An exploratory study to understand the critical factors affecting the decision to adopt cloud computing in Taiwan hospital

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A B S T R A C T

The purpose of this study is to investigate the critical factors that will affect the decision to adopt cloud computing technology in developing countries, specifically in Taiwan’s hospital industry. This study mainly integrates the TOE (Technology-Organization-Environment) framework and HOT-fit (Human-Organization-Technology-fit) model to understand this issue. Information was collected by employing a questionnaire research design to hospital CIOs in Taiwan. The obtained results indicate that the 5 most critical factors are data security, perceived technical competence, cost, top manager support, and complexity. Further, among the proposed four dimensions the most important one is technology followed by human, organizational, and environmental factors. Finally, the results show that significant differences exist in CIO innovativeness, data security, compatibility, top manager support, adequate resource, and perceived industry pressure across different adopting groups. For practitioners, this study identifies key factors for hospitals to make an adoption decision toward cloud computing technology. As for academia, this study can be provided as a useful reference for future studies in this subject field.

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1. Introduction

Cloud computing technology has recently become an important milestone in the area of information systems development. It provides such advantages as on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service for business (Mell & Grance, 2011). Being different from previous Information Technology (IT) paradigm shifts, service online is one of the key concepts for this new Information System (IS) infrastructure. Cloud computing technology has three major service models including Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). Additionally, depending on the usage scope, cloud computing technology can be grouped into four categories. They are private cloud, community cloud, public cloud, and hybrid cloud (Mell & Grance, 2011). Based on the above discussion, this study focuses mainly on adopting private cloud computing for hospitals. To this end, large and medium size hospitals are actually the research targets used in this study. This is simply because only these hospitals have the specific requirements and capabilities to establish their own private cloud computing platform to facilitate healthcare services.

Issues related to the cloud computing technology have been widely discussed in practical and academic fields, and the healthcare industry is certainly no exception. In the healthcare industry, Chatman (2010) and Kuo (2011) indicated that cloud computing is dramatically changing the implementation and adoption of health care information technology, especially for the development of electronic health records. In practice, the NEC and Fujitsu had proposed their cloud computing solution for hospitals in Japan (Japan-NEC, 2012). Additionally, Microsoft Europe also applied cloud computing technology to improve the quality of patients’ care. This led to reduced costs in Italy’s largest pediatric research and treatment center (Lisa, 2011). In the United States, IBM had proposed to use their new cloud computing based clinical information management system in hospitals (Ostrovsky, 2010). Consistent with the successful use of cloud computing as described in the aforementioned cases, cloud based healthcare information is quickly becoming a leading trend for the associated healthcare information systems development worldwide (Low & Chen, 2012). This new IT platform has positively changed the structure and nature of hospital information systems in general and in the development of telemedicine and mobile healthcare in particular. However, Kuo (2011) emphasized that hospital must be seriously evaluated before adopting this new IT innovation. He proposed four aspects to be evaluated when adopting the health cloud computing. These four are management, technology, security, and legal issues. In addition, these four dimensions are integrated into the research model of present study for an
empirical verification to further understand this issue in Taiwan hospitals.

Over the past twenty years, Taiwan has developed an outstanding healthcare program that is respected around the world. In The Economist Intelligence Unit’s (EIU) global healthcare industry report (2000), Taiwan was ranked as the second healthiest country in the world following Sweden. In 2012 Switzerland IMD’s (International Institute for Management Development) “World Competitiveness Rank” report, Taiwan’s technology infrastructure development is ranked 4th and the healthcare infrastructure is ranked 8th out of 59 countries. Additionally, the healthcare infrastructure is ranked number 2 in the Asia Pacific region (World Competitiveness Online, 2012). The Taiwanese government has made the development of medical cloud computing technology a key goal for their healthcare system. The reason this has been given such priority is that such technology will facilitate the development of Electronic Medical Records (EMRs) systems; which is not only another goal that the government has set but also a universal initiative to improve the healthcare industry as a whole. Therefore, understanding the experiences obtained, lessons learned and issues/challenges encountered while undergoing cloud computing adoption in Taiwanese hospitals are beneficial not only to the professionals in the health industry worldwide but also for developing countries aspiring to improve their healthcare systems particularly those in the Asia Pacific region.

