ABSTRACT
This study proposes an integrated research framework as a basis for further investigation of factors affecting the use of Health Information Exchange (HIE). A comprehensive literature review was conducted to propose an initial research framework and questionnaire. Then, the Delphi method was used to validate this initial framework and questionnaire. A total of nine factors were identified: 1) Information needed for patients' condition; 2) Quick access and save the data for subsequent use; 3) Utility of EMR Exchange; 4) Shorten Interrogation time; 5) Financial Incentives; 6) Perceived Usefulness; 7) Information Quality; 8) EMR exchange system characteristics; 9) Perceived Ease of Use.

KEYWORDS: EMR; EMR Exchange; Health Information Exchange

INTRODUCTION
Since 1995 over 99 percent of Taiwanese people are covered by the National Health Insurance Program (NHIP) which includes most medical treatments and related medicine costs with very low premium. The program, operated by the National Health Insurance Administration (NHIA) of Ministry of Health and Welfare (MOHW) provides equal access to quality healthcare. Thus, the goals of the NHIA are to provide good quality of medical services and avoid going bankruptcy at the first day it went to business.

Along with the rapid advances of Healthcare Information Technology (HIT), computerization of daily hospital activities including clinical and administration and digitalization of patients chart, can solve many problems of the traditional paper-based patient charts, and provide a variety of benefits. For instance, Hospital Information Systems (HIS), Picture Archiving and Communications Systems (PACS) and Electronic Medical Records (EMR) Systems are most widely adopted HIT in Taiwan at the present time. Furthermore, in order to improve medical quality and reduce the waste of medical resources, encouraging physicians to use Health Information Exchange (HIE) via EMR exchange has been promoted a lot by MOHW recently. It is assumed that the use of EMR exchange to proceed HIE by physicians not only can provide needed information for patients' condition from other medical institutions in time to support their routine practice, but also be able to reduce the waste of medical resources. To overcome the financial burden and to gain the benefits of adopting HIT, over the past
two-decade MOHW of Taiwan subsequently promote HIS and PACS and then promote EMR and EMR exchange. In addition, MOHW expect the people in Taiwan to have their complete medical history themselves and they can actively involve in their own health management and maintenance.

However, the expectation is not quite significant even when 90% of hospitals have claimed that EMR systems have been implemented. In fact rather than a full scale EMR all these hospitals have implemented only a partial part of EMR. From physicians perspectives content of these charts lack of sufficient evidence or studies to support its completeness or be able to meet clinical needs. There are only 4 charts (medical imaging and reports, blood test reports, outpatient medication records and discharge summary), officially announced by the MOHW are used for health information exchange (HIE) by EMR exchange center. There is no official data available regarding to the usage rates of these 4 charts, however many indirect evidences indicate that the usage of EMR exchange to deal with HIE has unable to meet the expectations during physicians’ routine clinical practices. Sometimes the physicians conduct clinical routines don’t prefer to use HIE, instead they advise for the same tests again. Additionally, the hospitals may not have a full-scale EMR system that has the proper functionality to exchange patients’ information. The clinical practice is one of the important factors to determine medical quality and the efficiencies of using medical resources. The use of EMR exchange to proceed HIE is able to facilitate the routine clinical practice by quickly providing important patients’ information from other medical institutes. The key users of EMR exchange are the physicians, who play a major role in providing medical treatments and also major coordinators in clinical activities (Anderson, 1997). Thus, to promote EMR exchange successfully it is important to understand the needs of physicians and their opinions about the EMR exchange. The purpose of this manuscript is to propose a research framework to identify factors affecting physicians’ intention to use EMR exchange.

