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E-health Readiness and Its Influences on E-health Transformation Success: A Change Perspective

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ABSTRACT
This study presents a conceptual model to investigate the e-health readiness required by healthcare organization and the impact of such readiness in enhancing e-health transformation success. A scale to measure e-health readiness was developed and validated; then it was used to collect the large-scale survey data. The partial least squares (PLS) method was used to empirically test the conceptual model and hypotheses through the large-scale survey collected. The empirical results support the proposed model. The results provide a means to understand what factors determine the e-health transformation success and can potentially be used in advance of e-health transformation for contemporary hospitals to check its e-health readiness level and prepare the needed changes for e-health implementations to ensure better e-health transformation.

Keywords
E-health, E-health readiness, E-health transformation success, Healthcare

INTRODUCTION
Over the last decade, the healthcare industry and healthcare system have encountered dramatic changes in information and communication technology (ICT) that influence the way healthcare services are delivered and used, and the relationship between healthcare provider and consumers. The rapid progress in ICT provides both opportunities and challenges in delivering high-quality and efficient health care, curbing the scourge of medical errors, facilitating point-of-care decision support, streamlining workflow, and reducing costs and improving the patient-physician relationship (Institute of Medicine, 2001). The influence of electronic health (E-health) will increasingly affect the very roots of our current healthcare system (Wu, Chen, and Greenes, 2009).

A variety of ICT have been implemented in healthcare industry, such as electronic medical records (EMR), computer-based physician order entry (CPOE), and picture archiving and communication system (PACS) to gain benefits. For instance, Hospitals adopt EMR that estimates to save 60 thousand lives, avoiding 500 thousand serious medical errors, and saving 0.97 billion medical expenditure (Milstein, 2006). In addition, the Office of the National Coordinators for Health Information Technology estimates that the annual savings attributions to widespread EMR adoption are likely to be 7.5% to 30% of annual health care spending (Shortliffe, 2005). Gaining these benefits from ICT will require the fundamental restructuring of care delivery.

Adopting e-health has become more complex and challenging to evaluate for healthcare organizations (WHO, 2005), that have embarked on e-health activities with limited success because insufficient attention has been paid to identify and tackle potential constraints (Institute of Medicine, 2001). There are several reasons with non-technical factor accounts for 30% of the failure rate and it is a major barrier hindering adoption of ICT (Thompson and Braier, 2004). More than ever, ICT implementations fail because of the organization’s lack of preparedness for change (Roberts, Jarvenpaa and Baxley, 2003). Therefore, comprehending these factors with respect to the healthcare organization of develop assessment tools can potentially provide
management insights in determining effective strategies to enable healthcare organizations to be competitive and they are able to retain their customers and patients.

However, a comprehensive theoretical framework to explore and empirically examine these interrelated concepts is still lacking. Reviews of IS literature (e.g., Broadbent, Weill, and Clair, 1999; Craig and Jutla, 2001; Roberts, Jarvenpaa, and Baxley, 2003; Willcocks and Feeny, 2006) reveal a lack of research that investigated the emerging management concept of e-health readiness and its impacts on hospitals’ e-health transformation success. Researchers have exerted relatively little theoretical effort on the development of causal relationships between e-health readiness and e-health transformation. Attributing the inconclusiveness of this body of work to the separate nature of the discussions on e-business readiness and IT success, this study develops a theoretical framework and empirically examines the relationships between e-health readiness and e-health transformation success. Two questions form the focus of our inquiry: (1) What are the areas of knowledge that characterize e-health readiness? and (2) what is the contribution of e-health readiness to enhancing hospitals’ e-health transformation success? Utilizing data from a survey of CIOs and TMT members in the healthcare industry of Taiwan, this study provides empirical grounding to these two questions.

THEORETICAL FOUNDATION AND CONCEPTUAL MODEL

Two theories provide a useful explanatory framework for addressing the above research problems. First, Lewin’s change theory serves as an initial foundation for examining e-health readiness and its influence on e-health transformation success (Lewin, 1961). Socio-technical system model provides the rationale for the formation of e-health readiness (Bostrom and Heinen, 1977). Finally, IOM (2001) reports and relative practices provide the bases for the formation of e-health transformation success.