For the above reasons, many hospitals in Taiwan have attempted to adopt cloud computing technology to meet not only the pressures which can follow the EMR development policy from the government, but also to satisfy competitive challenges arising in the industry. Even though it is being utilized, it must be noted that cloud computing is still a new technology that is not devoid of problems. One issue in particular that most studies on the topic have only emphasized the technology itself. More research is needed to address and analyze business related issues in regards to the adoption and implementation of cloud computing (Marston, Li, Bandyopadhyay, Zhang, & Ghalsasi, 2011). For this reason, hospitals still require more references and research done in regards to the successful adoption or implementation of cloud computing.

To fill up the aforementioned research gap, the purpose of this study is to provide a reference for hospitals adopting cloud computing technology. This study starts with investigating and analyzing relevant literatures and theories to propose an integrated model to study the critical factors affecting the decision to introduce cloud computing technology in the hospital industry. Next, a questionnaire survey is employed to justify and verify the proposed model. Finally, based on the research findings, discussions and implications are provided to complete this study.

2. Research model

Based on the Technology-Organization-Environment (TOE) framework (Tornatzky & Fleischer, 1990) and Human-Organization-Technology fit (HOT-fit) model (Yusof, Kuilis, Papazafeiropoulou, & Stergioulas, 2008; Yusof, Papazafeiropoulou, Paul, & Stergioulas, 2008), this study proposes a four dimensional model (human, technology, organization, and environment). Previous studies found that TOE frameworks are useful in understanding critical factors of new IT adoption in a given organization. Additionally, the HOT-fit model is mainly focused on the adoption of healthcare information systems within the context of a hospital. Therefore, integrating both of these frameworks seemed to be suitable for this study. Tornatzky and Fleischer (1990) summarized previous studies on innovative information technology adoption and proposed the TOE framework to understand the critical factors affecting the introduction of new information technology. Their framework contains three major elements that affect the process of adopting innovation technology and it includes the organization dimension, technology dimension, and environment dimension (Tornatzky & Fleischer, 1990). Although, this framework is not designed for the healthcare industry, it has been employed to facilitate the understanding of IS adoption in the healthcare industry on multiple occasions (Chang, Hwang, Hung, Lin, & Yen, 2007; Chong & Chan, 2012; Liu, 2011). For example, Chong and Chan (2012) found that the TOE framework can be applied to understand RFID (Radio Frequency Identification) adoption within the healthcare industry. Furthermore, Liu (2011) employed it to understand telecare adoption. Finally, the study of Chang et al. (2007) indicated that the TOE framework is useful to understand e-signature adoption within a hospital setting. Based on the above examples, the TOE framework is capable of being applied to the healthcare industry.

With a focus directly on the healthcare industry, Yusof, Papazafeiropoulou, et al. (2008) integrated human, organizational, and technological dimensions to assess the health information systems framework. Their research attempted to investigate whether or not health information systems performed as expected and to what degree they supported healthcare services. This model includes three major elements that need to be considered when adopting and implementing any technology innovation within the context of the hospital industry. They are the human, organizational, and technological elements (Yusof, Papazafeiropoulou, et al., 2008). Based on the aforementioned discussions, both the TOE framework and the HOT-fit model are suitable for the healthcare industry. Therefore, this study integrated the above two theories to understand cloud computing technology adoption; leading to the four factor analysis of the human component, technology, organization, and environment used in this article.

Regarding other literature about hospital information systems, Kazley and Ozcan (2007) argued that organizational and environmental factors will affect hospital EMR adoption. The study of Hsiao, Li, Chen, and Ko (2009) found that environmental, organizational, and technological factors will affect the adoption of mobile nursing information systems. In understanding the critical factors that will influence a hospital to adopt the Health Level 7 (HL7) standard, the study of Lin, Lin, Roan, and Yeh (2012) proposed that characteristics of the environment, technology, organization, and support from top management are all critical factors. In these aforementioned studies, top management support is an organizational dimension in both the TOE framework and the HOT-fit model. Finally, the study of Hung, Hung, Tsai, and Jiang (2010) justified that characteristics of organization and characteristics of IS are both critical factors to consider for Customer Relationship Management (CRM) adoption in hospitals.

