

2005

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### Recommended Citation

Hung, Shin-Yuan; Hung, Hsin-Min; and Huang, Mu-Yi (2005) "Impacts of B2C e-Commerce on Hospital Productivity: An Empirical Study," *Journal of International Technology and Information Management*. Vol. 14 : Iss. 1 , Article 6.

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## **Impacts of B2C e-Commerce on Hospital Productivity: An Empirical Study**

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### **ABSTRACT**

*This work conducted a comprehensive study of Business-to-Consumer Electronic Commerce (B2C e-Commerce) applications in Taiwanese hospitals. To further assess the impacts of B2C e-Commerce on hospital productivity, this study also employed three quantitative methods to analyze historical data. The results confirm those of broader research into applications of B2C e-Commerce to hospitals. Additionally, the results of the quantitative analysis demonstrate that B2C e-Commerce significantly impacts the hospital productivity.*

### **INTRODUCTION**

In March 1995, Taiwan implemented the National Health Insurance (NHI) Program, which made health and medical care available to all citizens. Before the implementation of NHI, the Taiwanese healthcare industry was more stable than other industries, owing to a stable number of patients that allowed hospitals to price according to their balance of revenue and expenditure. Following the implementation of National Health Insurance, medical treatment charges have come to be priced by the Bureau of National Health Insurance (BNHI). Simultaneously, the government uses a Fee-for-Service payment method for patient services. Numerous hospitals thus must increase numbers of outpatients and hospital utilization rate to remain competitive.

Due to this dramatic change in the pricing and payment method, hospitals are seeking information technology (IT) solutions, which can provide better services to attract patients and improve operational effectiveness and efficiency to reduce costs. Lots of hospitals thus have established Web sites to provide additional Web services. Furthermore, many hospitals are attempting to conduct Business-to-Consumer Electronic Commerce (B2C e-Commerce) in a planned manner. The study attempts to understand the applications of B2C e-Commerce to the hospitals and also to assess the influence.

This study has three main objectives: (1) to clarify the current status of B2C e-Commerce adoption in Taiwanese hospitals; (2) to identify the functionality of the hospital Web sites; (3) to assess the impacts of B2C e-Commerce on hospital productivity. This study first observed the functionality of the hospital Web sites and performed a questionnaire survey to investigate the timing of Web site establishment and online registration adoption at each hospital. Next, the Annual Health Statistics Annual from 1994 to 1999 was sponsored by the Statistics Division of the Department of Health, Taiwan. After gathering all the necessary data, the data were analyzed using three statistical techniques for measuring efficiency and the analytical results were interpreted.

The rest of this paper is organized as follows. Section 2 briefly reviews related literature. Section 3 describes the research methodology. Next Section 4 summarizes the results. Conclusions are finally made in Section 5.

## LITERATURE REVIEW

### **Current status of hospital operations in Taiwan**

Numerous standards can be used for hospital classification. This study classifies hospitals based on the results of a hospital evaluation, hosted by the Department of Health and Ministry of Education since 1988. This hospital evaluation classified hospitals based on number of beds. Medical centers were defined as having over 500 emergency beds, regional hospitals as having over 250 emergency beds, and local hospitals as having over 20 emergency beds. Meanwhile, teaching hospitals should have over 100 emergency beds and moreover should have departments of internal medicine, surgery, pediatrics, gynecology, anesthesiology, X-ray, and pathology.

The NHI is a key welfare policy in Taiwan. The three main components of the NHI system are the insured, the contracted healthcare providers and the Bureau of National Health Insurance. And the system works as follows: the BNHI collects premiums from the insured people and issues them the insurance cards. When an insured person uses the medical services, he or she only has to co-pay a portion of the cost in cash and then the provider makes claims to BNHI for reimbursement of the rest of the medical expenses

By the end of 1999, 96% of the total population (around 21 million) had enrolled in the NHI program. On one hand, the NHI has reduced the burden involved in seeking medical advice and made healthcare available. On the other hand, the NHI created a lot of significant challenges for hospitals. For example, the increase of Insurance businesses, the unbalanced distribution of the medical resources, and the shortage of the physicians. The keen competition among hospitals is obvious. Keen competition was noted not only among hospitals with the same scale, but also among those with different scales. Zhang (1998) indicated that hospitalization rates of the small hospitals and clinics have been decreased by increasing medical care requirements and the corrosion of the market of local hospitals and clinics.

Facing keen competition and limited financial and labor resources, hospitals are seeking information technology solutions to raise their productivity. Peng (1995) indicated that physicians believed that, through IT support, clinics could automatically claim insurance fees from the BNHI, simplify manual operations, and enhance their reputation. Tsaur (1999) also indicated that numerous benefits were achieved through installing the Internet in a hospital. For patients, the benefits include providing more healthcare services on the Internet, advocating distance learning, registering on-line, and simplifying medical treatment procedures. For hospitals, the advantages include promoting the reputation of hospitals, accelerating communication among hospitals, increasing interaction between hospitals and patients, enhancing health care quality, and improving ease of publication of hospital information.

