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Electronic data interchange usage in China’s healthcare organizations: the case of Beijing’s hospitals

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Abstract

China has long since realized the potential benefits of adopting electronic data exchange. In particular, the Chinese government is promoting the usage of electronic data interchange (EDI) in healthcare organizations. However, little research has described the current status of EDI usage in these organizations. This study investigates the extent of EDI usage in Beijing’s hospitals along four dimensions: volume, diversity, breadth, and depth. The results from 57 hospitals show that EDI usage is in its very early stages. The study provides possible reasons for the low EDI usage from cultural, economic, and technological perspectives, analyzes the differences of EDI usage in the different levels of China’s hospitals, and suggests strategies to promote EDI usage in China’s healthcare organizations.

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1. Introduction

Electronic data interchange (EDI) has revolutionized the way in which organizations conduct their activities. The rapid growth of electronic commerce (e-commerce) in the global scope is
forcing developing countries such as China to adopt EDI to fulfill international electronic business-to-business (B2B) trades (Gibbs, Kraemer, & Dedrick, 2003). China’s total amount of import and export trade reached 510 billion US dollars in 2001 (News, 2002). Accordingly, the Chinese government’s attention to the development of EDI is rapidly increasing. A series of policies have promoted the development of information technology (IT) and the leaders of China envisioned that electronic commerce (e-commerce) represents the future direction of business development and will bring more opportunities to China (He, 2000). The encouragement from the government greatly impacted the attitude of industry toward IT, especially B2B e-commerce. In addition, the rapidly changing global economic environment also mandates the use of new information technologies. Upon joining the World Trade Organization (WTO) on November 10, 2001, China promised to open its telecommunications and finance markets, which coerced the development of e-commerce in China. International companies have increased their investments in China and some global companies have started to implement EDI in their subsidiaries in China.

While e-commerce incorporates both the B2B model and the business-to-consumer (B2C) model, the B2B sector has been growing faster in China and has much greater potential than the B2C sector. The B2B sector accounts for 80% of the 9.3 billion US dollar e-commerce business in China (News, 2001). The Chinese government’s vision of e-commerce focuses on EDI via dedicated networks and is oriented toward wholesale procurement (Electronic Commerce, 2002). The Chinese government has undertaken various measures to promote the development of EDI, including new policies (e.g., trans-border security), significant infrastructure investment, and application promotion strategies. With the government’s advocacy, EDI is likely to be widely adopted by increasing numbers of organizations in China.

China’s healthcare system is experiencing tremendous changes because of China’s economic reforms and healthcare reforms that intend to solve the problems of the legacy healthcare systems (Yuen, 1996). The problems confronting healthcare organizations include rapid healthcare cost escalation, the inefficiency in healthcare resource allocation, and the inefficiency in healthcare provision. IT is considered as helpful in tackling these problems. China’s Ministry of Health (MOH) is undertaking a major project, the China Golden Health Medical Network Project, to establish a satellite-transmitted nationwide healthcare communications network (CBnet, 1997). A part of the project is to launch the Golden Health Card, a smart card with a small embedded chip to save patient financial and medical information and to help patients obtain appropriate healthcare from hospitals in different geographic locations. Hospitals have started to use EDI to communicate with other hospitals, medical resource suppliers, insurance companies, and banks. The MOH anticipates that using EDI can significantly contribute to the containment of healthcare costs and the efficient allocation of healthcare resources.

Although EDI adoption appears promising in Chinese organizations in general and healthcare organizations in particular, little research has been conducted to quantitatively measure the extent of EDI usage. Given the unclear nature of EDI usage in China, a descriptive study is considered most appropriate. A descriptive study, therefore, was carried out to assess EDI usage in Chinese hospitals from four dimensions: volume, diversity, breadth, and depth. One objective of this paper is to report the study results. The other objective is to explain the current situation of EDI usage in Chinese hospitals and explore possible means to promote EDI usage.
2. Theoretical background

EDI usage is a complicated organizational activity that can be measured from different aspects to obtain a reliable and valid view. Prior studies have used various instruments to measure the extent of organizational EDI usage (Cox & Ghoneim, 1995; Hart & Saunders, 1998; Johnson, Allen, & Crum, 1992; Massetti & Zmud, 1996). These instruments assess four dimensions of EDI usage, which include volume, diversity, breadth, and depth. In early studies, the four dimensions were rarely aggregated in a unified approach which would allow a comprehensive understanding of EDI usage. In an attempt to build a linkage between EDI strategies and operations, Massetti and Zmud (1996) proposed an EDI measurement approach integrating all four dimensions. The framework of EDI measurement used in this research is based upon Massetti and Zmud’s approach, with modifications to adapt the framework to our research context.