THEORETICAL DEVELOPMENT/MODEL

In the area of Management Information Systems there are many researches have been conducted to understand what factor will determine the individuals to use information systems (IS), because the acceptance and use of IS by individuals is one of the key factors to determine the success of implementation of IS. Davis (1986) proposed the technology acceptance model (TAM), modification of Theory of Reasoned Action (TRA) to predict user acceptance of IS (Davis, 1986). Davis et al. (1989) developed and validated the mediating role of perceived ease of use and perceived usefulness with user acceptance (Davis et al., 2989). Davis et al. (1989) posits two particular beliefs, perceived usefulness and perceived ease of use of primary relevance for IS acceptance behavior (Davis et al., 1989). Using the TAM, Venkatesh & Morris (2000) identified a robust model integrating the subjective norms (Venkatesh & Davis, 2000). Furthermore, Venkatesh and Davis (2000) proposed a new version of TAM, TAM2 that includes 5 antecedents and two mediators (Venkatesh & Davis, 2000). Later in 2003, Venkatesh et al. (2003) proposed the Unified Theory of Acceptance and Use of Technology (UTAUT) model (Venkatesh et al., 2003) that provides a useful tool to measure the factors needing for new technology adoptions and helps to design the research framework for the users who may be reluctant to adopt the new technology. In terms of explanatory power, the study in Rejection of the Telephone Technology conducted by Aversano (2005) argued that TAM explains only 40% to 50% of technology acceptance, whereas TAM2, as pointed out by Davis, reaches 60% (Aversano, 2005; Venkatesh & Davis, 2000).

As Physicians are the major users of EMR so, the successful use of EMR systems depends on whether it can meet the immediate needs of physicians’ clinical routine practices (Guthrie, 2007). While trying to identifying the failure to use HIE by physicians in emergency room, a prior research indicates two major problems: more than 85% of respondents felt that is not
easy to obtain external information, where 72% said that half of the information exchange attempt fails (Shapiro et al., 2001). Anderson (1997) also argued that the physicians’ acceptance of EMR systems will determine the success of the implementation (Anderson, 1997). One prior study indicates that customized EMR systems have overwhelming demands by physicians (Gans et al., 2005). The selection and implementation of EMR required physicians’ participation both in strong leadership and managerial support (Morton, 2009). The data structures and formats, interface presentations and the contents of the EMR have to meet physicians’ need (Ginneken, 2009). Physicians’ believe that information quality is a key factor affecting the EMR exchange. Patients’ charts are the important source in both having the record of personnel engaged in medical practice, and also an important source of information assist in clinical decision-making. EMR is the digitalization of patients’ chart with time stamp and e-signature. EMR allows healthcare providers to access patients’ data on-line to assist in clinical decision making. The operating definition of EMR in this study is “health care providers when performing operations on patients to check the implementation of the consultation, medical diagnosis and treatment process conducted by the record, and after filling the electronic signature can be inter-agency exchange circulation the record.” The use of EMR exchange allows physicians to access patients’ information in other healthcare institutions to facilitate conducting the current clinical practices. The quality of the exchange information is crucial for their clinical decision-making. One prior study confirms this argument indicates that the quality of information exchanged is one of the main factors to determine the success of HIE from physicians perspective. Based on the above discussions an initial research framework was proposed with 4 independent factors related to HIT to predict physicians’ intention to use EMR exchange. They are: 1) Perceived Usefulness; 2) Perceived Ease of Use; 3) Information Quality; 4) EMR System Characteristics.

Table 1 Operational Definition of HIT Factors

<table>
<thead>
<tr>
<th>Factors</th>
<th>No. of items</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Perceived Usefulness</td>
<td>4</td>
<td>The degree to which a physician believes that using EMR exchange would improve medical quality and efficacy for this patient</td>
</tr>
<tr>
<td>2. Perceived Ease of Use</td>
<td>4</td>
<td>The degree to which a physician believes that using EMR exchange would be free of effort</td>
</tr>
<tr>
<td>3. Information Quality</td>
<td>10</td>
<td>The degree of quality of patients’ exchange data including contents, accuracy, completeness and format which a physician believes that using EMR exchange</td>
</tr>
<tr>
<td>4. EMR system Characteristics</td>
<td>10</td>
<td>The degree of functions of EMR systems which a physician believes that using EMR exchange platform needed</td>
</tr>
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</table>

