Exploring innovation model and evolution of medical cloud service: A case study of Chung-Hwa Telecom

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***Abstract*-This study is a case study of Chung-Hwa Telecom. Based on a framework of cloud service, this study develops an innovation model of medical cloud services (MCS) and explores the evolution of the model. Through collecting the related secondary data of the case from 2002 to 2011 and in-depth interviews, this study has collected 274 events of service innovation. Each event is treated as an analysis unit. The findings are: 1) MCS innovations focus on CaaS, IaaS and PaaS, while SaaS and DaaS are insufficient; 2) MCS innovation evolution is from PaaS to IaaS; 3) The critical factors facilitating MCS concern infrastructure technology and network technology; 4) The quantity of both general and enterprise users served by MCS shows a U-type trend; the quantity of both government institutions and specific communities served by MCS shows an inverted U-type trend; the quantity of both education institutions and medical institutions served by MCS shows an increasing trend.**

Keywords- Medical cloud service, service innovation, cloud service, Chung-Hwa Telecom.

1 INTRODUCTION

Elderly population in Taiwan has more than 10% of total population. Elderly population is expected to be up to 30% in 2050. In 2000, Japan has been paid into the Tele-Medical project, which is the application of policies to promote the medical field including remote care and Tele-Medical applications. Furthermore, in 2009 mainland China has invested 850 billion yen (NT $ 4.2 trillion) to promote health care reform plan. These two countries integrated information and communication technology (ICT), health care ICT systems, and other medical information into key development projects. Remote, simplification and virtualization become the development trend of information software (wong, 2010). Through ICT, cloud services make enterprises rapidly develop new services and spread the services. Thus medical cloud services (MCS) become a potentially huge market. However, there were few studies concerning service innovation issues of medical cloud. Past studies related to the issues of cloud service, mainly focused on technology development and competitiveness of firms (*e.g.,* Edwards & Morris, 1999; Jingli *et al*., 2010; Thompson, 2000; Wolfgang, 2009), cloud service business model (*e.g.,* David, 2009; Federico & Stefano, 2010; Leimeister *et al*., 2010; Mario & Gernot, 2009), security and privacy (*e.g.,* Fujimoto, 2010; William, 2010) and cloud service application (*e.g.,* Feng, 2010; Samir & William, 2009). Knowing how to get the best out of the medical service and gaining access to healthcare facilities, particularly gaining information about illness are directly related to socio-economic status (Richards & Mc, 2000). Monitoring the outcomes of treatment and quantifying patients' functional status have assumed a prominent role in quality assurance programs (Spertus & Winder, 1994). This study aims to explore the innovation types and frequency distribution of MCS in Taiwan. In addition, this study focuses on the innovation evolution of MCS.

2 LITERATION REVIEW

2.1 Service innovation

Service innovation is the introduction of a new service product or an improvement of existing service products (Djellal & Gallouj, 2008). This includes all innovations involving changes in the characteristics of service products and in design of service. Service delivery innovation involves new or altered ways of delivering to clients (Schumpeter, 1989). This requires an ability on the part of service providers to identify and exploit heterogeneity in consumer demand. Opening a new market may depend on their being an unfulfilled consumer preference (Jacobidies & Winter, 2005). As the service sector continues to grow, over time new entrants are attracted, technologies change, and user needs are shifting. Continuous innovation efforts therefore become an imperative for incumbent service providers to reduce costs, enhance existing service quality, and to expand current service offerings to increase market share in existing markets or to enter new ones (Tether, 2003). As mentioned above, the service innovation research literature mainly on market demand, service design and development, service model design and

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government service policy. The research of exploring medical service innovation was little.

2.2 Cloud computing

Cloud computing delivers infrastructure, platform, and software as service (Armbrust *et al*., 2009). These services include software application, platform, database or infrastructure. Cloud computing can be classified into SaaS, PaaS and IaaS (Feng & Teng, 2010; Mell & Grance, 2009). Chen (2010) contended that cloud business models include medical cloud, education cloud, telecom cloud, financial cloud, manufacture cloud and logistics cloud. Business models include private cloud service, public cloud, common cloud and hybrid cloud (Mell & Grance, 2009). In addition, cloud services can be divided into five services including SaaS, PaaS, IaaS, DaaS and CaaS (Youseff et al., 2008). The development of intelligent network infrastructure and virtual resource allocation can be contributory to making a public and private cloud interaction (Mikkilineni & Sarathy, 2009). In sum, the study bases on the five cloud services, concerning SaaS, PaaS, IaaS, DaaS and CaaS, to explore MCS innovation model and evolution.