Change theory and IT-enabled Transformation

Change theory, introduced by Kurt Lewin (1961), views behavior as a dynamic balance of forces working in opposing direction. Lewin’s force field model describes the process of organizational change as one consisting of three stages: unfreezing the current organizational equilibrium, changing to a new position, and refreezing in the new equilibrium position. According to Lewin, the first step in the process of changing behavior is to unfreeze the existing situation or status quo. The second step in the process of changing behavior is movement. In this step, it is necessary to take the action and move the target system to a new level of equilibrium. The third step is refreezing. This step needs to take place after the change has been implemented in order for it to be sustained over time. Organization creates and embraces a new vision of the future, uniting behind the steps necessary to achieve that vision. Finally, as new attitudes, practices, and policies are put in place to change the corporation, these must be refrozen and transformed.

The implementation of ICT with healthcare model has been recognized as the price of entry for running a sizeable healthcare business and for being connected to other entities in a network economy. Willcocks and Feeny (2006) proposed the evolution of the IT functions as passing through delivery, reorientation, and reorganization phases that based on the business maturity in managing IT. Hoque et al. (2006) proposed the role of business technology is to facilitate the innovation of new business models, new products and services, and new modes of organizing work. The focus here is not so much on investment in specific business technologies as much as on the development of digital options, digitalization of product and services, and on experimentation with new business technology-enabled business ideas. Transformations bring organization into new kinds of entities, relationships, and activities to increase capacity of an organization which address its future business environment effectively (Venkatraman, 1994). Further, organizations implement ICT to transform business process reengineering and redesign management procedures to gain competitive advantage (Craig and Jutla, 2001). Healthcare organizations should have sufficient momentum to lead the beginning of the changing progress. In this study, this momentum could be regarded as what Lewin called the driving forces at the unfreezing stage (Burke, 1994) and as the preparation for e-health related change.

Developing a framework for e-health readiness

E-health implementations in hospitals carry a number of risks, along with the anticipated benefits and performance. The obvious risk of using e-health is the unintended widening of the gap in management and clinical care between different departments or individuals. Prior studies argued that ICT engendered unknown and possibly unanticipated problems when analyses of their organizational impacts are lacking (Bostrom et al., 1977; O'Hara, Watson and Kavan, 1999). One method to avoid this gap is for hospital to assess and prepare for change before adopting programmed that require e-health implementation. In this study, the processes of preparation for e-health related change is also referred to as e-health readiness.
Readiness refers to the state of being prepared for specific events or unpredictable situations. It is an important characteristic in achieving goals and tries to avoid negative outcomes. Prior research has treated readiness as a unitary concept with two related constructs: (1) The motivational construct relates to readiness to change; (2) the developmental construct is associated with readiness for change (Walker, 2004). Holt et al. (2007) defined readiness for change as a comprehensive attitude that is influenced simultaneously by the content, process, context, and individuals involved. Therefore, the exact nature of the interactions between IT and organizational change needs to be understood and managed. Socio-technical system (STS) model is regarded as an initial foundation for discussing the interactions between organization and ICT implementations (Bostrom et al., 1977; O'Hara et al., 1999).

The STS model views an organization as an open system and comprised of two interacting systems: the technical and social subsystems. These systems are encompassed of four highly interrelated factors: task (i.e. capabilities), people (i.e. incentives), structure (i.e. business model), and technology (i.e. information technology infrastructure). STS model can be applied to organization to elucidate the interaction between technology and people, such as how to motivate and operate effectively. These perspectives provide sound foundations to understand the interaction which would enable managers to develop a comprehensive plan for a particular e-health intervention.

Nevertheless, organizations must perceive positive value, possess abilities, and provide incentives to embrace changes before adopting ICT effectively. Therefore, e-health readiness is a representative of anticipated change generated by e-health whether the hospitals have enough momentum to put change into practice or not. According to prior healthcare studies, the measures of e-health readiness were neither clear nor undefined. In this study, we define e-health readiness stands for a hospital’s propensity to embrace e-health and intend to transform, which include information technology infrastructure, e-health capabilities, incentives, and e-health business model.

