

## The Factors that Affect Clinic Physicians' Usage Intention of Interoperable Electronic Health Records

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### Abstract

Taiwan has been actively promoting interoperable electronic health records (EHRs) for years. Physicians provide continuity of care by using patients' EHRs timely, and enhance the quality of care. In this study, we aim to explore the factors which affect clinic physicians' satisfaction of using EHRs, and further probe the intention to use and the relationship between satisfaction and use intention. We adapted information systems success model and government support and external pressure to develop a structured questionnaire. Our object is 1343 clinic physicians who has participated the project of Ministry of Health and Welfare. Totally 1066 questionnaires (71.07% response rate) were collected. The result shows that enhance using the information system of EHRs not only through government support to influence satisfaction and use intention, but also through external pressure. Moreover, the relation between satisfaction and use intention is modulate by government support and external pressures.

*Keywords: Physicians, usage intention, interoperable electronic health records, government support, external pressure*

### 1. Introduction

The traditional paper-based medical records using patient's name, birthday or phone numbers as an index to search patients' clinical information. It is not only to take a longer time to search the medical records, but also be a hard work to keep those documents. Then missed of the data in medical records or archive damages sometimes would cause treatment problem. Moreover, the paper-based medical records were stored in traditional way led to problems of medical information sharing such as diagnosis, drug, test reports etc. among hospitals and clinics, and it really limited patients to get continuous care.

With the development of information technology, United States and the United Kingdom, Australia and other countries are actively implementing an electronic health record (EHRs) systems in recent years. According to the Institute of Medicine (IOM) which is a United States medical research institute reported in 1999 that as many as 98,000 people died of medical errors every year in United States. But through the help of information technology, the mortality dropped to 55%. It can be seen that information technology can help and enhance the quality of health care. Compared to the EHRs with traditional paper medical records, it has reduced operating costs and storage space, and can integrate patient medical data between dispersed in various medical institutions. In addition, for medical institutions, EHRs not only has reduced the waste of medical resources, but also provided

greater continuity of health care for patient and the better quality of medical services.

In the beginning of 2010, Taiwan government implemented an accelerated plan to implement electronic health record systems at the hospitals. Hospitals were subsidized by government which had built electronic health record systems, and could be capable to exchange electronic health records among hospitals. With this kind of policy, government has promoted domestic hospitals and information industry which paid more concerns and efforts in implementing electronic health record systems in Taiwan.

At 2015, Ministry of Health and Welfare (MOHW) subsidized and supported 1500 primary care clinics through the project to implement electronic health records system for exchanging patients' medical records, and enabled clinic physicians to view discharge summary, hospitals' medication, exam, and radiology reports of their patients. This study try to evaluate the effectiveness of interoperable electronic health records system and explore the proposed model to understand the relationship between satisfaction and use intention.

### 2. Literature Review

#### 2.1 Interoperable Electronic Health Record

In hospital or clinic, the architecture of HIS systems were different, if the electronic health records want to reach the goal for exchange, each data must be generated an XML (eXtensible Markup Language) format file, than stored in the electronic

health records database. Use the private key to sign hospital electronic signature on XML file, and upload index of electronic health records and electronic signature which encrypted SSL (Secure Socket Layer) to the center of electronic health record. Last, the electronic health records would keep one in the electronic health record database in hospital and the other one upload to the center of electronic health record, let hospitals no matter located in anywhere would download electronic health record from center of electronic health record. (The Department of health of the Executive Yuan, 2003)

## 2.2 Information System Success Model

The factors influence the success of information system can be divided into several levels, Shannon and Weaver (1949) in the study defined that at technical level would according to accuracy and efficiency to produce the information, at semantic level is sending successfully meaning of message, and at validity level is effective in receiving messages. Mason (1978) redefine the effectiveness and influence, the influence usually occurs in the information system of the receiver, and it is often used to distinguish method at output level, than influence include message received and message evaluation and application, and influence the change of recipient's behavior and changes in system performance. (Cui, Y. et al., 2016) In 1992, DeLone and McLean according to the past study about information system, summed up the impact of six categories of information systems success and develop information systems success model.

After successful models of information systems is constantly being used, some scholars consider the quality of services should be included in information system success model to measure the quality. Pitt et al. (1995) observe when measuring system usually measure the product and ignore the service of systems. This is a very dangerous situation for information systems researcher. However, other scholars have the same kind of view, measurement of quality of service is also one of the factors leading to success. Later, scholars continue to research and verification service quality this dimension. Until 2003, DeLone and McLean collect and organize the scholars study to update the proposed of information system success model in 1992, update successful models of information systems research, and proposed a new information system success model.