Our framework utilizes the dimensions of volume, diversity, breadth, and depth to measure EDI usage. Volume refers to the extent to which a firm’s document exchanges are processed through EDI technology. Diversity refers to the extent to which different types of a firm’s business documents are processed through EDI technology. Breadth refers to the extent to which a firm is doing transactions with its business partners through EDI connections. Depth refers to the extent to which a firm’s business processes are intertwined with the capabilities of EDI technology.

The underlying idea is that EDI usage should be assessed through examination of all of the four dimensions. Failure to measure a dimension may cause a skewed perception of EDI usage and the quality of the strategies based on this perception will be flawed. In the following sections, each of the four dimensions and its importance will be discussed in the context of hospitals in China.

2.1. Volume

Volume is determined by the ratio of the number of documents exchanged via EDI to the total number of trading documents exchanged via all communication channels. A higher EDI ratio implies a firm has made progress toward the goal of “paperless” transaction processing. To gain insight, EDI volume is measured from both the organizational perspective and functional perspective. Correspondingly, this study measures both the overall EDI volume and the EDI volume for specific business functions such as purchasing, inventory, accounting, logistics, and others. Hospital-specific functions, such as hospitalization administration and drug compounding and preparation, were also included.

2.2. Diversity

The number of different document types exchanged through EDI indicates the diversity of an organization’s EDI usage. Electronic business documents differ not only in business functions but also in EDI standards. As a result, different types of EDI documents may require different hardware and software. Documents of the same business function but exchanged using different EDI standards also require different hardware and software components. Therefore, more diversity is associated with higher degree of computer integration (Hart & Saunders, 1998). Cox and Ghoneim (1995) argued that a firm’s competitive advantage gained from a single EDI
connection is unlikely to be sustainable. An increased diversity of EDI usage may be positively associated with the sustainability of a firm’s competitive advantage in the market.

2.3. Breadth

Breadth is calculated as the ratio of the number of the trading partners with which a firm has established EDI linkages to the number of all its trading partners. In this study, the percentages of manufacturers, distributors, domestic carriers, foreign carriers, IT partners, and others were obtained from each hospital. The higher the percentage, the more a hospital appears to be engaged in EDI and the more likely it will be successful in competing in the field of e-commerce. It is especially meaningful to measure EDI breadth in China’s healthcare industry, because EDI is not widely adopted in that sector.

2.4. Depth

In prior research, depth is represented by three levels of technical sophistication of EDI connections between trading partners. From simple to complicated, the three levels are file-to-file, application-to-application, and coupled work environment (Massetti & Zmud, 1996). Basically, the file-to-file connection needs human efforts to accomplish the electronic document exchange. The application-to-application EDI connection automates all the procedures of a business transaction. In the coupled work environment, a firm is able to directly access its partner’s computer-based system. More sophisticated EDI depth means more investment, so increasing EDI depth is not necessarily a strategically wise move.

After interviewing experts in healthcare information systems at Beijing University, the authors found that most hospitals in Beijing are restricted to the file-to-file level of EDI because of various barriers stemming from a lack of IT infrastructure capabilities, a lack of network bandwidth, and hospital policy. Despite the fact that application-to-application EDI and the coupled work environment are likely to be more efficient than file-to-file EDI, they require more highly trained employees, greater network bandwidth, and more open-minded hospital policy. In China’s hospitals, these requirements are not satisfied. Given this situation, measuring depth with Massetti and Zmud’s three levels is not applicable in Chinese hospitals. A new perspective to examine the depth of EDI usage is necessary.

Consequently, after consulting an IT expert in hospital information systems the authors created a new question to examine the type of document content that is exchanged at the file-to-file level of EDI in Chinese hospitals. This question classifies the depth of an EDI document into three incremental levels: (1) data, (2) data and text, and (3) data, text, and image. The three levels are based on the complexity and objective of the task for which an EDI document serves. At the first level, the task is simple and usually serves for simple hospital administration. For example, the payroll transfers between departments only require numbers and few texts. At the second level, the task is more complicated and serves for some administrative functions and most medical document exchange. For example, departmental monthly reports and patients medical records require a large amount of data and texts. At the third level, the task is mainly for medical purpose, especially telemedicine which not only requires text-based information but also multimedia information. For example, physicians performing telediagnosis for a patient with a broken spine.
need the patient’s medical records, vital signs, symptoms, CT images, and MRI images in order to make an accurate diagnosis. Therefore, this question can differentiate EDI usage at the file-to-file level and indicate the depth of hospitals’ EDI usage.