Information technology infrastructure

Information technology infrastructure stands for the capacity of a hospital to assess and implement the related hardware, software, networks, and protocols comprising e-health technology platforms. IT infrastructure forms a set of shared, tangible IT resources that provide a foundation enabling current and future business applications (Duncan, 1995). Besides, it represents a firm’s technological and information platforms from which enterprise applications emerge and to meet customer demand without increasing costs (Broadbent et al., 1999). Today’s healthcare organizations have to scan, implement, and evaluate the existing and emerging ICT in order to construct an integrated and reliable IT infrastructure to support the information needs for all medical units and ensure that the respective data resources can be accessed internally and externally. It's becoming a critical issue for healthcare organizations to maintain sound IT infrastructures to cope with new challenges and the impacts in today’s healthcare environment.

E-health capabilities

This category represents that hospitals can reconfigure, choose, identify and converge an integrated set of resources for adopting e-health. Willcocks and Feeny (2006) defined a capability as a distinctive set of human resource-based skills, motivations, and behaviors that have the potential, in suitable contexts, to contribute to achieving specific activities and influencing business performance. Sambamurthy et al. (2003) proposed firms organizing, integrating and deploying the ability of IT resources as IT capability. Such capabilities would facilitate healthcare organizations to visualize the relationships between novel ICT and business activities enabling the organization to react to an environment and emerge market opportunities in competitive actions. Organization should renew competences so as to achieve congruence with the changing business environment. Hospitals should cultivate IT capabilities to detect environmental change and respond in a timely manner. Therefore, contemporary healthcare organizations need to build up e-health capabilities to effectively carry out the tasks with emerging e-health technologies in highly competitive environment.

Incentives

Incentives stand for a hospital and its stakeholders in healthcare system which providing extrinsic and intrinsic motivations to induce its employees (e.g., nurses, physicians, medical professionals etc.) to change and adopt e-health. It creates a driving force for employee towards the desired goal for organization. The incentives had been classified as follows: (1) intrinsic motivation which motivates a person moved to act for the challenge, (2) extrinsic motivation which refers to do something well because it leads to a separable outcome (Ryan and Deci, 2000). Parente (2000) argued that hospitals must make sure whether their staffs are getting the right information and incentives to promote high quality care. Therefore, to gain a better e-health transformation outcome, it is important for hospitals to create the driving forces to smooth the progress of people’s psychological tendency towards the desired goals of e-health implementation.
E-health business model

A business model is a conceptual tool that contains a set of elements and their relationships and allows expressing the business logic of a specific firm. It is a description of the value a company offers to one or several segments of customers and the architecture of the firm and its network of partners for creating, marketing, and delivering this value and relationship capital, to generate profitable and sustainable revenue streams (Osterwalder and Pigneur, 2005). In healthcare industry, hospitals face the impacts of the complex challenges including technological innovation, preventive care needs and consumer-focused requirements. Parente (2000) argued that a business model can help healthcare organizations to identify the market barriers that must be overcome and provide perspective on opportunities for delivering healthcare services. Based upon the above discussions, we define e-health business model as a set of elements and relationships a hospital offers value to customers and its network of stakeholders for creating, enhancing, and integrating care services and products in order to generate profitable and sustainable revenues streams by e-health adoption.

Drawing on the perspectives of change theory and STS, e-health readiness can be referred to the preparation in driving forces, restraining forces, motivation, and the e-health transformation success can be referred to achieve organization’s desired goals. To effectively achieve e-health transformation, healthcare organizations must possess strong driving forces, decrease the restraining forces, motivation, and then well prepare for embracing changes. When healthcare organizations are well prepared and ready for change, they are more likely to perform well on the e-health transformation. Therefore, the following hypothesis is proposed.

H1: A higher level of E-health readiness will positively associate with e-health transformation success.