According to the above theory and literature discussion, usually use system quality (System Quality), and information quality (Information Quality), and service quality (Service Quality) to be the effect elements, to measure user's system of satisfaction degrees. And in the DeLone's and McLean's information systems success model, satisfaction would affect use intention.

Therefore, based on the front of literature of reference and our situation, we propose the following hypothesis:

*H1: Information quality is positively affect satisfaction.*

*H2: Service quality is positively affect satisfaction.*

*H3: System quality is positively affect satisfaction.*

*H4: Satisfaction is positively affect usage intention.*

## 2.3 Government Support and External Pressure

The literature in the field of marketing, technology application is an important issue has been the core of the problem. New technologies are considered to be sources of economic growth in the market, and for the team, community, firm or country the impact of new technologies, have always been topics of interest to the market (Gatignon & Robertson, 1989). The adoption of new technologies can be divided into two factors, benefits of economic and changes of the external environment, many enterprises through the adoption of new technologies to enhance the capacity and gain a competitive advantage (Abrahamson & Rosenkopf, 1993).

The government support is that government provides grant to support the use of advanced technology, and be an important role in the governance and policy at the right time. To the use of new technologies, sometimes government put it, but sometimes impede the development of new technologies (Gurbaxani et al., 1990; Jarvenpaa & Leidner, 1998; Kraemer et al., 1992; Rose & Straub, 1998) For example: when the Chinese enterprises face the challenges of financial resources, the Government provides opportunities for new financial resources in a timely (Li & Atuahene LFAT Gima, 2002).

From social views, regardless of economic or culture of features, Government support will directly affect enterprise to use new technology. In China environment, height Government support, not only social but also economic would increase technology of perception of use and the benefits from new technology. Than from enterprise view, enterprise think technology of development is to promote national economic progress, Government policy for enterprise is useful and can assist technology development (Calantone et al., 2006).

Therefore, based on the front of literature we proposed the following hypothesis:

*H5: The Government support which links between satisfaction and usage intention.*

In previous studies mentioned that external pressure was assessment through five impact of information technology, five items include competition from other companies, social factors, dependence on other e-commerce companies, industries, and government (Chang & Cheung, 2001; Chwelos et al., 2001; Iacovou et al., 1995). Chau and Hui (2001) electronic data exchange (EDI) is a across organization system, for whole enterprise network who is the interests related is important, and used

this system will effect by Government, also effect by industry which including industry leader, commercial partners or competition opponents. Respectively to positive or negative way to effect enterprise, positive way contains promotions, technology and recommends, and negative way including pressure, and levy, and commercial partners of competition. Different from innovative information systems, exchange of electronic data can be business to business or business to Government, and if the situation is latter, the Government usually plays an important role on promote system use or use system.

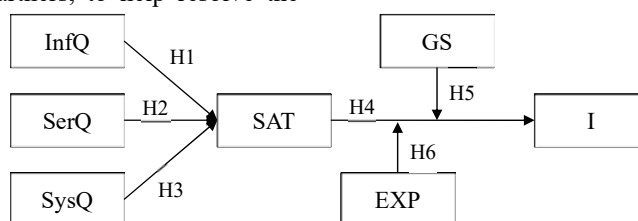
Influence of industry in the small business environment is very important, compared with large organizations, the small businesses with limited resources in the development of technology and knowledge base were limited, so small enterprises must rely on other partners, to help resolve the

problem (Hart & Saunders, 1997). Based on the front of literature we propose the following hypothesis:

*H6: The external pressure which links between satisfaction and usage intention.*

### 3. Methods

The research architecture that we examined was shown in Figure 1. It consisted of Information Quality, Service Quality, System Quality, Satisfaction, Usage Intention, Government support and External Pressure. This study aimed to explore the factors that affect Satisfaction, and affect the usage intention of information system of interoperable electronic health records. Whether Government support and External Pressure modulate the relationship between Satisfaction and Usage Intention as the moderators is also we try to find out.



Note:

InfQ : Information Quality ; SerQ : Service Quality ; SysQ : System Quality ; SAT : Satisfaction ; GS : Government support ; EXP : External Pressure ; I : Usage Intention

Figure 1: Research Framework

The questionnaire were referred from past related field of literatures and finally developed total 45 items. The questionnaire was measured on a Likert 5 point scale, from "strongly agree" to "strongly disagree". To ensure questionnaire items of quality and provide the measure of electronic records exchange information system in the full of views of field. We invited 5 specialists represented from medical field and information field to validate the questionnaire for testing the content validity.

This study collaborated with the clinics' information system service providers which delegated by MOHW's technology research plan in 2015, they offered clinic physicians' list and collected questionnaires for us. We also asked for the help from MOHW to promote clinic physicians to respond questionnaire. Although the cost for collecting questionnaire is high, the questionnaire recovery rate up to 71.07%.