2.3 Medical cloud service

Social problems are worthy of paying attention. The policy obsession with need assessment has been prompted by a desire to reduce public expenditure, and this should not be detracted from the possibility of using need assessment, particularly that with community involvement, as a means of not only promoting good health but reducing inequalities in its distribution (Robinson & Elkan, 1996). Hospitals can be compared between practices and localities. Such data must be interpreted carefully, as demand and supply often have more influence on hospital usage than does need. Use of hospital service may not be a proxy for morbidity in the community (Harley & Jones, 1996). Resolving social and environmental issues remains an important issue in the era of ever-increasing medical technology (Hawe, 1996). Routine data from general practices can highlight needs that are dealt with in primary care (Wilkinson & Murray, 1998). The application of medical cloud goes to provide a new service (Chen, 2010). Through the appropriate network monitoring users can access and use shared resources anytime, including self-service requirements (Mell & Grance, 2009). In sum, the study is focused on exploring MCS innovation types provided by the research case.

3 METHOD

This study is an exploratory research. Chung-Hwa Telecom, one of the most famous cloud service firms in Taiwan, is selected as the subject. The method of data collection concerns secondary data from 2002 to 2011 in Digitimes database and in-depth interviews, official website of the case, related studies etc. Finally the study has collected 274 events of service innovations. Each event is treated as an analysis unit. Furthermore, the study bases on the framework of cloud service consisting of PaaS、IaaS、SaaS、CaaS and DaaS to analyze the collected data. The data analysis strategies include pattern matching, explanation building, time series and program logic model. The study was divided into three stages according to the critical development events of Department of Health of Taiwan.

Stage1: Stage of health service network

The plan of "E-Taiwan" was initiated from 2002. The main issue was information system and medical information network, including health service network.

Stage2: Stage of mobile health service

The plan of "M-Taiwan" was launched from 2005. The main issue was home-care services, including mobile medical service and home care.

Stage3: Stage of remote medical service

The plan of "U-Taiwan" was started from 2008. The main issue was geriatric and child care medical services, including remote medical, electronic cases and personal health information service.

4 RESEARCH FINDINGS

The study collected 274 service innovation events in Taiwan from 2002 to 2011. The induced results are shown in Table Ⅰ. The ranking of the five types of MCS is shown as follows: 1. 【D】CaaS has 126 events (45.99%); 2. 【B】 IaaS has 71 events (25.91%); 3.【A】 PaaS has 69 events (24.82%); 4.【E】DaaS has 9 events (3.28%); 5.【C】SaaS has no event (0%). In addition, there are 16 types of MCS classifications in this study. Observing Table I, the MCS above five percent have eight classifications. The classifications ranking the first (D4 MIS), second (D2 BNS) and fourth (D1 FNS) are categorized into CaaS. The classification ranking the third (B6 SP) belongs to IaaS. The classifications ranking from the fifth to eighth (A2 MMS, A4 RMS, A1 HMS and A3 IMS) are categorized into PaaS. Consequently this study derives the following finding:

【Finding 1】 MCS innovations focus on CaaS, IaaS and PaaS, while SaaS and DaaS are insufficient.

TABLE I EVENT DISTRIBUTION OF SERVICE INNOVATIONS OF MCS

Type		Classification	Freq.	Per.%	Rank
A PaaS	A1 HMS.	Hybrid Mobile Service	16	5.84%	7
	A2 MMS.	Mobile Medical Service	20	7.30%	5
	A3 IMS.	Instant Message Service	15	5.47%	8
	A4 RMS.	Remote Monitor Service	17	6.20%	6
B IaaS	B1 MHT.	Medical Hosting	10	3.65%	10
	B2 MHS.	Medical Host Service	12	4.38%	9
	B3 MIU.	Mobile Internet Unit	9	3.28%	11
	B4 IMP.	Instant Message Phone	2	0.73%	16
	B5 CP.	Customize Phone	8	2.92%	14
	B6 SP.	Smart Phone	30	10.95%	3
C SaaS		-	-	-	-
D CaaS	D1 FNS.	Fiber Network Service	24	8.76%	4
	D2 BNS.	Broadband Network Service	32	11.68%	2
	D3 PWS.	Publish Wireless Service	9	3.28%	11
	D4 MIS.	Mobile Internet Service	53	19.34%	1
	D5 HIS.	Hybrid Internet Service	8	2.92%	15
E DaaS			9	3.28%	11
	Total		274	100%	