This section has discussed how this research addresses the four dimensions of EDI usage in Chinese hospitals. Section 3 describes the context in which the study was conducted; i.e., the Chinese hospital system and how hospital IT managers define EDI.

3. China’s hospital system

In 1995, the MOH began classifying hospitals into three major levels according to the hospitals’ medical, educational, and research capabilities and their medical equipments (Ling & Le, 1999). Level I hospitals are community level small-scale hospitals that provide primary care and refer difficult cases to Level II hospitals. Level II hospitals are regional centers of medicine practice. These hospitals treat and monitor patients with serious diseases and receive referrals from Level I hospitals. Level II hospitals have limited research and education activities in addition to providing medical care. Level III hospitals are in the highest level and usually national hospitals with more than 500 beds. With the best physicians and medical equipments in China, Level III hospitals provide medical care and public health services and carry out a lot of teaching and research activities. The number of different levels of hospitals and their proportions are listed in Table 1. Since low-level hospitals refer patients to high-level hospitals and high-level hospitals are responsible for providing guidance and assistance to low-level hospitals, hospitals in China communicate with each other on a regular basis.

In China, the majority of hospitals are not-for-profit organizations. Their income comes from three sources: the finance budget from the government, medical services, and drug sales. Traditionally, pharmacies are an integral part of hospitals and drug sales constitute approximately 70% of hospitals’ income (BeijingReview, 2001). Although the Chinese government has been attempting to separate pharmacies from hospitals during its healthcare reforms, the current situation will not change in the short run. In 2002, the drug sales income still represents 47.6%, a major proportion of the total income of general hospitals in China (MOH, 2003).

| General hospital         | Traditional Chinese medicine hospital | Specialized hospital | Total     | Percent |
|--------------------------|--------------------------------------|---------------------|-----------|---------|
| Level III                | 649                                  | 141                 | 168       | 977     | 5.7     |
| Level II                 | 3610                                 | 1166                | 328       | 5198    | 30.3    |
| Level I                  | 2370                                 | 106                 | 169       | 2674    | 15.6    |
| Other                    | 5585                                 | 1036                | 1447      | 8299    | 48.4    |
| Total                    | 12,214                               | 2449                | 2112      | 17,148  | 100     |

Source: The MOH’s official website, http://www.moh.gov.cn/statistics/digest03/t6.htm.
The ownership of hospitals in China is complicated. Hospitals may belong to the MOH, local
governments, city districts, counties, or the military. Upon joining the WTO, China promised to
open the healthcare practice market and allow foreign countries to invest in hospitals. As a result,
joint-venture hospitals and private hospitals start emerging.

3.1. Definition of electronic data interchange in China

In the early 1990s, China began to adopt EDI. Many Chinese researchers have tried to give EDI
a precise definition, but to date there has been no consensus in this regard in China. After
interviewing five IT department managers in China’s hospitals, the authors found that these
managers consider organizational internal data exchange as a form of EDI. These managers think
that exchanging data electronically among different departments within one organization enables
the organization to exchange data electronically with other organizations. Based on these
interviews, the term of EDI in this study was broadly defined as the direct exchange of electronic
documents among computer systems in different departments within an organization or between
different organizations without human intervention.

4. Research method

4.1. Sample

Beijing was chosen as the research site for several reasons. First, it is the capital of China
and one of the China’s most industrialized cities. Second, many organizations in Beijing have
excellent IT infrastructures in place. Third, Beijing is one of the 13 cities that established EDI
centers of the China Public Electronic Data Interchange Business Network early in 1996. Due to
these factors, the hospitals in Beijing usually receive more assistance from the government and
various industry organizations to implement new technologies than hospitals in other cities. As a
result, Beijing’s hospitals are typically the earliest health institutions to experiment with new
technologies. Therefore, choosing Beijing as the research site means that our findings might
predict the future of EDI usage in hospitals in other parts of China. The strategies generated
based on our findings will help China promote and implement EDI in hospitals not only in Beijing
but also nationwide.

