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## **Financing eHealth: Tsuji – Akematsu model revisited**

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### **Abstract**

Information and Communication Technology (ICT) plays an essential role in the provision of health care system, especially for the rapidly increasing ageing population all over the world. In line with this, eHealth helps a significant role in the overall management of this data in terms of potential gains in efficiency, financial savings, quality of care and patient safety. But implementation of eHealth requires huge amount of capital at the beginning and problematic to determine quantitative benefits. Determination of quantitative and non-quantitative benefits is essential to support financing eHealth for policy makers. Thus, the study aims to explore and develop an accurate financing model for eHealth using Tsuji – Akematsu Model so that both the economic and non-economic benefits can be identified. Initially eHealth implementation requires extensive amount of cost but long-term usage, increasing number of users can reduce costs and increase benefits. Although the benefit to cost ratio (B/C ratio) was estimated 0.25 or negative NPV in the model but if the services is promoted nationwide and more user use this service a positive NPV can be attainable.

**Keywords:** eHealth; finance, health expenditures, economic evaluation, Japan

### **1. Introduction**

Currently, health systems are an essential focus for leaders and policy makers of many countries. This fact reflects the availability of health services to the population using existing system and possibility to develop the current systems to Universal Health System (UHS) so that everyone can access to better health services. To reach UHS requires a country to adopt nationwide quality health services through implementing more hospitals, skill staffs, public awareness and so on. A quantitative description of current health system and to meet the expected system requires a new health model to be developed in which Information and Communication Technology (ICT) plays an essential role in the provision of health care system, especially for the rapidly increasing ageing population all over the world.

eHealth, an integrated system healthcare delivery that employs ICT as a substitute for face-to-face contact between medical staff and patient (ITU, 2014), helps a significant role in the overall management of this data in terms of potential gains in efficiency, financial savings, quality of care and patient safety. Many researchers note that the potential benefits of eHealth, but few take this beyond speculation, by measuring outputs or outcomes directly

linked to such investments (Michael, 2009, Vital Wave Consulting, 2009; World Bank, 2005). Micro view of the literature and case-specific evaluation of exiting technologies on health are seen on much of the literatures (Istepian and Lacal, 2003; Michael, 2009; Vital Wave Consulting, 2008,2009; Storetmann, Jones, Dovrev, and Stroetmann, 2006; World Bank, 2005). Some key economic and financial questions for eHealth policy and strategy investments, and a measurement and evaluation framework for the economic outcomes are outlined by Schweitzer, J., and Synowiec, C., 2012.

But implementation of eHealth requires huge amount of capital at the beginning and problematic to determine quantitative benefits. Determination of economic benefits is essential to support financing eHealth for policy makers. Economic and non-economic benefits are clearly determined and discussed in Tsuji-Akematsu model (Tsuji, M., 2001; Akematsu, Y., and Tsuji, M., 2009, 2010; Akematsu, Y., and Tsuji, M., 2012,2013). Thus, the study aims to explore and develop an accurate financing model for eHealth using existing literature on health care financing and reviewing Tsuji – Akematsu Model so that both the economic and non-economic benefits can be identified.

## **2. Background**

Tsuji-Akematsu model is conducted in Nishi-aizu town, located in Fukushima prefecture, Japan and attempted to demonstrate that telecare use reduces not only medical expenditure but also days of treatment/hospital visits for patients. Besides, an attempt has been initiated to determine benefit for the aging using the eHealth system. The study was conducted on 8,000 inhabitants consisting of 3,000 households and the percentage of the elderly was ( $\geq 65$  years) high. Two groups of panel data were surveyed, first; 2002 to 2006 and then 2007 to 2009.

In order to prevent chronic diseases such as cerebral infarction and stroke, the town office introduced e-Health in 1994 which is Japan's longest-running e-Health. 300 peripheral devices called “*Urara*,” manufactured by Nasa Corporation, were provided to residents who have symptoms of the above diseases. Each terminal is connected a host computer via PSTN (Public Switched Telephone Network), and health-related data of users, such as blood pressure, pulse, ECG, blood oxygen, weight and temperature are transmitted to a host computer. In 1996 and 1997, an additional 50 terminals each were purchased. These terminals use the CATV network for transmitting data. All costs of operating the system are paid by the town. In 2010, new peripheral device called “*Sauri*,” was introduced in accordance with the network renovation of CATV for optical fiber. Currently all network were transformed to optical fiber.