Based on the theoretical background information and the review of findings in the literature, this study proposes a four dimensional model (Fig. 1), which incorporates the variables of human, technology, organization, and environment in understanding the decision to adopt cloud computing in the hospital industry. This study infers that these four dimensions will affect hospitals’ decisions toward the adoption of cloud computing technology in a positive manner.

2.1. Human dimension

The human dimension represents issues encountered by the hospital IS staff (including Chief Information Officer (CIO) and IS employees) when medical institutions engage in the adoption of an innovative technology. For hospitals, cloud computing technology is one type of new IT innovation. Therefore, the CIO will play an important role in the adoption decision process. For this reason, we argue that if a CIO can easily accept and conform to an innovative technology, he/she will have/exert a positive attitude.
toward the adoption of that new IT application (cloud computing) (Thong, 1999; Thong & Yap, 1995). The staffs’ technological capabilities and/or competencies will also impact a hospital when adopting an innovative information technology (Lin et al., 2012; Liu, 2011). If the IS staff has sufficient knowledge and the needed skills to adopt cloud computing, that hospital will certainly have more confidence throughout the process. From the above discussion, this study examines two variables in this dimension including CIO innovativeness and perceived technical competence.

Rogers (1995) defines personal innovativeness as the speed with which one adopts and accepts new ideas relative to other members in the same system. Agarwal and Prasad (1998) apply this aforementioned viewpoint to the field of applying information technology and further extend it as the willingness to try new information technology. This concept is employed to understand CIO innovativeness toward the adoption of new information technology and measured by selecting the four items developed by Agarwal and Prasad (1998). In addition, the measurement proposed by Kuan and Chau (2001) was employed to understand technical competence of hospital’s IS staffs in this study.

2.2. Technology dimension

The technology dimension entails the internal and external influences of adopting specific information technology in the organization. Due to the nature of cloud computing technology, data security and privacy are the major concerns for adoption; particularly in the healthcare industry and also as a general concern (Kuo, 2011). Furthermore, cloud computing technology proves to be the needed infrastructure of the Electronic Health Record (EHR). As a result, establishing a secure environment for EHR data integration and sharing is indeed critical (Chen, Lu, & Jan, 2012). For this reason, data security is included as one of the critical key variables in the technology dimension.

Previous studies have also indicated that IS complexity (Chang et al., 2007) and compatibility will affect IT adoption decision positively (Lin et al., 2012; Liu, 2011). Generally for those in the medical industry, adoption of cloud computing technology is more often than not a large scale project. Therefore, perceived system complexity will be a key criterion when making an adoption decision. Furthermore, hospital information systems such as Picture Archiving and Communication System (PACS), Hospital Information System (HIS), and Radiological Information System (RIS) are rather unique by nature. How to migrate these systems with the cloud computing platform will also be a critical factor that these organizations need to consider. Consequently, the level of system compatibility is another key factor in the technical dimension. If cloud computing technology can be compatible with the existing systems and/or applications of the hospital, then it will be more helpful and also more feasible for the adoption of cloud computing technology.

Finally, like any other IT investments, costs also play such an important role when hospitals decide to adopt cloud computing technology. Establishing a cloud computing platform requires different types of investments in such areas as hardware, software, and systems integration. Because of the varied and extensive nature of the costs, organizations can find the expenses associated with this type of project to be very sizable. For this reason, costs will also be a critical factor for the adoption decision. Based on the above discussions, this dimension is composed of four variables. These variables are data security, complexity, compatibility, and costs. Data security is measured by the metrics proposed in a study conducted by Soliman and Janz (2004), while complexity is measured by the scale proposed in a study produced by Premkumar and Roberts (1999) and Chang et al. (2007). In addition, measurement of compatibility is adapted from the studies of Premkumar and Roberts (1999) and Premkumar and Ramamurthy (1995). Finally, costs are measured by the scale from the studies of Kuan and Chau (2001) and Premkumar and Roberts (1999).