#### 3.1 Descriptive Statistics

This study through the science and technology research project of the Ministry of Health and Welfare in 2015, cooperate with the vendor development of electronic health records system, to get the list of clinics have used the electronic health records system, and mail paper questionnaires to those clinics. Although the higher cost, the respondents were the representatives of the major

physician in clinics. However the questionnaires were done by major physician and assisted by project of the Ministry of Health and Welfare. So that the quality of response rate were enhance. The response rate of questionnaires in this study as high as 71.07%. The questionnaire in this study used five-point Likert scale to measure strongly agree to strongly disagree. This study totally receive 1066 responses, 93.2% of respondents are male, 26.5% of the respondents between 45 to 49 years old, most of the physicians graduation from college and seniority were more than 20 years.

#### 3.2 Validity and Reliability of Data

This study used Smart PLS analysis of statistical methods. Measurement mode analysis can assess reliability and validity, including convergent and discriminant validities. Three criteria for assessing convergent validity, first is the standardization factor weight must be greater than 0.5, followed by the combination of reliability (CR) must be higher than 0.7, finally, is the average amount of variation of extraction (AVE) to above 0.5, criteria for evaluating the results of this study are consistent with showing has the ability to assess the results of the questionnaire. (Fornell & Larcker, 1981)

Table 1: Instrument Reliability and Validity

	EXP	GS	I	InfQ	SAT	SerQ	SysQ
EXP	0.812						
GS	0.604	0.833					
I	0.644	0.595	0.812				
InfQ	0.593	0.592	0.629	0.831			
SAT	0.591	0.516	0.637	0.594	0.846		
SerQ	0.626	0.588	0.664	0.782	0.700	0.873	
SysQ	0.551	0.474	0.530	0.558	0.574	0.643	0.730
AVE	0.660	0.695	0.660	0.691	0.715	0.763	0.533
CR	0.853	0.872	0.853	0.899	0.883	0.906	0.771
R Square	-	-	0.550	-	0.520	-	-

Note:

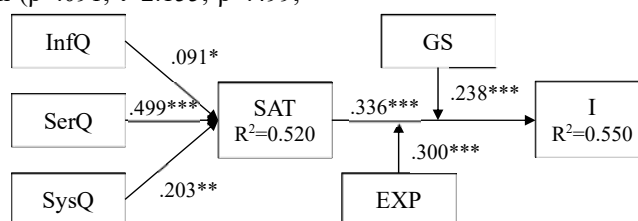
1. InfQ : Information Quality ; SerQ : Service Quality ; SysQ : System Q ; SAT : Satisfaction ; GS : Government support ; EXP : External Pressure ; I : Usage Intention

2. Values on the diagonal (in boldface) are the square of average variance extracted.

#### 4. Results

Partial Least Squares was used to assess this study model, the factors that affect the doctor used information system of interoperable electronic health records. Figure 1 demonstrates the test result of proposed model. The model showed that the variance explained 52.0% and 55.0% of the Satisfaction and Usage Intention. The system quality of information, service and system had a significant influence on Satisfaction ( $\beta=.091$ ,  $t=2.155$ ;  $\beta=.499$ ,

$t=8.854$ ;  $\beta=.203$ ,  $t=3.180$ ), then Hypothesis 1, 2 and 3 are supported. As hypothesized, Usage Intention ( $\beta=.336$ ,  $t=11.563$ ) is significantly influenced by Satisfaction. At last two modulating effects, Government support and External Pressure, had significantly modulated the relationship between Satisfaction and Usage Intention ( $\beta=.238$ ,  $t=8.001$ ;  $\beta=.300$ ,  $t=9.142$ ). Thus, Hypotheses 4, 5 and 6 are supported.



Note:

1.\*=  $p < 0.01$  ; \*\*=  $p < 0.05$  ; \*\*\*=  $p < 0.001$

2. InfQ : Information Quality ; SerQ : Service Quality ; SysQ : System Quality ; SAT : Satisfaction ; GS : Government support ; EXP : External Pressure ; I : Use Intention

Figure 2: Result of Data Analysis

#### 5. Discussion

##### 5.1 Theoretical Implication

One of the main purposes of this study is to explore factors that affect the information exchange of electronic medical records. We believe that the health care environment is quite different from the other business industries. Thus, the DeLone and McLean model of success as the foundation for this study needed to be modified to adapt and fit the environment of hospital information system. (Strudwick, 2015) Also, we found out that different environments and systems will affect users' intention and satisfaction.