The section in charge of e-Health is the town office’s Department of Health and Welfare, which consists of seven public health nurses which represents a much larger ratio than in other towns. They check the above health data transmitted by users and if these nurses observe unusual data, they ask medical doctors in clinics to see the patient in question. The health data of each user are summarized in a “Monthly Report,” which is sent to a physician in charge. After a public health nurse adds their comments, the report is sent to the user. When the user sees a doctor, he/she is asked to bring the report with him/her.

e-Health is being operated as a part of the town’s “Project for Promoting Total Care,” and its essence lies in the close collaboration of health, medical and welfare activities. One

important example of this collaboration are “Regional Care Meetings,” which consist of doctors, nurses, public health nurses, staff of the town office, helpers of elderly people, and living advisers. The total number of participants in each meeting is over 20. Problems and treatments regarding a particular user, such as medical examinations, health advice, and care are discussed in detail. The health data of e-Health plays a role in this meeting. In Nishi-aizu Town, many such examples of exchanging information on residents can be found in the town office.

In addition, the town office organizes users’ meetings five times a year in order to enhance motivation to use e-Health, and users exchange their experiences with using the system. These activities promote usage of the system. The introduction of e-Health is not the sole factor promoting regional healthcare; rather, it should establish a framework for the system to assist all related sections and personnel.

Initially, Tsuji et al., (2001) describes whether social hospitalization of the aged using tele-home care based on multimedia can help in saving the cost of hospitalization of the aged in the future or not. The estimation carries in to two phases, first, the trends of the aged population and their hospital expenses using the regression analysis is estimated and second, new technology such as multimedia and new medical instruments developed in order to logistic curve is assumed. Then, the diffusion of CATV and ISDN are estimated using logistic curve. Their finding illustrates that USD 257.3 billion, or nearly 7.4% of total hospitalization costs of the aged can be saved using tele-home care by the year 2050.

The Model is developed and empirically tested on the residents of Nishi-aizu Town, Fukushima prefecture, Japan, from 2002 to 2010. Two sets of survey are conducted; first, from 2002 to 2006 and second, 2006 to 2010. Total of 1600 residents were sent questionnaire and 519 of valid respondents are used in the analysis. Thus, the primary data was collected through extensive survey of user and non-user and proved that eHealth usage can reduce burden of medical expenditure and ageing cost. Recommendations mainly made through empirical findings and special effect was determined on chronic disease such as heart disease, blood pressure, stroke, diabetes and so on. Besides, the Model suggests that JPY 12000 to JPY 20000 (up to USD 220) cost can be reduced who use eHealth services for one year. The cost of implementing eHealth is also considered in the analysis. In comparison with the cost and benefits, the study offers a financing model which aims to capture both quantitative and non-quantitative benefits especially for the economy who suffers extensive health divide and lack of ICT infrastructure.

### **3. Methodology**

For method, the paper intends to construct possible financing model for eHealth considering two sources; first, to review Tsuji-Akematus model and second, to review related works on health financing. Tsuji-Akematsu model develops an empirical model based on survey data and discusses both recurrent and non-recurrent costs and benefits for eHealth. The paper also attempts to review four financing models for health care; namely, the Beveridge model, the Bismarck model, the National Health Insurance model, and the Out-of-Pocket model that can be implemented for eHealth financing.

### 3.1 Revision of Tsuji-Akematsu Model

Tsuji-Akematsu model implemented regression analysis to assess whether eHealth reduces days of treatment and/or medical expenditures. Because of the endogenous explanatory variables the model employs system GMM which allows treatment of not only endogenous explanatory variables but also of the dynamic relationships among the variables that arise due to the chronic time-lagged effect of chronic diseases on patients (Minataki, K., Akematsu, Y., and Tsuji, M., 2011; Akematsu, Y., Tsuji, M., 2010, 2013).