2.3. Organization dimension

Organizational factors will affect the hospital’s intention to adopt new information systems technology (Chang, Hwang, Yen, & Lian, 2006; Hsiao et al., 2009). In this study, the organizational dimension represents different organizational conditions including but not limited to variables such as relative advantage, top manager’s support, adequate resources, and benefits for adoption. Relative advantage refers to checking if the adoption of cloud computing technology can reduce operating costs and increase the relative operational benefits for a given hospital. The study of Premkumar and Roberts (1999) indicated that relative advantages will affect businesses and push them to adopt new information technologies. Top manager’s support refers to whether or not the executives understand the nature and functions of cloud computing technology and therefore fully support the development of it. The study of Chang et al. (2006) found that top manager’s support will affect new IS adoption in hospitals. Additionally, the adoption of cloud computing technology is usually a large project and a huge undertaking for hospitals. If a given hospital has a sufficient budget, adequate human resource support, ample time, and good top manager’s involvement, then the adopting of cloud computing technology will be met in a positive manner. To this end, adequate resources are also critical to the success of adoption (Chang et al., 2007). Finally, potential benefits such as improving a hospital’s image, gaining strategic advantage over that of their competitors, improving their service quality, and enhancing the efficiency of internal operations will also be critical. The study of Chang et al. (2006) found that the benefits of IS will lead to a positive adoption by a given hospital. The measurements used for this dimension were adapted from the studies of Premkumar and Roberts (1999), Chang et al. (2007), and Kuan and Chau (2001) respectively.

2.4. Environment dimension

The environmental dimension represents the current operating environment of the healthcare industry. This will no doubt impact hospitals as they adopt new information systems (Hsiao et al., 2009; Chang et al., 2006). In Taiwan, with the implementation of a national health insurance system in 1995, the healthcare industry environment has dramatically changed; competition between hospitals has become more intense. These competitive pressures will force hospitals to adopt new information systems quickly to
provide better services and gain strategic advantages. Previous studies also confirm the fact that business competition significantly affects hospitals to adopt mobile nursing systems in Taiwan (Hsiao et al., 2009). Besides, regarding HL 7 adoption, environmental pressure is found to have a positive effect onto the adoption decision (Lin et al., 2012).

One of the main objectives that the current Taiwanese government policy is trying to meet is determining the best way to avoid wasting medical resources. For example, the Taiwanese government enforces the promotion of the cross-hospital electronic health record interchange. This advance in cloud computing technology is highly correlated with the application of EHR. Additionally, the study of Chang et al. (2006, 2007) also found that government policies have a positive impact on hospitals trying to adopt new information systems technology. From the above discussion, the environment dimension includes the following two variables: government policy and perceived industry pressure. Each of these two variables was measured using the studies of Kuan and Chau (2001) and Premkumar and Roberts (1999) accordingly.

Based on above discussions, this study considers 12 variables and also categorizes them into four dimensions.

3. Research method

3.1. Participants and data collection

This study takes advantage of the questionnaire survey approach. Due to the different requirements for adopting cloud computing technology (private cloud or public cloud) across hospitals of different size, this study focuses on the adoption of private cloud computing technology for hospitals (Mell & Grance, 2011). Moreover, the major research targets are large- and medium- (metropolitan hospital) sized hospitals. Based on the official (Ministry of Health and Welfare) data, there are around 131 medical centers and metropolitan hospitals in Taiwan. The research participants are the CIOs from these aforementioned hospitals. After individual telephone contact, due to the reasons for either maintaining confidentiality or having no IS department, 7 hospitals refused to participate in this study. Therefore, 106 subjects with a willingness to participate in this research were identified and surveyed. Data collection was conducted from January to March in 2012. Following Dillman’s (1978, 1999) suggestion, questionnaires were sent out after first round telephone contact to confirm the respondent’s commitment and intention to participate. A statement indicating our desire to receive the response within two weeks is emphasized in the questionnaire. If questionnaires were not returned within three weeks, a second round telephone reminder was conducted accordingly. For those respondents claiming that they had either not received or misplaced the questionnaire, another copy of said questionnaire was sent again. Finally, a final call was conducted after one month for these non-respondents. After this final call, the authors continued to wait for another two weeks to accommodate the possibility of a late reply. During these aforementioned time periods, if returned questionnaires were found to contain partial data or incomplete data, a follow up call was conducted again with an effort to complete the data set. After the data collection was finished, a thank you card is mailed to express our appreciation. Sixty of the hospital CIOs who were contacted actually completed questionnaires.