E-health transformation success

Transformation refers to increase capacity and capabilities of an organization to address its future business environment effectively. ICT offers an opportunity to reinvent fundamentally of healthcare services and transform care delivery digitally related to the business side. Venkatraman (1994) developed a framework and recognized that ICT plays a major role in enabling businesses to respond to flexible and dynamic markets. The framework focuses on organizational and management process changes required to exploit ICT. Davidson (1999) stated transformation which encompasses more than just improvements in performance. Manager needs to reconsider how the transformation after the new core competencies and new services, to achieve business goals and redefine the value in the market.

Last decade, healthcare reforms in Western countries had begun transforming and reconstructing of healthcare as commodities and products. E-health transformation can be considered the efforts and processes of introducing e-health into an organization and adopted to provide services and connections to consumers, employees and partners. Therefore, hospital adopts e-health become a changing agent that alters and breaks the status quo of healthcare systems which toward to the customer-driven. It will cause redefinitions in the nature of healthcare systems, management goals, and business model.

Change theory elucidates the organizational change could encourage and facilitate for long-term success. Assessing the success of Information Systems (IS) had been ongoing for nearly three decades. However, the scopes and approaches of these IS Success evaluation studies are varied, and there are little consensus on the appropriate measures of IS Success (Gable, Sedera and Chan, 2008; Wu and Wang, 2006). The objective of successful transformation is to create a new value reposition for organization, and achieve business aims. In this study, evaluating e-health transformation successes need to base on the achievement of healthcare system goals and meet the quality requirements of patient care by e-health adoption.

The Institute of Medicine’s report (2001) and related researches provide sound foundations to measure e-health transformation success. The invocation of “Crossing the Quality Chasm” by Institute of Medicine discloses the current healthcare systems which often cannot conform the modern medical care requirement appropriately. It established a new era of healthcare quality norms and principles of the healthcare system reform. Patient care must be delivered by systems that are carefully and consciously designed to provide safety, effectiveness, patient-centeredness, timeliness, efficiency, and equity. Thus, we defined the e-health transformation success as the degree to which a hospital utilizing e-health successfully to achieve aims of healthcare system including safety, effectiveness, patient centeredness, timeliness, efficiency, and equity.

Pressure

The pressure refers to the degree of which hospital senses the external threats from competitors and changes in the healthcare environment, technology, and policy. Prior studies considered external environment as an important moderator in organizational change. Most organizations do not cope well with large environmental shifts (Laudon, 2009). Organization systems are open to, and interact with their environments. The environmental change has deterministic impacts on
organizational structure (Orlikowski, 1996). For these reasons, pressure should be exerted to drive hospitals to change and interact with the healthcare environment, including changes in the healthcare industry, technology, and policy. In this study, pressure is viewed as a moderate variable, and expected to have significant moderate effect on the influence of e-health readiness on e-health transformation success. Therefore, the following hypothesis is proposed.

**H2: The influence of e-health readiness on e-health transformation success will be positively moderated by pressure.**

Larger-size hospitals or research oriented hospitals (e.g., medical center) may have more slack resources required for experimenting with the e-health implementations, tolerating the costs of implementing innovations, proactively seeking the opportunities to innovate with technologies, purchasing expensive innovations and withstanding adoption failures and, as a result, a greater capacity for assimilating innovations and technologies (Liang, Saraf, Hu, and Xue, 2007). This study anticipates that larger healthcare organizations have greater successful opportunities of e-health transformation in improving their healthcare quality, efficiency, patient centeredness, and so forth. In this study, the size of acute beds was adopted as measure of hospital size. Besides, the types of hospitals were used as another important control variable that would affect the relationship between e-health readiness and transformation success. Although higher e-health readiness may provide innovative opportunities for hospitals to conduct transformation success, the potential extent may be different among the medical centers, regional hospitals and other institutes.

Based on the foregoing discussion, we propose a conceptual framework which suggests that e-health readiness of healthcare organizations influences their e-health transformation success and this relationship is moderated by pressure from the external environment, as shown in Fig. 1.