In the estimation, the model employs dependent variables as 1) days of treatment of outpatients, all diseases, 2) medical expenditure for outpatients, all diseases, 3) days of treatment of outpatients, chronic diseases, and 4) medical expenditure for outpatients, chronic diseases. The objective of selecting the dependent variables is to determine both the recurrent and non-recurrent costs and benefits associated with the eHealth implementation. The telecare use (for user 1; and 0 otherwise), patients age, income, and the presence of any of the four main chronic diseases such as heart disease, hypertension, diabetes, and stroke (if treated 1, 0 otherwise) are selected as independent variable for the regression model. Total of 1600 (users 565; 1035 non-users) questionnaire were sent from year 2002 to year 2009 both to male and female respondents and 272 users and 247 non-users were selected as valid respondents. The selected diseases treated between 2002 to 2010 are illustrated in the following table

Table 1: Selected diseases treated between 2002 to 2010

	Users (%)		Non-users (%)		Total (%)	
	2002– 2006	2007– 2010	2002– 2006	2007– 2010	2002– 2006	2007– 2010
Heart disease	19 (0.21)	19 (0.21)	15 (0.13)	15 (0.13)	34 (0.16)	34 (0.16)
Hypertension	49 (0.54)	51 (0.56)	40 (0.34)	57 (0.48)	89 (0.43)	108 (0.52)
Diabetes	8 (0.09)	11 (0.12)	9 (0.08)	14 (0.12)	17 (0.08)	25 (0.12)
Stroke	5 (0.06)	8 (0.09)	7 (0.06)	9 (0.08)	12 (0.06)	17 (0.08)

Source: Akematsu, Y., Nitta, S., Morita, K., and Tsuji, M., 2013

The results obtained in the previous study based on survey data can be classified into two; first, the results obtained using OLS, system GMM and PSM from 2002 to 2006 and second, the results obtained considering long-term use of eHealth use, that is, from 2002 to 2010. The summary of the previous studies are demonstrated as follows:

Table 2: Previous results on five-year data from 2002 to 2006

	OLS <sup>1</sup>	System GMM <sup>2</sup>	PSM <sup>3</sup>
Medical expenditure	JPY 15,302 (US\$ 191.28)	-	JPY 25,538–39,936 (US\$ 319.23–499.20)
Days of treatment	1.6 days	2.0 days	2.6–4.0 days

Source: Akematsu, Y., Nitta, S., Morita, K., and Tsuji, M., 2013

Table3: Summary of results obtained from 2002 to 2010 (Long-term use of eHealth)

	OLS <sup>1</sup>	System GMM <sup>2</sup>
Medical expenditure	JPY 10,216 US\$93.17	JPY 64,944 US\$ 592.29
Days of treatment	-	4.44 days

Source: Akematsu, Y., Nitta, S., and Tsuji, M., 2013 and Taher, S. A., Uddin, K., and Tsuji, M., 2017

In table 2 and 3 summarizes the benefits of using eHealth for short-term and long-term user. Let us discuss the results as follows:

### 3.1.1 Savings of health costs

eHealth is increasingly viewed as a cost-effective method to deliver patient care and expand access (American Hospital Association, 2016). Health related costs in Japan especially for aging people are increasing sharply. In order to 2014 estimates, 33% of the Japanese population is above the age of 60, 25.9% are aged 65 or above, 12.5% are aged 75 or above (Japan Statistical Year Book, 2016). By 2050, it is expected that one in every three persons will 65 years or older (ILC, Japan). Aging and health costs are positively related. Two factors that increases the medical expenditures are critically evaluated by Hsu, M., and Yamada, T., (2013). Thus, while there will be large percentage of aging population in the country it will have remarkable health costs to be emerged. Long-term usage of eHealth can save up to JPY 64,944 (table 3) and if only aging population of Japan are considered as the potential patient for using eHealth, large amount of health expenditures can be saved. This is clear evidence of financial benefits that can be attained by using eHealth system in Japan. For chronic disease patient, cost of treatment is the largest burden because of long-term treatments.