3.2. Measurements

Since cloud computing technology is a newer information technology application, it is common for respondents to not fully understand what constitutes cloud computing technology. In order to avoid the misunderstanding created among the respondents, in the cover page of the questionnaire, we have defined and illustrated cloud computing technology as

“A kind of new online service which has three major service models including Software as a Service (Saas), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). This new platform can be served as an infrastructure in hospital information systems such as Electronic Medical Record (EMR), Picture Archiving and Communication System (PACS), Hospital Information System (HIS) and so on. Besides, it can be divided into the following types such as private cloud, community cloud, public cloud, and hybrid cloud. This study is focused on adopting the private cloud computing platform adoption in the hospital”.

About the measurements and questionnaire design, this study includes 12 major variables with a total of 42 items (see Appendix A). Measurements were modified/extended from prior studies.

Table 1 presents a summary of these item numbers and the associated references. Each variable was measured using a 5-point Likert type scale, with values ranging between 1 (very unimportant or very disagree) and 5 (very important or very agree). A higher value represents greater importance or agree perceived by the respondents. Each statement was translated by language and information management experts. In order to make sure the questionnaire is suitable for the research context, a pilot study is conducted. In this phase, the questionnaire was reviewed first by one IS professional (a professor from the Institute of Healthcare Information Management) and one healthcare industry professional (who has more than ten years’ worth of experience working in the hospital information field) before the distribution. The questionnaire is then modified based on their suggestions. Appendix A lists the items employed in this study.
Table 2
Validity and reliability.

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<td>0.70</td>
<td>0.63</td>
<td>0.82</td>
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H: human; T: technology; O: organization; \(\alpha\): Cronbach’s \(\alpha\); K: KMO value; B: significant of Bartlett’s test; TVE: total variance explained.

Additionally, based on Rogers (1995) diffusion of innovation concept, this study divides the development status of the cloud computing technology into four groups: innovators, early adopters, majority, and rejecters. This item is a category scale in the questionnaire. Hospitals that have completed the development of cloud computing technology are considered as innovators. Hospitals currently developing their cloud computing platform are regarded as the early adopters. Most research subjects are still assessing the need to adopt this new platform and hence, they will be grouped under the “majority” category. Finally, rejecters are those who have decided not to adopt cloud computing technology. Respondents chose the suitable category that best described the current development status of adopting cloud computing technology.

4. Data analysis

Data collection was conducted from March to April 2012. Sixty usable questionnaires were returned, for a valid return rate of approximately 57%. The following sections present the detail descriptive statistics regarding the instrument validity and reliability. Finally, Analysis of Variance (ANOVA) technique was employed to analyze the critical factors affecting hospitals’ decisions to adopt cloud computing technology across different adoption groups.

4.1. Descriptive statistics

The 60 responding hospitals comprised 12 (20%) medical centers and 48 (80%) metropolitan hospitals. This distribution is very similar to the real distribution in Taiwan. Of the total, 25 (41.7%) hospitals are public hospitals and 35 (58.3%) are private hospitals. Based on the previous definitions about the development status, 9 (15%) hospitals are innovators, 12 (20%) are early adopters, 34 (56.7%) belong to the majority, and 5 (8.3%) are rejecters.

4.2. Validity and reliability

Measurements in this study were modified/extended from previous studies. As a result, the validity and reliability of these measurements had to be tested. Factor analysis was employed to determine the instrument validity and Cronbach’s \(\alpha\) was used to test the reliability. Factor analysis with VARIMAX rotation was specifically used to assess the discriminant and convergent validity. The threshold of factor loading is 0.5 and the eigenvalue is larger than 1. Based on above criteria, four items are dropped due to cross loading or low value of the factor loading. Finally, twelve variables (38 items) are extracted from the four dimensions. The variables are labeled and abbreviated as follows: V1: CIO innovativeness; V2: Perceived technical competence; V3: Data security; V4: Complexity; V5: Compatibility; V6: Costs; V7: Relative advantage; V8:
Table 3
Overall analysis.

<table>
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<tr>
<th>Dimensions (mean/rank)</th>
<th>Variables</th>
<th>Mean</th>
<th>S.D.</th>
<th>Rank</th>
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<td>CIO innovativeness (V1)</td>
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<td>Environment (3.75/4)</td>
<td>Government policy (V11)</td>
<td>3.84</td>
<td>0.70</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Perceived industry pressure (V12)</td>
<td>3.67</td>
<td>0.75</td>
<td>10</td>
</tr>
</tbody>
</table>

Top manager’s support; V9: Adequate resource; V10: Benefits; V11: Government policy; and V12: Perceived industry pressure.