![Figure 1. Research Framework](image)

**RESEARCH METHODOLOGY**

**Measurement development**

At the outset, this study developed the constructs of e-health readiness, e-health transformation success, and the associated measures. A number of prior relevant studies were reviewed to ensure that a comprehensive list of measures were included. The initial survey instrument and subsequent refinement of the instruments were done by researchers via several rounds of in-depth personal interviews with a panel of academic and top management members (e.g., superintendent, vice-superintendent, chief of medicine, CIO) in the healthcare industry in Taiwan. It ensures content validity through the calculation of content validity ratios on each scale item. This process was continued until no further modifications to the questionnaire were necessary. Feedback from the in-depth personal interviews served as the basis for refining the experimental scales of the survey instrument.

This questionnaire contained two major parts including a portion for the respondent’s basic data and another for the responses to our research constructs. The basic data portion requested the top management team members in hospitals to give hospitals’ characteristics include type, size, and ownership. The second part contained five constructs relating to the e-health readiness and six constructs relating to the e-health transformation success. Data were collected using a five point Likert-type scale. Table 1 summarizes the operationalized definitions of latent variables and example measures of the survey instrument administered in this study.
<table>
<thead>
<tr>
<th>Construct</th>
<th>Operationalized definitions and example scale items</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure</td>
<td>The degree of which hospital senses the external threats from competitors and changes in the healthcare environment, technology, and policy.</td>
<td>Laudon, 2009&lt;br&gt;Orlikowski, 1996&lt;br&gt;Sambamurthy et al., 2003</td>
</tr>
<tr>
<td></td>
<td>■ Example scale items (1: Very disagree ~ 5: Very agree):</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PR1: Our hospital can sense the development trends of e-health technology to affect care services.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PR2: Our hospital can sense the requests for e-health regulation from government and third party.</td>
<td></td>
</tr>
<tr>
<td>E-health readiness</td>
<td>The degree to which a hospital’s propensity to embrace e-health and intend to transform, which includes information technology infrastructure, e-health capabilities, incentives, and e-health business model.</td>
<td>Bostrom et al., 1977&lt;br&gt;Broadbent et al., 1999&lt;br&gt;O'Hara et al., 1999&lt;br&gt;Osterwalder and Pigneur, 2005&lt;br&gt;Parente, 2000&lt;br&gt;Ryan and Deci, 2000&lt;br&gt;Sambamurthy et al., 2003&lt;br&gt;Walker, 2004</td>
</tr>
<tr>
<td></td>
<td>■ Example scale items (1: Very disagree ~ 5: Very agree):</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RIT1: Our hospital can scan relative standards, protocol and regulation of e-health</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RHCl: Our hospital can reconfigure resources of e-health to create value</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RMO1: Enhancing the cooperation with other hospitals</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RIN1: Top management team (TMT) can support e-health implementation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RHBl: Our hospital can exploit e-health to integrate clinical and care delivery system</td>
<td></td>
</tr>
<tr>
<td>E-health transformation success</td>
<td>The degree to which a hospital utilizing e-health successfully to achieve aims of healthcare system, which includes safety, effectiveness, patient centeredness, timeliness, efficiency, and equity.</td>
<td>Davidson, 1999&lt;br&gt;Institute of Medicine, 2001&lt;br&gt;Venkatraman, 1994</td>
</tr>
<tr>
<td></td>
<td>■ Example scale items (1: Very disagree ~ 5: Very agree):</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TSA1 Creating effective standard operation procedures to avoid errors more than the past.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TEA1 Providing sufficient evidence-based medicine database to support clinical decision making more than the past.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TPC1 Providing sufficient information which can make patients involve in treatment decisions more than the past.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TTM1: Enhancing care procedures to save wait for patients more than the past.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TEE1: Enhancing processes to reduce administrative costs more than the past.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TEQ1: Providing multiple care channels (paths) to serve patients more than the past.</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Operationalization of the Major Constructs and Example Scale Items