According to the results of the literature review other related factors can be classified into two categories, one is related to financial incentives and the other one is related to the clinical practice of physicians. The factor of financial incentives is always one of the most important considerations to affect both organizations’ decision making and individuals’ intention. There are always two major considerations during developing of EMR systems and the use of EMR exchange. At the beginning hospitals need to invest a lot of capital to install EMR systems, after that hospitals need capital and manpower to continue the systems working properly. However, most hospital authority would not be interested to invest to develop a full scale EMR system without significant benefits. The other financial incentives for hospitals and physicians come from the subsidiary of government (Bates, 2005; Kumar & Aldrich, 2010;
Patel et al, 2011; Robinson et al., 2004). The amount of subsidiary may affect the hospitals' decision to implement EMR and the use of EMR exchange by physicians. Prior studies indicated that financial incentives might affect physicians' clinical behavior (Conrad et al., 2002; Meade et al., 2009; Melichar, 2009). So, financial incentives are assumed to be an important factor to physician's intention to use of EMR exchange.

The other Non-HIT factor is related to physicians’ clinical practices. For the purpose of increasing the uses of EMR exchange center, it must provide some useful information to physicians during their clinical routines. In other words, this information makes physicians believe that it can improve medical quality; otherwise physicians may not use EMR exchange. Information needed for clinical routine will differ with age; different age divisions generate large differences in the patient's condition. Therefore medical needs and factors affecting physician wishes of the exchange may be different. Prior studies of the successful implementation of IS indicate that the factor of meeting users' needs is the most important factor to determine the success of IS (Morton, 2009). In other words, the success of use of EMR exchange depends on how far it meets the user's needs. Clinical needs of physicians should be satisfied, as they are the key user of EMR exchange. But lack of training and insufficient computing literacy of physicians may be a barrier of using EMR exchange for physicians (Meadev et al., 2009; Vest et al., 2011). However, prior researches indicate that most of the physicians already have sufficient computing literacy and training, and also are experienced in HIS users (Shapiro et al., 2007).

There are many advantages of using HIE, including: reducing costs, improving medical quality (Fontaine et al., 2010; Wright et al., 2010), timely identification of a specific disease (Kho et al., 2008), reducing adverse drug cases, prevention of potential medical errors, improving medical safety and efficiency (Fontaine et al., 2010; Kaelber, & Bates, 2007), reducing time (Fontaine et al., 2010), avoiding duplication and improving the efficiency on collecting of clinical information and public health notification to the supervising authority (Patel et al., 2011; Robinson et al., 2004). It is assumed that utility of EMR exchange is an important factor to draw the attention of physicians.

While physicians conduct clinical practices both the needed information for patients' condition and the time for needed information are very crucial for better medical quality. The quicker to have needed information for patients’ condition in conducting clinical activities, the shorter time needed for physicians in making right diagnosis and proceed appropriate treatment. In Taiwan, HIS and PACS are used widely to diagnosis in time and to gain the better medical quality due to benefits of using HIS and PACS to reduce clinical session time and increase both physicians’ and patients’ satisfaction. So, the time of getting needed information plays a major role in this situation. Likewise, the use of EMR exchange also allows the physicians to access patients’ information from other healthcare providers, which reduces the required time for collecting relevant information. Based on above discussions an initial research framework was proposed with 4 independent factors related to Non-HIT to predict physicians’ intention to use EMR exchange. They are: 1) Financial Incentives; 2) Utility of EMR Exchange; 3) Information Needed for Patients’ Condition; 4) Time.
Table 2. Operational Definition of Non-HIT Factors