### **Applications of B2C e-Commerce to the healthcare industry**

Diverse definitions of e-Commerce exist. Authur and Hagel (1996) defined e-commerce as a method of dealing with communication and transaction among enterprises on the Internet. Kalakota and Whinston (1997) noted that e-Commerce is a modern business way for reducing capital costs, improving quality of goods and service, and increasing management efficiency. Zwass (1996) also defined e-Commerce as the use of the Internet to share business information, maintain business relationships, and conduct business transactions.

The white paper on e-Commerce published by the former American President, Mr. Clinton, in 1997 indicated that e-Commerce includes Business-to-Consumer (B2C) and Business-to-Business (B2B). The applications of B2C e-Commerce give enterprises access to new customers and new markets by using the Internet with a friendly user interface. The benefits of B2C e-Commerce applications involve providing Internet services 24 hours a day, reducing time of transaction by on-line purchasing system, and providing customized services by analyzing a large amount of customer behaviors. (Rao et al., 2002)

The goals of e-Commerce in Taiwan managed by the NII and other related departments of the Executive Yuan, the highest administrative organ in Taiwan, summarized as follows: (1) to enhance internal and international networks; (2) to review and change the laws related to e-Commerce; (3) to extend local educational networks and provide increased opportunities for teachers to receive training in the use of information technology in education; (4) to establish bone networks and develop e-Commerce applications; (5) to popularize electronic business; (6) to develop new generation network technology; (7) to improve health care services for patients having physical or

mental problems and for residents of remote districts; and (8) to avoid computer crime. Regarding the e-Commerce of medical care, the Taiwanese government is promoting distance healthcare, which applies Internet technology to improve the quality of medical services in suburban districts.

Much work demonstrated information technology and B2C e-Commerce applications can be successfully implemented to the healthcare industry (Hsieh et al., 2003; Holmes and Miller, 2003; Lee and Asllani, 2003; Lin and Umoh, 2002; Walter and Tung, 2002; Kohli et al., 2001; Sower, Motwani and Mirchandani, 2001).

Specifically, Tseng and Chang (1997) analyzed the contents of medical information Web sites and user utilization behavior. A total of 167 health Web sites, including 85 hospitals and clinics, 45 personal Web sites of physicians, and 37 healthcare Web sites established by public welfare or other organizations, were compared in terms of the health information content provided. The functions of those Web sites were classified into eight categories, among which 79.6% provide medical science knowledge, 53.3% introduce their hospital on the home page, 13.8% provide e-mail functions, 18.6% provide professional periodicals and the functions of leaving messages on line, 10.2% provide e-books, 3.6% provide on-line medical consultations, 3.0% publish e-paper, and 4.2% enable querying of drug and poison information. For hospitals, Internet home pages frequently introduce the hospital, provide healthcare knowledge to answer patient questions, and provide a communication channel between the hospital and patients.

Lin (1995) classified internet use into communication oriented, goods buying oriented, and information delivery oriented. Five applications, namely: popularizing enterprises and promoting enterprise reputation, marketing goods and services, selling goods and services, supporting goods and services, and collecting and researching business information were also noted. Web sites in hospitals are frequently for the goods buying and the information delivery oriented. Moreover, the applications of the Internet in hospitals include popularizing enterprises and promoting the reputation of enterprises for marketing goods and services, and for gathering and researching business information.

Internet technology, especially Web sites, can significantly influence hospitals. Zhu (1998) noted that hospital Web sites could be used to send information among hospitals, provide hospital and disease information for patients, and connect hospitals and patients. Hospitals can expand their information systems, strengthen registration systems, add a channel through which patients can interact, establish an Internet healthcare community, improve hospital reputation, and provide medical information through Web sites. Furthermore, hospitals can also improve the relationship between physician and patient by providing healthcare information on Web sites. Ho (1997) developed a model for evaluating commercial Web sites based on the value offered to visitor. This model classified the business purposes of commercial Web sites as including: (1) product or service promotion; (2) data and information provision; (3) business transaction processing.

This study classified the benefits of B2C e-Commerce into online marketing and online registration. Online marketing introduces hospitals, health care information, online consultation, and E-mail on hospital Web sites. Hence, online marketing can benefit hospitals by marketing and promotion. Online registration can dynamically adjust the quantity of outpatient services, and can achieve benefits by simplifying artificial operations.