In the Cronbach’s $\alpha$ evaluation, the study of Hair, Black, Babin, and Anderson (2009) indicated that values of 0.6–0.7 be deemed as the lower limit of acceptability of Cronbach’s $\alpha$. In this research, the values of Cronbach’s $\alpha$ are all in the acceptance level (0.6). The results are summarized in Table 2.

4.3. Results of the critical factors

4.3.1. Overall analysis

The 60 respondents surveyed in this study indicated that the five most critical factors are: in sequence data security, perceived technical competence, costs, top manager’s support, and complexity (see Table 3). Among four different dimensions, the most important one is technology (mean = 4.17), followed by human (mean = 4.03), organization (mean = 3.85), and finally environment (mean = 3.75).

4.3.2. Comparisons between different groups

This study uses one-way ANOVA to test the differences between different groups. These results indicated that a significant difference for V1: CIO innovativeness ($p=0.002$); V3: data security ($p=0.032$); V5: compatibility ($p=0.002$); V8: top manager’s support ($p=0.003$); V9: adequate resource ($p=0.034$), and V12: perceived industry pressure ($p=0.017$). The major differences in V1, V5, and V8 are between rejecters and other groups. For V3, the major differences are between early adopters (mean = 4.21) and the majority (mean = 4.72). For V9, the major differences are among rejecters (mean = 3.16), innovators (mean = 4.20), and the majority (mean = 4.07). At last, for V12, the major difference exists between innovators (mean = 4.11) and rejecters (mean = 2.90).

Among the four dimensions, there was a significant difference in organization ($p=0.014$) and environment ($p=0.010$). In organization, the major differences exist between innovators (mean = 4.17) and rejecters (mean = 3.11) and between majority (mean = 3.87) and rejecters (mean = 3.11). In environment, the major difference exists between innovators (mean = 4.17) and rejecters (mean = 3.20). Table 4 lists the means and standard deviations, indicating that rejecters have the lowest scores on average.

5. Discussion

5.1. Human dimension

The human dimension reflects the importance of IS human resources in developing cloud computing in the hospitals. This is simply because IS personnel play a critical role in adopting new IT applications. There are two variables included in this dimension, and they are CIO innovativeness and perceived technical competence. The first variable represents the personal characteristics of the CIO while the second one refers to the capability of IS employees. Obtained results show that this dimension is the second most important among the proposed four dimensions. Further, perceived technical competence ranks second among the 12 variables. Therefore, a hospital should carefully assess its IS capability before a decision to adopt cloud computing technology is made. This is because the adoption of this new platform may completely change the operating nature of the hospitals’ existing information systems and furthermore, this resulting change may have a significant impact on said hospital. From the above discussion, it is obvious that IS human resources are a crucial consideration to take into account. To further investigate the differences between groups, this study shows that early adopters place more importance on the item of CIO innovativeness. However, there are no significant differences that exist between the importance of perceived technical competence across different groups.

5.2. Technology dimension

The technology dimension represents the technical issues involved in cloud computing technology adoption. As expected, data security and costs are perceived as the two most dominant factors in this dimension. Security problems are the most important issues in the context of a distribute environment (Luxtton, Kayl, & Mishkind, 2012), and the cloud computing environment is certainly no exception (Subashini & Kavitha, 2011; Zissis & Lekkas, 2012). This is particularly true for hospitals because healthcare data requires a more secure environment for storage and retrieval. Privacy issues are also a critical concern in the healthcare industry (Barua, Liang, Lu, & Shen, 2011). This variable is also perceived as more important by innovators. This may be due to the fact that they are first movers and have rather limited reference to previous experiences and/or lessons for implementation. Compatibility also has a similar result among our findings. Rejecters perceived compatibility as the least important factor. This is simply because they think they do not need cloud computing technology and therefore, compatibility is less important for non-adopter decision.