<table>
<thead>
<tr>
<th>Factors</th>
<th>No. of items</th>
<th>Operational Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Information Needed for Patients’ Condition</td>
<td>6</td>
<td>The degree to which a physician believes that patient’s information needed from other healthcare providers via EMR exchange to make clinical decisions</td>
</tr>
<tr>
<td>2. Financial Incentives</td>
<td>3</td>
<td>The degree to which a physician believes that subsidiaries from MOHW or NHIA to either hospitals or physicians</td>
</tr>
<tr>
<td>3. Utility of EMR Exchange</td>
<td>4</td>
<td>The degree to which a physician believes that benefits of using EMR exchange</td>
</tr>
<tr>
<td>4. Time</td>
<td>5</td>
<td>The degree to which a physician believes that access patient’s information from other healthcare will shorten work-time</td>
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DELPHI METHOD AND RESULT

A total of 54 questions were summarized and divided into 3 parts. The first part with a total of 46 questions were categorized into these 8 factors of this initial research framework to identify the factors which may affect the physicians’ intention to use EMR exchange. The second part with 2 questions was to determine physicians’ intention namely intention to use EMR exchange. The third part with 6 questions was the conditions that physicians need to access patients information from other institutions via EMR exchange. In order to increase the content validity the initial conceptual framework was validated by the Delphi method. 4 experts formed an expert panel and they are male physicians and served as directors of the divisions of Rehabilitation, Neurology, General Internal Medicine and Family Medicine in a medical center respectively. Three of them received a master degree and one had a bachelor degree. Age distribution of the experts is between 41-60 years (Three of them belong to 51-60 and one belongs to 41-50). The major concern to ask those directors to serve as the panel members is due to their expertise areas that are much more related to the chronic diseases of older people. After 3 rounds expert panel meetings a research framework and questions were proposed for a pilot study. We use 5-point Likert scale, with a measure of very important, important, neutral, not important and not very important. In order to avoid memory effect, each round of expert panel meeting was separated by 3 weeks. In order to increase the content validity, the modifications of the questionnaire were done based on experts’ opinion and relevant literature review. After receiving the questionnaire from experts the mean value, standard deviation and internal consistency were checked respectively. The expert panel suggested 3 modifications: 1) simplification of the questions that are similar and difficult to understand; 2) systematics presentation of the questions; 3) adding financial incentives from NHIA. Furthermore, two questions were deleted due to the redundancy of the questions. Then, 3 questions based on NHIA were added to the factor financial incentives. So, a total of 57 questions were sent for the round two of the Delphi method. In the second round of Delphi method the internal consistency coefficients of the variables are ranged from .815 to .982. The Pearson coefficients of the repeated questions in the both round were ranged from .577 to 1. Only 3 questions were less than .577. Due to both low mean scores and high standard deviations of the degree of importance, one question from the factors EMR system characteristics; perceived usefulness; perceived ease of use; financial incentives were deleted respectively. Two questions of conditions that physicians need to use EMR exchange were also deleted due to low mean scores of the degree of importance. Based on the experts suggestions 2 questions were added both in time factor and in information quality factor, while 7 questions were added in utility of EMR exchange.
factor to simplify and clarify some questions. So, a total of 60 questions included in this questionnaire: including 54 questions to measure affecting factors, plus the other 2 questions (measure intention) and 4 questions for pathways were used for the third round. After the third round, the Chronbach’s $\alpha$ value is .814 in pathways, and others come out in range from .858 to .972. Average of the importance of each variable turns out to be in between 3.75 to 5.00 with standard deviation in between 0.5 to 1.5. In this round 5 questions were added in the factor of “information quality,” and 3 questions were added in “time.” In a summary, a total of 68 questions included in this questionnaire: including 62 questions to measure affecting factors, 2 questions to measure physicians’ intention, 4 questions for pathways. Based on the suggestions from the third round meeting, HIT factors remain the same as the proposed initial research framework, namely: 1) Perceived Usefulness (PU); 2) Perceived Ease of Use (PEOU); 3) Information Quality (IQ); 4) EMR System Characteristics (ESC). However, Non-HIT factors were increased from 4 to 5 due the time factor was split into 2 two factors, namely: quick access and save the data subsequent diagnosis used and expectation of time trade-off. Thus, there are 5 factors of Non-HIT, namely: 1) Information Needed for Patients’ Condition (IN); 2) Quick Access and Save the data for subsequent Use (QA&S); 3) Utility of EMR Exchange (UOEX); 4) Financial Incentives (FI); 5) Expectation of Time Trade-off (EOT). Fig 1 presented the research framework for this study including a total of 62 questions and 9 factors.
Fig. 1 Research Framework
Table 3  Operational Definition of Factors in research framework