Beijing had 62 Level III hospitals, 47 Level II hospitals, and 230 Level I hospitals when this
study was conducted. A convenience sample of 68 hospitals (approximately 20.1% of the total
number of hospitals in Beijing) was selected since some of these hospitals’ managers took a class
of healthcare management continuing education offered by Beijing University. Forty-eight
Level III hospitals (approximately 77.4% of Beijing’s Level III hospitals) were selected for our
sample because they are more likely to adopt EDI (Hellbruck & Schoder, 2001). Considering
other hospitals in Beijing also have the opportunity to use EDI, we selected 13 Level II hospitals
and seven Level I hospitals. Consequently, 70.6% of our sample were Level III hospitals, 19.1%
Level II, and 10.3% Level I. The Level III hospitals consisted of 33 comprehensive hospitals and
15 specialized hospitals. All the Level II hospitals were comprehensive hospitals. The Level I
hospitals included five comprehensive and two specialized hospitals.
4.2. Measurement instrument

The questionnaire employed in this study has four sections. The first section is a consent letter to solicit respondents’ agreement to provide information. Anonymity was guaranteed to the respondents. The second section contains a brief introduction where EDI is clearly defined in order to prevent misunderstanding. The third section gathers hospital demographic data. The fourth section consists of the questions concerning the extent of EDI usage along the four dimensions of volume, diversity, breadth, and depth.

In order to apply the questionnaire in China’s hospitals, a Chinese translation of the questionnaire was necessary. An independent translator translated the original questionnaire from English to Chinese. Then, a different independent translator reverse translated the Chinese questionnaire back to English. The second English questionnaire was compared with the original questionnaire to ensure that the contents were not different. The comparison suggested that the Chinese translation of the questionnaire was semantically equivalent to the original questionnaire except for some expression differences that were deliberately made to address the issues of culture differences. For example, in the Chinese questionnaire, the respondents are called in a respectful way that is regarded as an educated courtesy in China, instead of the straightforward American way of calling “you” or “your hospital”.

The questionnaires were hand delivered to the contact persons of the hospitals. These contact persons were hospital departmental managers who play important roles in their hospitals. Each contact person acquired the permission to release hospital information from the president of the hospital. The contact person then filled out the questionnaires with help from various departments of the hospital. All 68 hospitals returned the questionnaires. Fifty-seven of the hospitals have adopted EDI and were able to provide usable data on the fourth section of questionnaire.

The high response rate was expected because the survey was conducted under the name of the Department of Pharmacy Administration, Beijing University. The department offers continuing education courses to physicians and pharmacists in hospitals in Beijing from whom the contact persons were selected. All the contact persons were given course credits for assisting in completing the questionnaires. In addition, the department maintains good work relationships with the hospitals, which also contributed to the high response rate.

5. Results

Among the 68 responding hospitals, 57 hospitals use EDI and the other 11 do not. Only the 57 hospitals using EDI are considered in the data analysis. The EDI users consist of 41 (71.9%) Level III hospitals, 12 (21.1%) Level II hospitals, and four (7.0%) Level I hospitals. In terms of ownership, 21 hospitals (36.8%) belong to the MOH, 22 hospitals (38.6%) belong to the government of Beijing, 11 hospitals (19.3%) belong to a district of the Beijing city, and the remaining includes a county hospital and two military hospitals. The average number of employees in the Level I, Level II, and Level III hospitals are 470, 757, and 1608, respectively.

Respondents reported three types of EDI connections: internal EDI, regional EDI, and military EDI. As discussed earlier, the domain of EDI is restricted in this study as a result of Chinese IT managers’ perceptions. Internal EDI is intra-organizational document exchange at the
departmental level. Regional EDI refers to inter-organizational document exchange in the organizational level but restricted within a certain geographical area. In China, EDI services are provided by the government’s EDI centers located in major cities at regional, national, or international level. Military EDI is separate from the commercial EDI systems in China. Due to security concerns, the authors could not obtain information about military EDI. Among our participating hospitals, 36 (63.2%) use internal EDI, 20 (35.1%) use regional EDI, and one uses military EDI.