5.3. Organization dimension

This dimension includes four variables as per previous discussion. Top manager’s support and adequate resources are perceived as more important in this dimension. Both factors exhibit significant differences across different adopting groups. The major difference is between rejecters and other groups. The other difference is among rejecters, innovators, and the majority. This is simply because the adoption of cloud computing technology is such a large project for a hospital that some hospitals lack the resources to
implement cloud computing effectively. Therefore, the support of top managers and adequate resources are truly crucial. Finally, this study shows that the relative advantage and benefits of adopting cloud computing technology are relatively unimportant to hospitals. This finding is in disagreement with those of previous studies. This may be because cloud computing technology is perceived as a helpful tool in improving hospital information service quality, and therefore, these two variables are not crucial for the adoption decision.

5.4. Environment dimension

Government policy and perceived industry pressure fall under the environment dimension. This study shows that there is a significant difference between innovators and rejecters in perceived industry pressure. This means that first movers attempt to improve their competitive advantage more than laggards. However, the scores of the variables in this dimension are relatively lower compared to the variables in other dimensions. This means that inner requirements of cloud computing technology are deemed to be more important than outside pressures. The reason is that the Taiwan government has implemented an EMR policy. Hospitals thus, view cloud computing technology as an enabling technology and a necessary investment. Consequently, this variable shows little differences across the various groups.

5.5. Overall

Again, the most important dimension is technology, followed by human, organization, and finally environment. Additionally, the most critical concern for adopting cloud computing is the problem of data security. In 2012, Taiwan amended the Personal Information Protection Act to enforce the responsibility of protecting sensitive information through various penalties to incentivize the organization’s chief to take charge of this issue. For this reason, many hospitals have growing concerns about the data protection issues of adopting cloud computing. However, present study only focused on adopting private cloud computing, it is relative less security and privacy concern than public cloud computing adoption. Jansen and Grance (2011) particularity indicated that the key security and privacy issues of public cloud computing, including governance, compliance, trust, architecture, identity and access management, software isolation, data protection, availability, and incident response. In Taiwan, the Ministry of Health and Welfare attempts to promote “Health Cloud” for exchanging medical records between hospitals in the next few years. It is a kind of typical public cloud computing for hospitals. However, this project is still ongoing, therefore, we suggest that future study can focus on public cloud computing for advanced study and compare the similarities and differences between the different kinds of cloud computing architectures.

Following the security concern is the factor of IS technical competence for cloud computing technology, since moving the IS platform toward cloud adoption is a rather large project and thus implementation requires to mitigate any and all mistakes that could impact the day to day functions of hospitals. To this end, hospitals are concerned more about the IS department’s capability of adopting IS techniques. It is thus suggested that this concern can be reduced by consulting extensively with external IS experts to learn about their experiences with the adoption process. Finally, the last factor is the importance of cost/performance for adopting cloud computing technology. Due to the regulations of the National Health Insurance in Taiwan, decreasing expenditures and increasing income are one of the major objectives for hospitals. On the other hand, to establish a private cloud computing platform is an expensive investment and therefore the significance of this cost/benefit concern become quite obvious. The above critical findings are crucial for hospitals to consider whether and when to adopt cloud computing technology. Additionally, organization and environment dimensions indicate one obvious difference across different groups. Since, operating environments may vary across countries, the effect of the environment dimension may be different between countries.

Comparing the results of this study with previous studies conducted in different countries, Lin and Chen (2012) found that the critical concern for adopting cloud computing technology in Taiwan as a software company includes the following three factors. They are: (1) compatibility with companies’ policy, (2) IS environment and business needs and (3) relative advantages. For British Small and Medium Enterprises (SMEs), the major concerns for adopting cloud computing technology are such factors as control, vendor lock-in, performance, latency, security, privacy and reliability (Sultan, 2011). In Taiwan’s high-tech industry, the critical determinants for adopting cloud computing technology are relative advantage, top management support, firm size, competitive pressure, and trading partner pressure (Low, Chen, & Wu, 2011).
Based on these discussions above, it is noted that different industries have their own concerns toward the cloud computing adoption. Therefore, understanding of these critical success factors across different industries certainly has its unique value and contribution. In short, this study fills a gap related to understanding adoption of cloud computing technology in the healthcare industry.