<table>
<thead>
<tr>
<th>Factors</th>
<th>No. of items</th>
<th>Operational Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Information needed for patients' condition</td>
<td>6</td>
<td>Patient's information needed from other healthcare providers via EMR exchange for physicians to make a clinical decisions</td>
</tr>
<tr>
<td>2. Quick access and save the data for subsequent use</td>
<td>4</td>
<td>Shorten time to access patient's information from other healthcare providers and it can be saved for the subsequent diagnosis or treatment used</td>
</tr>
<tr>
<td>3. Utility of EMR exchange</td>
<td>11</td>
<td>Benefits of using EMR exchange</td>
</tr>
<tr>
<td>4. Financial incentives</td>
<td>5</td>
<td>Subsidiaries from MOHW or NHIA to either hospitals or physicians</td>
</tr>
<tr>
<td>5. Expectation of time trade-off</td>
<td>6</td>
<td>Trade-off of expected access time of patient’s data from other healthcare provider</td>
</tr>
<tr>
<td>6. Perceived usefulness</td>
<td>3</td>
<td>The degree to which a physician believes that using EMR exchange would improve medical quality and efficacy for this patient</td>
</tr>
<tr>
<td>7. Perceived ease of use</td>
<td>3</td>
<td>The degree to which a physician believes that using EMR exchange would be free of effort</td>
</tr>
<tr>
<td>8. Information quality</td>
<td>17</td>
<td>Quality of a patient’s exchange information including contents, accuracy, completeness, format, trusty, and timeliness</td>
</tr>
<tr>
<td>9. EMR system characteristics</td>
<td>7</td>
<td>Functions of EMR exchange platform include access control, operation, process of save, and the degree of compatibility with other HIT applications</td>
</tr>
</tbody>
</table>

SUMMARY

A research framework was proposed based on the results of three rounds of the Delphi meetings. The research framework of this study includes two types of factors. One type is HIT related factors: 1) perceived usefulness (PU); 2) perceived ease of use (PEOU); 3) information quality (IQ); 4) EMR system characteristics (ESC). The other type is Non-HIT factors, namely: 1) information needed for patients’ condition (IN); 2) quick access and save the data for subsequent use (QA&S); 3) utility of EMR exchange (UOEX); 4) financial incentives (FI); 5) expectation of time trade-off (EOT).

In addition, a copy of questionnaire including 62 questions to validate this research framework was also developed based on the results of 3 rounds of Delphi meetings. There are 4 sections of this questionnaire besides the cover letter. The first section is the main section of this study includes the questions related to variables of these 9 factors. The second section is the factor of physicians’ intention. The third section with 4 questions are the pathways that patients for medical treatment. The fourth section is to collect background information of respondents. A 5-point Likert scale was used to measure each variable (1 represents very unimportant, and 5 represents very important).

REFERENCES

Hwang et al. Identifying Factors to Affect the Use of HIE


Venkatesh V, Morris MG, Davis GB, Davis FD. User acceptance of information technology: toward a unified view. MIS Quarterly 2003;27: 425-78.


Ginneken BV et al. Active shape model segmentation with optimal features. IEEE Transaction on medical imaging. 2002; 21(8)


Kho AN, Lemmon L, Commiskey M, Wilson SJ, McDonald CJ. Use of a Regional Health Information Exchange to Detect Crossover of Patients with MRSA between Urban Hospitals. JAMIA 2008;15:212-216.