Data collection

The empirical data were collected using a questionnaire survey administered from October to November, 2008. The initial mail-out list for questionnaires included all medical centers (20) and regional hospitals (72) and 21 qualified district hospitals from the Department of Health annual statistics in Taiwan. The perceptual data of this study were collected through a self-administered questionnaire. Considering the numbers of top management team member in different size hospital, the copies of questionnaire for medical center, regional hospital, and distinct hospitals was ten, seven, and six, respectively. Overall, we distribute 830 questionnaires to all target hospitals. Owing to the conventional expectation of low survey response rates in healthcare organizations, this study endeavored to find a specific local contact person (i.e. secretary of superintendent) for each target hospital. In addition to a reasonable response period— four weeks, follow-up activities were also conducted by email, phone call or mail to increase response rate, and to minimize the extent of common method variance bias and non-response bias.

The initial survey was mailed in early October, 2008. Postcard and phone call reminder was sent to non-responders in the early November, 2008. Two hundred and one returned questionnaires were received. Data were excluded to ensure the construct validity while a respondent gave incomplete answers for each construct. Fourteen responses were considered incomplete and had to be discarded. This left 187 valid responses for the statistical analysis, and a valid response rate of 22.53% of the initial samples. The potential non-response bias was assessed by comparing the early (e.g. early four weeks N=141) versus late (e.g. last four weeks N=46) respondents that were weighed on hospital type, ownership type, and number of acute beds. None of the chi-square was statistically significant (p>0.05, two-tail tests). These results suggest that non-response bias was not a serious concern. The characteristics of respondents and the results of non-response bias analysis were shown as in Tables 2, respectively.
RESULTS

Measurement properties

All of the constructs in the conceptual model were modeled as reflective and were measured using multiple indicators. The assessment of item loadings, reliability, convergent validity, and discriminate validity was performed for the latent constructs through a confirmatory factor analysis (CFA). Reflective items should be unidimensional in their representation of the latent variables, and therefore correlated with each other. Factor loadings of scale items should be above 0.707, showing that all of the variance is captured by the constructs in Table 3. All constructs in the measurement model exhibit good internal consistency as evidenced by their composite reliability scores. The composite reliability coefficients of all constructs in the proposed conceptual framework are more than adequate, ranging from 0.825 to 0.927. Besides, Harman’s one-factor test was conducted to verify the common method variance bias. The one general factor loading was under 0.5 and did not account for the majority of the covariance among the measures.

<table>
<thead>
<tr>
<th>Construct Sub-construct</th>
<th>Indicator</th>
<th>Loadings</th>
<th>Composite Reliability (AVE/Cronbach’s α)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure</td>
<td>-</td>
<td>PR1-2</td>
<td>0.701-0.746 0.825 (0.587/0.703)</td>
</tr>
<tr>
<td>E-health readiness</td>
<td>IT infrastructure</td>
<td>RIT1-4</td>
<td>0.796-0.831 0.891 (0.672/0.834)</td>
</tr>
<tr>
<td></td>
<td>E-health capabilities</td>
<td>RHC1-4</td>
<td>0.853-0.887 0.927 (0.761/0.895)</td>
</tr>
<tr>
<td></td>
<td>Extrinsic Motivations</td>
<td>RMO1-2</td>
<td>0.841-0.850 0.834 (0.715/0.602)</td>
</tr>
<tr>
<td></td>
<td>Intrinsic Motivations</td>
<td>RIN1-2</td>
<td>0.803-0.891 0.837 (0.720/0.616)</td>
</tr>
<tr>
<td></td>
<td>E-health business model</td>
<td>RHB1-5</td>
<td>0.772-0.858 0.899 (0.641/0.859)</td>
</tr>
<tr>
<td>E-health transformation success</td>
<td>Safety</td>
<td>TSA1-4</td>
<td>0.811-0.827 0.888 (0.666/0.832)</td>
</tr>
<tr>
<td></td>
<td>Effectiveness</td>
<td>TEA1-4</td>
<td>0.790-0.847 0.896 (0.683/0.845)</td>
</tr>
<tr>
<td></td>
<td>Patient centeredness</td>
<td>TPC1-3</td>
<td>0.842-0.862 0.888 (0.726/0.811)</td>
</tr>
<tr>
<td></td>
<td>Timeliness</td>
<td>TTM1-4</td>
<td>0.746-0.869 0.887 (0.665/0.831)</td>
</tr>
<tr>
<td></td>
<td>Efficiency</td>
<td>TEE1-4</td>
<td>0.768-0.866 0.895 (0.680/0.843)</td>
</tr>
<tr>
<td></td>
<td>Equity</td>
<td>TEQ1-4</td>
<td>0.736-0.876 0.883 (0.655/0.823)</td>
</tr>
</tbody>
</table>