This study has proved our hypothesis that the higher government support linked significantly between satisfaction and usage intention. (Premkumar & Bhattacharjee, 2008) In other words, the government support is a modulating effects between the satisfaction and use intention. It showed that government's support could be one of the positive factors affect the new technology. (Chen & Liu, 2013; Li X. et al., 2017) We believe that the interoperable EHRs system are not only the future of health care but they are also big challenges for Taiwan. Thus, the government has to play a leading role in defining policies and offering incentives to encourage health care organizations to engage in clinics and cross-hospital integrated health care.

Also, the higher external pressure linked strongly between satisfaction and use intention. Therefore, the external pressure was a modulating effects between the satisfaction and use intention.

### 5.2 Empirical Implication

In this study, we found that Information quality, Service quality and System quality positively affected users' satisfaction. Physicians' satisfaction positively affect their further usage intention. Therefore, the financial aids and technological supports for improving the quality of information system would be the main task for government to implement the interoperable EHRs program. Like health insurance reimbursements and health care accreditations could provide incentives for raising the usage intention of physicians. We believe that the interoperability and connectivity of EHRs are not only the future of health care but they are also big challenges around the globe. Thus, the government has to play a leading role in defining policies and offering incentives to encourage health care organizations to engage in cross-hospital integrated health care. Moreover, the regional medical groups or associations could share their usage experience to promote and encourage to use interoperable EHRs information system.

### 5.3 Research Limitation

The collecting samples in this study only represented for clinic physicians who has participated the project of Ministry of Health and Welfare. In addition, the interoperable EHRs program is still implementing in Taiwan and this study was limited by time and resources for exploring more related factors affected the adoption behavior in clinic physicians.

### Acknowledgments

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Attachment: Study questionnaire

Items	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
1. Interoperable EHRs system could provide me the recent information of patients.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Interoperable EHRs system could provide me the latest information of patients.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. The information from interoperable EHRs system always updates the latest.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Interoperable EHRs system could provide me complete information of patients.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Interoperable EHRs system could provide me various information of patients.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Interoperable EHRs system could provide me detail information of patients.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. The information from interoperable EHRs system can present well.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. The information from interoperable EHRs system can display well.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. The information from interoperable EHRs system can be read clearly.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Interoperable EHRs system could provide me correct information of patients.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. The information from interoperable EHRs system is correct and no error code.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12. Interoperable EHRs system could provide me precise information.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13. Interoperable EHRs system could provide me personalized information of patient.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14. Interoperable EHRs system could provide me the patient 's information what I want .	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15. Interoperable EHRs system could meet my unique requirement.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
16. Interoperable EHRs system could reach its commitment in time.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17. Interoperable EHRs system could respond my required service correctly.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18. Interoperable EHRs system provide reliable service.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19. I am confident that Interoperable EHRs system could help me diagnose the patient.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20. I don't worry when I use the Interoperable EHRs system.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
21. Interoperable EHRs system could respond my searching requirement.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
22. The operation of interoperable EHRs system won't be broken easily.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
23. Interoperable EHRs system could reliably reach its required task to search data.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
24. The stability of interoperable EHRs system is reliable.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
25. According my using experience, I am satisfied the interoperable EHRs system.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
26. I am satisfied the current interoperable EHRs system.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
27. I am satisfied the services which provide by the interoperable EHRs system.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
28. Interoperable EHRs system could provide me adequate patient's information for diagnosis.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
29. Interoperable EHRs system could enhance the communication between hospitals.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Items		Strongly disagree	Disagree	Neutral	Agree	Strongly agree
30.	Interoperable EHRs system could enhance the quality of patient care.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
31.	It is easy for me to access the information of interoperable EHRs system.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
32.	It is easy for me to learn how to get the information of interoperable EHRs system.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
33.	It is easy and clear for me to operate the interoperable EHRs system.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
34.	Ministry of Health and Welfare (MOHW) provide clear policy to implement interoperable EHRs system.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
35.	MOHW provide subsidies for implementing interoperable EHRs system.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
36.	MOHW continues to promote the interoperable EHRs system.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
37.	The adoption of the interoperable EHRs system could raise the competency of clinics.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
38.	Patients will ask physicians to use the interoperable EHRs system.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
39.	If other clinic physicians use the interoperable EHRs system would encourage to adopt it.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
40.	I would like to use the interoperable EHRs system continuously for the need of job.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
41.	I would like to use the interoperable EHRs system to review patients' information.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
42.	I would prefer to use the interoperable EHRs system to review patients' information.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
43.	Interoperable EHRs system could really reduce the medical errors.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
44.	Interoperable EHRs system could really accelerate the time of diagnosis and decision.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
45.	Interoperable EHRs system could really enhance the quality of patient care.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