### 3.1.2 Days of treatment/Hospital visits

For the short-term user, maximum 4.0 days while for the long-term user, 4.44 days can be reduced in order to the model. Reduction of treatment days means reduction of health costs too. The finding is important for the policy makers to rethink eHealth implementation nationwide. In a survey carried out by Health and Global Policy Institute in December 2016 (HGPI) reported that 58% of untreated patients believe that telemedicine could reduce the frequency of their hospital visits and make it easier to commit to continuous long-term treatments.

## 3.2 Revision of financing models for health care

Four financing models for healthcare are discusses as follows:

### 3.2.1 The Beveridge Model

In this model, health care is provided and financed by the government through tax payments and is called “socialize medicine” (Wallace, L. S., 2013). This model is currently found in UK, Spain, some Scandinavian countries and New Zealand. Government is the sole

controller of the whole financing system where a large percentage of hospitals and clinics are owned by the government including some doctors and nurses even the privately doctors they collect their fees from the government.

### 3.2.2 The Bismarck Model

The model is also called social insurance schemes (SIS) which uses an insurance system usually financed jointly by employees through payroll deduction. The model is developed not to make profit by providing health services to the user rather than a broad objective to universal health coverage of the country. This is a multi-payer model and Japan also uses this health care financing model for their economy.

Table 4: Comparison of healthcare financing models

	Financing	Providers	Cost	Benefit	Control	Coverage	Profit	Countries
The Beveridge model	Government (through tax)	Public	Strictly enforced	Implicit + Explicit	Government solely	Universal	Non-profit	UK, Scandinavia, Spain, New Zealand
The Bismarck model	Sickness fund, wages (employee and employer)	Public	Negotiated	Explicit	Monopsony	Universal	Non-profit	Germany, France, Belgium, Japan, Switzerland
The National Health Insurance model	Government run insurance into which every citizen pays	Private	Negotiated	Explicit	Monopsony	Universal	Non-profit	Canada, Taiwan, South Korea
The Our-of-Pocket model	Individual	Private	None	Explicit	None	The payer for service only	For profit	India, Bangladesh, Africa, China

Source: Authors

### 3.2.3 The National Health Insurance model

This is also call the mix financing model for healthcare services which has both the characteristics of Beveridge and Bismarck model. The health services are provided by private sector and payment comes from government-run insurance program that every citizen pays through a premium or tax. The system has low expense and administrative costs than American-style for profit insurance plans. The cost is controlled and administered by limiting the medical services the patient pay for or requiring patients wait to be treated. This model, in particular, finds in Canada while some newly industrialized economies like South Korea and Taiwan adopt this health financing system.

### *3.2.4 The Out-of-Pocket model*

Only few countries in the world adopt the tree models as discussed earlier. Most of the countries in all over the world adopt this Out-of-Pocket model for their health system. This is a profit making model and requires the patient to pay before the service consume. The model is best for the rich to get proper health care while the poor stay sick or die. Aging population needs to bear out-of-pocket costs since medical expenditures increases with age while the average out-of-pocket costs ratio estimated approximately 15% (Hsu, M., and Yamada, T., 2013).

## **4. Financing dilemma for eHealth**

Although the benefits that have been empirically identified in Tsuji-Akematsu model with the implementation of eHealth system in Nishiaizu town in Fukushima prefecture, the nationwide adoption of this service is still low. The low rate of adoption may be explained as; the challenges that arise in implementing the systems, the inability of providers to capture all of the financial returns of the eHealth, the possibility in the case of health insurance plans that the efficiencies they garner through the use of eHealth will benefit their competitors, and uncertainty about the value of the advantage to be gained from adopting a eHealth system and the evolution of laws affecting acquisition and financing (CBO, 2008). Reduction of hospitalization costs for elderly patient is discussed which is about US\$257.3 billion or 7.4% of total hospitalization costs (Tsuji, M., 2001), but there is no clear indication of costs of implementing the system. Besides, benefit to cost ratio (B/C ratio) is estimated 0.25 or negative NPV in the model in consideration with financial model, but if all explicit and implicit benefits can convert to numerical values and promote the service for last mile, a positive NPV can be attainable. The quantifiable and non-quantifiable benefits that are considered in the model are discussed as:

### *4.1 Quantitative and non-quantitative benefits*

Benefits refer to the effects that alternative interventions have on people's health (Bergmo, T.S., 2015). Days of treatment/hospital visits and hospitalization costs can be reduced using eHealth system which is empirically determined in the Tsuji-Akematsu model. These two benefits are clear to the patients as their financial benefits and can be converted into quantifiable benefits. First, each hospital visits require patient to pay attention to transportation costs and time. Besides, reduction of days of treatment potentially reduces hospitalization costs along with time. Other benefits such as the patient who have chronic diseases (heart diseases, high blood pressures, diabetes, and strokes) may get 24/7 medical services without visiting to the clinics or hospitals. This helps patient to pay more attention to their own health and ultimately reduces health related costs. To the health care provider, on the other hand, allows to work more effectively, determine the proper treatment quickly, and avoid mistakes. Doctors have less paper work to do and can share information securely and easily. Along with these quantifiable and non-quantifiable benefits there are some common benefits that are blood pressure and glucose levels control, cases of illness avoided, symptom free days, successful treatments, lives saved, and life of years gained (Bergmo, T.S., 2015)



## 5. The financing model

We propose government to collect direct tax from population to finance eHealth infrastructure at the beginning and operating costs during the system to be continued. This extra financing needs government to collect more tax from the population to adjust the health care expenditures. A possible reform in Universal Health Insurance (UHI) for the countries that adopt this policy and increase in tax burden may help to boost this expenditure (Hsu, M., and Yamada, T., 2013). The possible financing model for eHealth can be illustrated as follows:

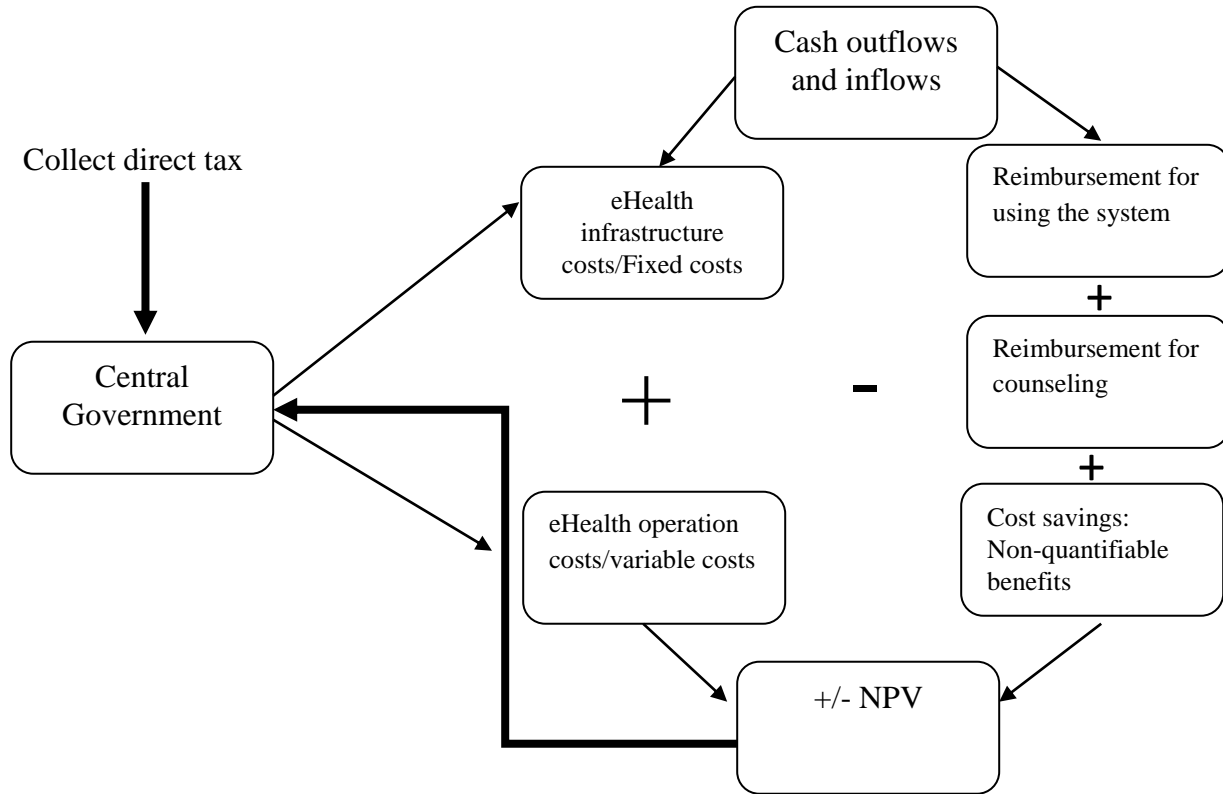


Figure1: eHealth financing model

## 6. Discussion

Health care financing schemes are financed either by contributions (public or private insurance) or by government direct/indirect taxes (Cichon, M., et al., 1999). Health financing involves the basic functions of collecting revenue, pooling resources, and purchasing goods (WHO, 2000) in which eHealth systems is not an exception. Complex interactions are involved among a range of stakeholders to perform these functions. Revenue collection is the way health systems raise money from households, business and external sources (World Bank, 2006). In the model, we propose revenue collection from those who use the system.

User payment can be segmented to two; first, monthly subscription fee, and, second, usage of the system for specific purposes. These two types of price given by the user are associated with the benefits receive by the user. User can pool risks of unpredictable health expenditure through regular monitoring of health, consulting with the doctors and checking the health records. Purchasing indicates financing to supply side or health care providers so that they can adopt the system.

Here, we discuss four financing models for health services (table 4). In Japan, the Bismarck model is used for health financing. The health system is financed through sickness fund, health insurance (government and private) and wages of the employees. The care is given both by the private and public hospitals and 70% health expenditures are reimbursed by government health program. For eHealth, however, the Beveridge model seems to be suitable since central government can finance through tax system and the price given by the user will automatically transfer to government fund. State-funded systems are suitable for most countries that have the administrative and economic capacity to raise taxes, establish an efficient network of providers, and the capacity the capacity to target the poor (World Bank, 2006). The Health Insurance System (HIS), can also be a solution for adopting eHealth system where the prospective user will be charged for using the system. It is difficult to implement Out-of-Pocket (OOP) model since user needs to “pay as you go”.

In the Tsuji-Akematsu model, local governments launch the eHealth system for a limited number of users. The financing is made through local government and private partnership like NTT communications. The cost of using the system for each user is not identified there. If costs of using the system could be identified, that would be transformed to the revenue sources and made a proper financing model for eHealth. But the benefits are quantified through statistical model and non-quantified benefits such as reduction of days of treatment and hospital visits are identified in the model.

## **7. Conclusion**

The challenges for eHealth implementation are revenue and cost determination. There is no available evidence based research to prove whether eHealth benefits user than the traditional health system or not. Besides, the legal framework to implement the service nationwide is still underway. Tsuji-Akematsu model first attempts to identify the quantitative and non-quantitative benefits for the user using econometric analysis. The model empirically tested among for 220 users from 2002 to 2010. The model ensures that JPY 64,944 can be saved per user for each year (table 3). If more user uses this system or even the system can be adopted nationwide, this savings will potentially reduce the health expenditures for government.

Another essential question for eHealth implementation is how the system will be financed? This emerges a point to the government to change existing financing policy in health care. Developed countries in the world implements the first three financing models (section 3) while the developing or the least developed countries exploit out-of-pocket financing model for health care. To reform the existing financing policy for both developed and developing countries need further research to discuss. In our paper, we discuss the quantitative and non-quantitative benefits empirically identified by Tusji-Akematsu model that encourages the policy makers to think freshly for financing eHealth.

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