Table 3. Factor Loadings and Composite Reliability of Constructs

To assess discriminate validity, (1) indicators should load more strongly on their corresponding construct than on other constructs in the model and (2) the square root of the average variance extracted (AVE) should be larger than the inter-construct correlations (Chin, 1998). The percent of variance captured by a construct is given by its AVE. PLS method was applied to evaluate discriminate validity of the major constructs of the conceptual framework. As the results in Table 4 show, all constructs meet this requirement. The values for composite reliability are all above the suggested minimum of 0.7. Thus, the convergent and discriminate validity of all constructs in the proposed conceptual framework can be assured.
Table 4. Descriptive Statistics and Inter-correlations among Major Constructs

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Composite Reliability</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. IT Infrastructure</td>
<td>0.891</td>
<td>0.820</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2. E-Health Capabilities</td>
<td>0.927</td>
<td>0.556</td>
<td>0.872</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Extrinsic Motivations</td>
<td>0.834</td>
<td>0.111</td>
<td>0.370</td>
<td>0.846</td>
<td></td>
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<td>4. Intrinsic Motivations</td>
<td>0.837</td>
<td>0.385</td>
<td>0.519</td>
<td>0.390</td>
<td>0.848</td>
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<td>5. E-Health Business Model</td>
<td>0.899</td>
<td>0.481</td>
<td>0.672</td>
<td>0.321</td>
<td>0.552</td>
<td>0.800</td>
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<tr>
<td>6. Safety</td>
<td>0.888</td>
<td>0.465</td>
<td>0.537</td>
<td>0.245</td>
<td>0.378</td>
<td>0.603</td>
<td>0.816</td>
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<td>7. Effectiveness</td>
<td>0.896</td>
<td>0.464</td>
<td>0.495</td>
<td>0.260</td>
<td>0.409</td>
<td>0.587</td>
<td>0.655</td>
<td>0.658</td>
<td>0.608</td>
<td>0.852</td>
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<td>8. Patient Centeredness</td>
<td>0.888</td>
<td>0.344</td>
<td>0.539</td>
<td>0.392</td>
<td>0.403</td>
<td>0.520</td>
<td>0.587</td>
<td>0.608</td>
<td>0.667</td>
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<td>9. Timeliness</td>
<td>0.888</td>
<td>0.345</td>
<td>0.477</td>
<td>0.240</td>
<td>0.347</td>
<td>0.458</td>
<td>0.693</td>
<td>0.618</td>
<td>0.667</td>
<td>0.815</td>
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<tr>
<td>10. Efficiency</td>
<td>0.895</td>
<td>0.340</td>
<td>0.516</td>
<td>0.262</td>
<td>0.437</td>
<td>0.498</td>
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<td>11. Equity</td>
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<td>0.377</td>
<td>0.520</td>
<td>0.326</td>
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<td>0.621</td>
<td>0.606</td>
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*Diagonal elements are the square roots of average variance extracted (AVE).*

Test of the structural model

As shown in Fig. 2, the path linking from e-health readiness to e-health transformation success represents the total impacts on healthcare organizations’ e-health transformation success. These results provide strong empirical evidences for the nomological validity of the e-health readiness construct and the effects on e-health transformation success. The estimate of 0.501 on the construct of e-health transformation success ($R^2 = 0.501$) for the path provides good support for the hypothesized impact of e-health readiness on the dependent variable, e-health transformation success. Additionally, pressure as a moderator to influence e-health readiness on e-health transformation success is significant ($P<0.05$). An F test is further applied to test the significance of the effect size of the overall model. All of the dependent variables are significant ($p<0.05$) in e-health readiness and e-health transformation success.