6. Conclusions

Taiwan has a very high degree of e-healthcare maturity (Liu, Hwang, & Chang, 2011). Research findings in Taiwan can contribute to the development of healthcare information systems around the world. This study integrates the TOE framework and HOT-fit model to investigate the critical factors affecting hospitals’ decisions regarding the adoption of cloud computing technology. The main contribution of this study is its discussion of implications for practitioners and academia. For practitioners, this study identifies key factors affecting a hospital’s decision to adopt cloud computing technology. Hospitals can refer to the findings of this study to make a better decision. For academia, this study applies previous theories to the field of cloud computing technology. Future studies can extend this study based on its findings. The major limitation of this study is due to the different requirements toward the adoption of cloud computing technology; the authors focus only on medical centers and metropolitan hospitals. Regional hospitals are excluded from the sample. This limits the capability to generalize this study to other types of hospitals. Future research should extend this study to other hospital categories. Finally, healthcare industry environments may vary across different countries. Therefore, future research should make cross-country comparisons to enhance the completeness of this study.

Appendix A. Measurement items

Human dimension

1. CIO innovativeness (adapted from Agarwal & Prasad, 1998)
   (1) If I heard about a new information technology, I would look for ways to experiment with it.
   (2) Among my peers, I am usually the first to try out new information technologies.
   (3) In general, I am hesitant to try out new information technologies.*
   (4) I like to experiment with new information technologies.
   Note: *Denotes items that were reverse scored.

2. Perceived technical competence (adapted from Kuan & Chau, 2001)
   (1) The ability of IS staff in IS support.
   (2) Previous IS development experience of IS staff.
   (3) The ability of IS staff in supporting cloud computing system development.

Technology dimension

1. Data security (adapted from Soliman & Janz, 2004)
   (1) If cloud computing techniques provide sufficient security transfer channel during the process of mass data interchange.
   (2) Data security and privacy.

2. Complexity (adapted from Chang et al., 2007; Premkumar & Roberts, 1999)
   (1) The complexity of learning cloud computing applications.
   (2) The difficulty of transferring current systems to cloud computing platform.
   (3) The complexity of maintaining cloud computing platform.
   (4) The complexity of developing cloud computing applications.

(5) The complexity of system integration.

3. Compatibility (adapted from Premkumar & Ramamurthy, 1995; Premkumar & Roberts, 1999)
   (1) If cloud computing technology is compatible with current practices.
   (2) If cloud computing technology compliance with hospital’s core values and goals.
   (3) If cloud computing technology is compatible with current information infrastructure.

4. Costs (adapted from Kuan & Chau, 2001; Premkumar & Roberts, 1999)
   (1) The cost of establishing cloud computing technology.
   (2) The cost of maintaining cloud computing technology.
   (3) The cost of cloud computing technology user training.

Organization dimension

1. Relative advantage (adapted from Premkumar & Roberts, 1999)
   (1) If cloud computing technology can improve the communication efficiency between the partners.
   (2) If cloud computing technology can reduce the operating costs.
   (3) If cloud computing technology can improve the profits.
   (4) If cloud computing technology can provide real time information to users.

2. Top manager’s support (adapted from Premkumar & Roberts, 1999)
   (1) Top manager’s enthusiasm in adopting cloud computing technology.
   (2) If top manager provide resources in adopting cloud computing technology.
   (3) If top manager understand the benefits of cloud computing technology.
   (4) If top manager encourage the development of cloud computing technology.

3. Adequate resource (adapted from Chang et al., 2007)
   (1) If hospital have enough resources to support the development of cloud computing technology.
   (2) If hospital have enough time to develop cloud computing technology.
   (3) If hospital have enough budget to develop cloud computing technology.
   (4) If hospital have enough human resources to develop cloud computing technology.
   (5) Top manager’s involvement in developing cloud computing technology.

4. Benefits (adapted from Kuan & Chau, 2001)
   (1) If adopting cloud computing technology can improve hospital image.
   (2) If adopting cloud computing technology can improve competitive advantage.
   (3) If adopting cloud computing technology can improve internal efficiency.
   (4) If adopting cloud computing technology can improve healthcare service quality.
   (5) If adopting cloud computing technology can improve the relationship between hospital and patient.

Environment dimension

1. Government policy (adapted from Kuan & Chau, 2001)
   (1) If healthcare cloud computing development is becoming one of the government major policies.
   (2) The government’s schedule to develop Electronic Medical Records.
2. Perceived industry pressure (adapted from Premkumar & Roberts, 1999)

(1) The impact of adopting cloud computing technology to the hospital future operating.

(2) If cloud computing technology is becoming the major strategy for improving competitive advantage.

References


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