. More importantly, one key implication in our findings indicates that telemedicine offerings with more weights on medical IT service are more suitable for post-adoptions patients. On the contrary, if the offerings with more weights on medical caring service, they are more suitable for pre-adoptions patients.

In conclusion, while academics and practitioners both agree with the importance of promoting eHealth, prior studies barely addressed what can drive a sustainable use of eHealth. On one hand, many researches claimed that eHealth can lead to cost-effective and quality health care. On the other hand, it is a fact that, in practice, eHealth adoption rate remains low across countries. This study is hence very helpful in terms of bridging the gap between academics and practitioners.

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