Hypothesis H1 effectively drawn from e-health readiness to e-health transformation success is supported by the significant path coefficients. That is, e-health readiness encompassing five factors (i.e., IT infrastructure, e-health capability, extrinsic motivation, intrinsic motivations and e-health business model) does apparently influence the e-health transformation success. With the significant path coefficient, the analysis result also provides support for Hypothesis H2. This indicates that pressure has positively moderate effect on the influence of e-health readiness on e-health transformation success. In this model we suppose hospital types and size as control variables, but results were not significant. As a whole, the research model has strong explanatory power for the constructs of e-health readiness and e-health transformation success. The significant path coefficients, effect size, and the value of the $R^2$ reinforce our confidence in the results of hypotheses testing and provide support for the nomological network of the proposed model.

Figure 2. PLS Results
CONCLUSIONS

This study proposed a comprehensive model of e-health readiness, identified five broad categories of constructs concerning IT-healthcare related knowledge of healthcare organization in the healthcare industry, developed measures of these constructs, and validated the conceptual model through a rigorous PLS analysis. The nomological structure of e-health readiness encompassing the five knowledge domains, namely, IT infrastructure, e-health capabilities, extrinsic motivations, intrinsic motivation, and e-health business model, are well validated by the empirical data. The results indicated that the level of e-health readiness is positively associated with e-health transformation success and the influence of e-health readiness on e-health transformation success is positively moderated by pressure.

The conceptual model of e-health readiness is of particular value to those concerned with e-health knowledge training and competency development in healthcare organizations. It provides a systematical structure to help CIO or TMT members in healthcare organization to identify the necessary knowledge for their organization in accordance with their own organization context. Once the knowledge portfolio has been identified, a well-defined program of required training responses can be identified. The resulting e-health readiness knowledge requirement can then guide the relevant training activity. The CIO or TMT can also take advantage of such profile to assist in making succession-planning decisions by evaluating the readiness levels and development needs of their healthcare organization. Understand the factors of e-health readiness would be beneficial for promoting hospitals’ e-health transformation.

From the viewpoint of managerial implications, our findings have important implications for CIO and TMT members involved in efforts to introduce e-health into their hospitals. They reinforce the importance of institutional factors such as IT infrastructure, e-health capability, incentives and e-health business model on the heightened levels of e-health transformation success. While numerous advocates have prescribed such a collective responsibility as a normative guideline, our research provides empirical support for this prescription. Another important implication of our research is the finding that the influence of e-health readiness on e-health transformation success is positively moderated by pressure. This implies that pressure from external environment is helpful to enhance e-health transformation, for instance request of e-health regulation from government or competitive advantage loss due to other hospital implementing e-health.

Although our study provided interesting insights into the e-health readiness and its impact on e-health transformation success, it has several limitations that also represent opportunities for future research. First, a potential limitation of our study is its cross-sectional design. Since implementing e-health takes years, there is usually a multiple year delay. The potential concern on time delay is lacking in the research design of our study. The responses to our e-health transformation success questions are likely to be the result of actions in this past. Thus, it would be interesting to use a longitudinal design to examine the cyclical reference relationships among the identified research variables. Second, since the model was validated using the sample data gathered in Taiwan, the interpretation of the findings should be made with caution when generalizing to other systems or countries. Other samples from different nations, cultures and technology environments should be gathered to confirm and refine the findings of this study. Our work provides judicious knowledge to researchers and practitioners interested in learning how hospitals facilitate more effective transformations to today’s e-health environments and adds to the body of knowledge of Lewin’s change theory by extending the casual relationship between change behavior and desired goal achievement. That is, change to the desired direction will occur when the combined strength of the driving forces is greater than the combined strength of the opposing forces. We hope that our theoretical perspective and findings will stimulate and encourage more research into this important phenomenon.

ACKNOWLEDGMENTS

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REFERENCE