5.1. Volume

As shown in Table 2, the average overall EDI volume is 57.9%, which means that on average more than half of hospital documents are exchanged via EDI between the departments of the hospitals or between the hospitals and their trading partners. For the various specific functions including purchasing, inventory, accounting, compounding, finance, IT, logistics, and inpatient management, the EDI volume ranges from 24.4% to 85.3%. The Kruskal–Wallis test (Hollander & Wolfe, 1973; Neter, Kutner, Nachtsheim, & Wasserman, 1996), a non-parametric alternative of ANOVA, was used to examine the difference of EDI volumes among different hospital levels. Results indicated that the EDI volumes in purchasing are significantly different among hospital types ($\chi^2 = 6.16, p < 0.05$). Further analyses using Mann–Whitney tests (Hollander & Wolfe, 1973; Neter et al., 1996), a non-parametric alternative of $t$-test, pinpointed that Level I and III hospitals are significantly different in EDI volume for purchasing ($U = 24.00, p < 0.05$) and IT ($U = 25.50, p < 0.05$). There are no significant differences among the three types of hospitals in terms of other EDI volumes.

5.2. Diversity

The average number of different EDI document types is 9.3 in Level III hospitals, 10.1 in Level II hospitals, and 6.8 in Level I hospitals. The most mentioned document types include accounting forms, medical charts for hospitalized patients, inventory quotes, drug compounding files, and patient billing forms. The Kruskal–Wallis test showed that the EDI diversity does not differ significantly among the three levels of hospitals ($\chi^2 = 4.22, p > 0.05$).

Table 2
EDI volume

| Document Type          | Level I (%) | Level II (%) | Level III (%) | Mean (%) |
|------------------------|-------------|--------------|---------------|----------|
| Accounting             | 85.00       | 78.75        | 87.24         | 85.30    |
| Inpatient administration| 92.50       | 71.67        | 86.46         | 83.77    |
| Inventory              | 95.00       | 72.50        | 81.59         | 80.61    |
| Drug compounding       | 95.00       | 74.58        | 74.24         | 75.77    |
| Finance                | 60.00       | 61.25        | 67.61         | 65.74    |
| IT                     | 7.50        | 46.25        | 57.80         | 51.84    |
| Purchasing             | 0           | 24.58        | 27.30         | 24.82    |
| Logistics              | 2.50        | 32.08        | 24.24         | 24.37    |
| Overall                | 57.50       | 57.08        | 58.23         | 57.94    |
5.3. Breadth

Table 3 shows the EDI breadth of the hospitals. It is most likely for a hospital to have an EDI connection with its drug distributor partners (22.5%) and least likely with its foreign carrier partners (0.12%). Kruskal–Wallis tests indicated that none of the EDI breadth is significantly different among the three levels of hospitals ($p > 0.05$).

|                  | Level I (%) | Level II (%) | Level III (%) | Mean (%) |
|------------------|-------------|--------------|---------------|----------|
| Distributor      | 0           | 26.25        | 23.60         | 22.50    |
| IT               | 20.00       | 19.58        | 15.51         | 16.68    |
| Bank             | 0           | 9.17         | 11.61         | 10.28    |
| Manufacturer     | 0           | 0.42         | 6.73          | 4.93     |
| Domestic carrier | 0           | 1.25         | 5.34          | 4.11     |
| Foreign carrier  | 0           | 0            | 0.17          | 0.12     |

5.4. Depth

A total of 44 (77.2%) hospitals transmitted data and text via their EDI linkages with their trading partners. Nine hospitals (15.8%) only transmitted data and four (7.0%) transmitted data, text, and image. One hospital reported to conduct telediagnosis via EDI channels. The Kruskal–Wallis test indicated that the three levels of hospitals are significantly different in terms of EDI depth ($\chi^2 = 9.31$, $p < 0.05$). Mann–Whitney tests demonstrated that the difference locates between the Level I and Level III hospitals ($U = 26.5$, $p < 0.05$).

6. Discussion

6.1. Interpretation of results

Although 57 hospitals stated that they have adopted EDI, the findings showed that 63.2% of the EDI are actually internal EDI, which cannot be called EDI if a stringent definition is applied. As far as EDI volume is concerned, the overall volume of 57.9% seems optimistic. However, purchasing and logistics, the two individual business functions involving the most inter-organizational transactions, have volumes lower than 25%. Other business functions such as inventory, accounting, finance, IT, and hospitalization administration are more likely related to inter-departmental EDI usage within the boundaries of a hospital.