Furthermore, the innovation evolution of the MCS model with different stages is shown in Figure Ⅰ and Table Ⅱ. Based on Figure Ⅰ, the MCS percentages in the three stages of 【A】PaaS are 30.77%, 31.18% and 14.56%. The evolution of PaaS shows a decline trend. In contrast, the MCS percentages in the three stages of 【B】IaaS are 15.38%, 15.05% and 43.69%. The evolution shows an increasing trend. MIC (2011) surveyed that IaaS is continuously increasing. Especially observing stage 3 in Table II, the ranking is described as follows: 1. 【B6】Smart phone (25.24%) shows a sharp rise from 3.23% to 25.24%; 2. 【B2】Medical host

service (9.71%) shows a sharp rise from 0% to 9.71%. On the other hand, 【A2】Mobile medical service shows a drop from 12.90 to 6.80%; 【A4】Remote monitor service shows a drop from 10.75% to 5.83%. Consequently this study derives the following finding:

【Finding 2】 MCS innovation evolution is from PaaS to IaaS.

Moreover, observing Figure Ⅰ, the MCS percentages in the three stages of 【D】 CaaS are 51.28%, 48.39% and 39.81%. The evolution of PaaS shows a decline trend. As mentioned above, the MCS percentages in the three stages of 【B】IaaS are 15.38%, 15.05% and 43.69%. The evolution shows an increasing trend. The reason may be related to network bandwidth and hence it influences transmission speed. An interview with a manager is: *"The infrastructure was called as IDC before. A storage space can let clients store data in computer. At that time, network bandwidth was smaller."* In addition, network technology drives mobile communication development. An interview with a senior engineer is: "*The improvement* of n*etwork infrastructure technology has an impact on MCS development."* Other researchers advocate that cloud technology development with enterprise depends on infrastructure environment (Edwards & Morris, 1999; Jingli, Ke *et al*., 2010; Thompson, 2000; Wolfgang *et al*., 2009). Consequently this study derives the following finding:

【Finding 3】The critical factors facilitating MCS concern infrastructure technology and network technology.

In this study, we also analyzed the users served by MCS. The served percentages of general users in the three stages are 66.23%, 58.89% and 71.57%. The service evolution of general users shows a U-type trend. The served percentages of hospital cooperation in the three stages are 15.58%, 6.67% and 11.76%. The service evolution of hospital cooperation shows a U-type trend. The served percentages of government institutions in the three stages are 3.90%, 11.11% and 1.96%. The service evolution of government institution shows an inverted U-type trend, where a sharp drop is from stage 2 to stage 3. The served percentages of users in specific fields or groups in the three stages are 10.39%, 13.33% and 1.96%. The service evolution of users in specific fields or groups shows an inverted U-type trend, where a sharp drop is from stage 2 to stage 3. The served percentages of international users in the three stages are 1.30%, 1.11% and 4.90%. The service evolution of international users shows an increasing trend. The served percentages of education institutions in the three stages are 0.00%, 6.67% and 5.88%. The service evolution of education institutions shows an increasing trend. The served percentages of medical institutions in the three stages are 0.00%, 6.67% and 5.88%. The service evolution of education institutions shows an increasing trend. In sum, this study derives the following finding:

【Finding 4】 The quantity of both general and enterprise users served by MCS shows a U-type trend; the quantity of both government institutions and specific communities served by MCS shows an inverted U-type trend; the quantity of both education institutions and medical institutions served by MCS shows an increasing trend.