From the aspect of document diversity, a hospital in China normally has hundreds of different document types. The results of this study show only 11.6 document types on average are handled through EDI connections. The majority of document types are still manually processed, implying a large space for improvement for EDI development in China’s hospitals. Similarly, the low
percentages (less than 25%) of EDI breadth denote that the hospitals have established EDI connections with only a very limited number of trading partners. This finding implies that the adoption of EDI is still in its early stage for both the hospitals and other firms. In addition, most hospitals only use EDI at the file-to-file level. At this level, 93.0% of the EDI documents do not contain image information, indicating that EDI is mostly used to support hospital administration and simple professional healthcare tasks. These findings suggested that EDI has been adopted by a number of hospitals in China, but its usage is at a relatively low level.

Given that high-level hospitals have more resources, we anticipate that Level III hospitals should exceed Level I and Level II hospitals in all of the four dimensions of EDI usage. Surprisingly, few differences were identified among the three hospital levels. Other than the fact that Level III hospitals have significantly greater EDI volumes in purchasing and IT and a greater EDI depth, there are no other statistically significant differences among hospital levels. The results of differences among hospital levels are interpreted with great caution because a convenience sample was used which might not represent the general population of hospitals in Beijing. For example, seven Level I hospitals were selected from a total of 230; it is very likely that this sample was biased. A plausible explanation of the lack of EDI differences between Level III hospitals and lower-level hospitals is that those Level I and Level II (especially Level I) hospitals who sent their managers for continuous education in Beijing University are likely to be the ones who put more emphasis on technology and have more resources. These Level I and Level II hospitals may tend to be champions with respect to leveraging advanced information technologies; therefore, the level of their EDI usage is shown in this study to be close to that of the Level III hospitals. Nevertheless, the major objective of this paper is to depict the EDI usage status in China’s hospitals. The selection of Beijing and the inclusion of more Level III hospitals enable us to study a sample where EDI usage would more likely be great. Based on a reasonable analysis of the sample, it can be inferred from the results that in general the various aspects of EDI usage in China’s hospitals will be less than the extent of EDI usage in our sample.

6.2. Explanation

The limited EDI usage in Beijing’s hospitals can be explained from three perspectives: the cultural and social, the economic, and the technological. First, the Chinese people’s cultural assumptions and social issues might inhibit EDI usage. In China, businesses, especially in the B2B sector, operate to a large extent on the basis of personal relationships. The Chinese people build friendships with each other before undertaking any serious business initiatives. Using EDI to conduct B2B transactions can often involve unfamiliar or new trading partners, which is incongruent with the Chinese business culture. Given the great geographical expansion and heterogeneous traditions in China, people living in different regions have dissimilar beliefs. Companies that are not located close to each other are reluctant to do business with each other using manual methods because of trust concerns, let alone using EDI. This trust hurdle will not be easily overcome in a short period of time in China.

In addition, there are no sufficient legal and physical infrastructures nationwide to support settlements, delivery, and materials acquisition in China (Foster & Goodman, 2000). The lack of regulation and monitoring of e-behaviors worsens the trust crisis and puts huge obstacles in the way of EDI progress. When patient data are involved, security and confidentiality become a more
sensitive issue. China has no regulations to define the legitimacy of electronic patient records (EPR) and control the exchange of EPR, which has greatly impeded the electronic communication among hospitals, employers, and insurance agencies. For example, China’s current medical regulations require that any change to a patient’s medical record needs to be made in red ink. Obviously, this is impossible in a digital format.

Second, from an economic perspective, implementing EDI in an organization is typically costly, requiring substantial monetary and human capital. Shifting from traditional business to electronic business can profoundly change an organization’s structure and business processes, which is perceived highly risky. Labor in China is so cheap that the start-up costs of EDI can be higher than the labor costs. As a result, the perceived benefits of EDI such as reduced costs and automated business processes may not be attractive enough to justify EDI adoption. A related issue of EDI adoption in China is the unemployment dilemma. The high unemployment rate is currently a big problem facing China (Smyth, 1999). The tradeoff between efficient business processes and distressing unemployment concern is difficult for organizations, especially state-owned enterprises such as public hospitals, to determine.

Third, from the technological perspective, the complexity of health-related data makes data standardization a big problem. Compliance with the Health Level 7 (HL7) standard is rare in China’s healthcare organizations. HL7 standards are widely accepted “for the exchange, management and integration of data that support clinical patient care and the management, delivery and evaluation of healthcare services” between healthcare information systems (HL7, 2002). In the US and many European countries, the HL7 standards have become the main EDI standard for healthcare systems (Spyrou et al., 2002). IT infrastructure inadequacy is another technological obstacle for EDI adoption. Compared with other industries in China, healthcare organizations demonstrate the minimal level of leased-line connectivity (Foster & Goodman, 2000). According to United Nation, high Internet access cost, restrictions on Internet services, slow and uncertain delivery of network connections, lack of awareness of perceived benefits, and lack of knowledge of e-commerce technology are reasons for the delay of e-readiness in developing countries (UnitedNations, 2001). It appears that these factors have also delayed the EDI development in China.

The preceding explanations apply to all the levels of hospitals in China. In an effort to augment the understanding of EDI adoption in China’s hospitals, the differences between hospital levels are discussed next. This study did show some differences between the Level III hospitals and the lower-level hospitals, although these differences were much less than expected. Based on the authors’ observation, the differences among hospital levels can be illustrated in three aspects: resources availability, government-driven adoption, and market position. First, Level III hospitals have more resources, thus more capabilities to implement EDI than lower-level hospitals (Level I and Level II). The resources include financial resources, human resources, and IT resources. Second, Level III hospitals tend to be early adopters of information systems due to the government’s requests. In China, it is a common strategy for the MOH and local governments to use several Level III hospitals to develop or experiment with innovations. If the experiments are successful, the Level III hospitals will become “model hospitals” and their experiences will be shared by other hospitals which will become followers. For example, the China Golden Health project requires high-level hospitals to take initiatives earlier than low-level hospitals. This national project entails building hospital information systems, insurance accounting and payment
networks, and telemedicine, and the objective is to electronically link stakeholders in the healthcare systems to improve management and quality of care. Given that Level III hospitals are early innovators taking part in this project, it is a rational anticipation that they will have more inter- and intra-organizational electronic connectivity than lower-level hospitals.

Finally, China’s context has an effect on the competitive relationship between Level III hospitals and lower-level hospitals. For example, outpatient registration fees are determined by the healthcare policy in China. The registration fee difference between Level III hospitals and lower-level hospitals is approximately USD $0.2. Since the fee difference is so small, many patients are willing to pay more to go to Level III hospitals where they think better care can be provided. As a result, Level I and Level II hospitals have few outpatient visits while Level III hospitals have long waiting lines. This situation affects hospitals’ strategic foci. For Level III hospitals, the focus is likely to be on performance improvement by leveraging IT so that their competitive advantages can be sustained. For lower-level hospitals, patient attraction is a critical issue with the first priority and they are more likely to invest on marketing rather than IT. By explicating these three differences, some insights are offered regarding the phenomena of EDI usage in the different levels of hospitals.

6.3. Implications

This study presents an assessment of the use of EDI in 57 Beijing hospitals across the dimensions of volume, diversity, breadth, and depth. The investigation shows that the use of EDI in China’s healthcare sector is still in its infancy. Possible reasons for low EDI usage are explored in China’s socioeconomic context. Based on these explanations, we propose the following strategies to improve EDI usage in China’s healthcare systems.

First, China should take a “top-down” approach to promote EDI adoption and diffusion in its healthcare systems. The Chinese government has great influence on the business processes of healthcare organizations through regulations and policies that administer the usage of information technologies. On the one hand, existing government regulations and policies exert external pressure on healthcare organizations to undertake new IT initiatives. On the other hand, new regulations, or new laws, if necessary, could be enacted to audit EDI transactions and prevent possible misbehavior, thus increasing the potential for healthcare organizations to adopt EDI.

Second, China’s IT infrastructure should be further developed. EDI requires powerful, sophisticated information systems to support its applications. Despite China’s efforts to build a national network structure, the access and availability of the Internet remain a problem. Slow and uncertain network availability can turn EDI into a serious problem for organizations.

In addition, healthcare organizations need to be aware of the strategic importance of investing on IT. Although this notion has been well accepted in the US, Chinese healthcare managers are not fully aware of its importance. For example, one well-known large hospital (Level III) in Beijing developed and installed a hospital information system. The hardware configuration included two IBM servers, one with 128 megabytes of main memory and four gigabytes of hard drive capacity, and the other with 512 megabytes of main memory and 10 gigabytes of hard drive capacity. These servers are simply not powerful enough to support information-intensive tasks such as EDI. In addition, the client computers at this hospital have only 16 megabytes of main memory and 540 megabytes of hard drive capacity. With such a limited hardware configuration,
the online transaction speed will be greatly affected and the advantages of information systems in general, and EDI in particular, cannot be realized. Greater IT investment may occur after managers of healthcare organizations are convinced of the return on investment of building an effective organizational IT infrastructure.