TABLE Ⅱ: STAGE ANALYSIS OF MCS CLAFFICITATIONS

		Stage1			Stage2			Stage3		
CLF..	Trends	Vol.	Per.%	Rank	Vol.	Per.%	Rank	Vol.	Per.%	Rank
A PaaS										
A1 HMS.	Drop	10	12.82%	4	4	4.30%	8	2	1.94%	11
A2 MMS.	inverted U	1	1.28%	12	12	12.90%	2	7	6.80%	5
A3 IMS.	Drop	12	15.38%	3	3	3.23%	10	-	-	-
A4 RMS.	inverted U	1	1.28%	12	10	10.75%	3	6	5.83%	7
B IaaS										
B1 MHT.	U	5	6.41%	5	1	1.08%	14	4	3.88%	9
B2 MHS.	U	2	2.56%	8	-	-	-	10	9.71%	4
B3 MIU.	Rise	2	2.56%	8	2	2.15%	13	5	4.85%	8
B4 IMP.	Drop	2	2.56%	8	-	-	-	-	-	-
B5 CP.	inverted U	-	-	-	8	8.60%	6	-	-	-
B6 SP.	Rise	1	1.28%	12	3	3.23%	10	26	25.24%	1
C SaaS	-	-	-	-	-	-	-	-	-	-
D CaaS										
D1 FNS.	Rise	3	3.85%	7	9	9.68%	4	12	11.65%	3
D2 BNS.	Drop	16	20.51%	1	9	9.68%	4	7	6.80%	5
D3 PWS.	Drop	5	6.41%	5	3	3.23%	10	1	0.97%	13
D4 MIS.	inverted U	15	19.23%	2	20	21.51%	1	18	17.48%	2
D5 HIS.	inverted U	1	1.28%	12	4	4.30%	8	3	2.91%	10
E DaaS	inverted U	2	2.56%	8	5	5.38%	7	2	1.94%	11
Total		78	100%		93	100%		103	100%	

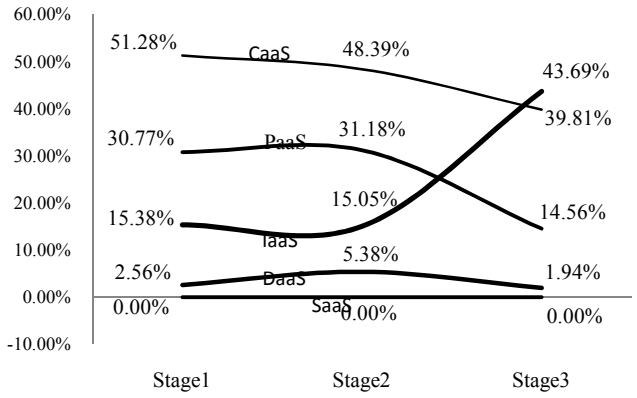

FIGURE Ⅰ: STAGE DISTRIBUTE OF SERVICE INNOVATION OF MCS

5 CONCLUSIONS

This study is a case study of Chung-Hwa Telecom (CHT). The study develops an innovation model of MCS and explores the evolution of the model. Finally, according on the findings, the study proposes some managerial implications.

As stated in Finding 1, it is obvious that complete network infrastructure and stable network environment as key factors of MCS (Mikkilineni & Sarathy, 2009). CHT should establish market-oriented MCS software and emphasize customer service and risk management (Rajkumar et al., 2009). CHT should also provide cloud diagnostic environment and SaaS service to strengthen the construction of industrial and other cloud services (MIC, 2011).

In Finding 2, evolution of the MCS is from PaaS to IaaS. PaaS places more emphasis on revenue in the data transmission. Along with the development of new network generation, MCS may focus on security and privacy protection (Fujimoto, 2010). However the upgrade of IT infrastructure is very expensive (George & Shyan, 2009). Therefore, CHT should not continuously invest IaaS and network technology. In contrast, CHT had better concentrate SaaS, such as to strengthen ability about security and privacy protection.

In Finding 3, the critical factors of MCS are infrastructure

and network technology. Cloud service through appropriate monitoring and virtualization technology makes users share resources and use in any time (Mell & Grance, 2009). Through "mobile service" by providers, industrial border has become increasingly blurred (Hirschorn & Gilmore, 1992). Therefore, CHT should develop integrated and value-added mobile services by utilizing itself advantages of fixed-line infrastructure and data communication.

Finally, Philip, Arun and Dan (2010) contended that in the initial stage of cloud services, service providers should understand what customers want. As stated in Finding 4, the U-type service evolution of general users may be the reason that the persons of living alone and the disadvantaged groups need more health care (Janz & Janevic, 2001). The increasing service evolution of medical institutions reveals one of significant implications of MCS. That is CHT should enhance software service for medical institutions based on IaaS advantages. The industrial advantage in Taiwan is hardware development, while software development was insufficient. Thus Taiwan government should construct and improve software environment and establish industrial policy by providing appropriate resources.

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