Finally, China’s healthcare organizations should consider developing standards for Chinese EDI. Institutes in the US and Europe have developed several standards in the healthcare domain to facilitate inter-organizational information exchange. Considering differences in languages and health policies, however, these standards might not be appropriate for EDI transactions conducted among Chinese healthcare organizations. A strategic approach for China is to join the efforts from several leading healthcare organizations to form a standard development organization. The purpose of this organization is to create EDI standards that are compliant with international standards and characterized by China’s unique situations. With such standards in place, the document transformation tasks will be easier and the communication among organizations will be enhanced.

For future research, to gain a richer understanding about the EDI usage and its influencing factors, an explanatory model can be built and tested in the unique context of China’s healthcare organizations. Factors that have been identified by prior research (Iacovou & Benbasat, 1995; Jun, Cai, & Peterson, 2000) such as internal needs, perceived benefits, competitive pressure, organizational readiness, technology concerns, customer power, and trust between trading partners could be examined. Results of such a study will provide additional information about EDI usage that yields important implications for healthcare IT practitioners and international IT vendors who are trying to enter China’s healthcare IT market.

7. Conclusions

This study investigates the extent of EDI usage in Beijing’s hospitals along four dimensions: volume, diversity, breadth, and depth. The results from 57 hospitals show that EDI usage is in its very early stages. The study proposes possible reasons for the low EDI usage from cultural, economic, and technological perspectives, analyzes the differences of EDI usage in the different levels of China’s hospitals, and suggests strategies to promote EDI usage in China’s healthcare organizations. Despite the descriptive nature of this study, the findings and analyses bear considerable importance since little is known about the EDI usage status in China’s healthcare sector. This section stresses the significance of this paper.

Coincidently, during the reviewing process of this paper, the severe acute respiratory syndrome (SARS) broke out in China, which has totally exposed the vulnerability of China’s healthcare information infrastructure. China’s healthcare information networks were criticized because they did not transfer critical disease information in a timely way and failed to allow healthcare providers to share medical knowledge effectively. Even inside the boundaries of a hospital, the ineffective information flow has delayed informing physicians and other staff. By our definition, exchanging medical information both within and among healthcare organizations belongs to the domain of EDI. Because of the massive destruction caused by SARS and the criticality of information sharing in the healthcare sector under a national and international emergency situation, research that looks into IT usage, especially inter-organizational IT usage such as EDI,
in China’s healthcare organizations is greatly needed. This research, which attempted to achieve an understanding of EDI usage in Beijing’s hospitals, can be considered as a response to the call. In addition, the lack of EDI usage in China’s healthcare sector offers a great opportunity for health IT vendors. China has 17,148 hospitals, and it is implied from the results of this study that the extent of EDI use is relatively low in the country. There is a tremendous market opportunity waiting to be exploited. However, China’s unique context should be understood before rolling out any marketing operations. The depiction of EDI usage in different levels of China’s hospitals is expected to give the health IT vendors a picture of China’s healthcare IT market. Finally, the four-dimension assessment of EDI usage provides a framework that can be exploited to evaluate IT assimilation in healthcare organizations. For China and other developing countries that are seeking for more healthcare IT assimilation, this framework can offer a comprehensive view and help identify the weak dimensions.

Appendix A

Electronic data interchange usage questionnaire

- **Volume**: Overall, what is the ratio of the total number of documents organizational functions handle via EDI divided by the total number of the organizational functions’ documents or transactions? ___%.
- **Breadth**: Overall, what is the ratio of the number of customers, suppliers, or carriers that have EDI connection with your hospital over the total number of the customers, suppliers, or carriers? ___%.
- **Diversity**: Estimate the number of distinct document type your hospital handles via EDI connection with its trading partners. Number of document types ________.
- **Depth**: EDI depth refers to the degree of electronic consolidation that had been established between the business processes of two or more trading partners. Please check to what degree of your hospital is currently using EDI with your business partners.
  1. Using EDI to transfer data only.
  2. Using EDI to transfer data and text.
  3. Using EDI to transfer data, text, image, etc.

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