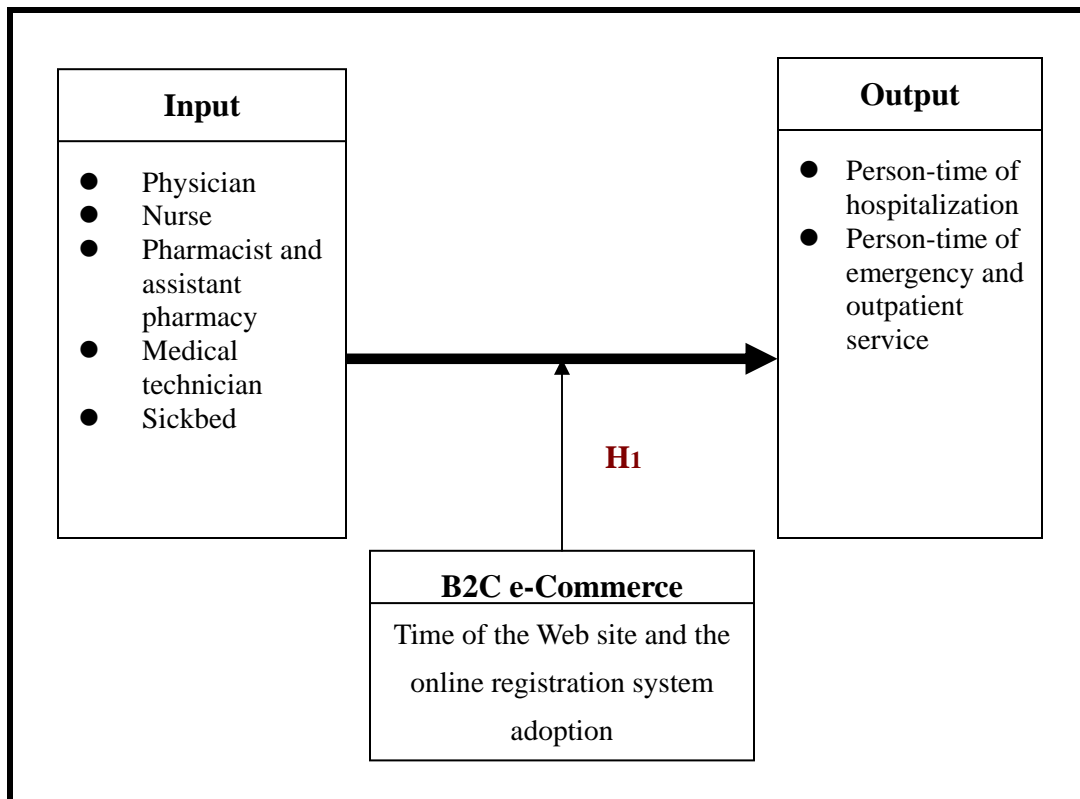
### **Possible impacts of B2C e-Commerce on hospital productivity**

Information technology can help hospitals to reduce capital cost, simplify artificial operations, and improve hospital productivity (Ko and Osei-Bryson, 2004; More and McGrath, 2002; Lin et al., 2002). Menon et al. (2000) examined the productivity of information technology in hospitals and found that the hospitals investments, including IT Capital and IT Labor, correlate positively with hospital productivity. Consequently, information technology exerts a clear influence on hospital productivity. Narver and Slater (1990) indicated that marketing oriented organizations track customer actions and make appropriate responses. In this manner, organizations can enhance customer satisfaction and organization performance. Raju et al. (1995) also indicated that marketing oriented hospitals must gather useful information effectively, improve customer satisfaction, and respond to customer and competitor requirements. Hospital performance is positively related with a marketing orientation.

### RESEARCH FRAMEWORK

This study examines whether the hospitals could raise its productivity by the applications of B2C e-Commerce. Benefits can be brought either from online marketing or online registration (Figure 1). Our hypotheses are shown as follows.

**Figure 1: B2C e-Commerce benefits of online marketing or online registration.**



The study used a multiple research strategy. This comprised three major approaches: (1) a questionnaire survey of the webmasters of the hospital Web sites; (2) an observation study of the Web sites; (3) a secondary data analysis of the change of the hospital productivity before and after adoption of B2C e-Commerce.

Hospital inputs used in the current study include: (1) number of physicians; (2) number of nurses; (3) number of pharmacists and assistant pharmacies; (4) number of medical technicians; (5) number of sickbeds. Meanwhile, hospital outputs include: (1) person-time of hospitalization; and (2) person-time of emergency and outpatient service.

The sample used in this study comprised the hospitals included in the hospital evaluation conducted from 1997 to 2000 by the Department of Health, Taiwan. The sample included a total of 13 medical centers, 56 regional hospitals, and 50 local hospitals.

This study requires the collection of various data, as follows: (1) times of Web site establishment and online registration system adoption, collected by a questionnaire survey to all of 119 hospital webmasters (from to; (2) services and functions provided on hospital Web sites, observed and coded by a researcher; (3) annual health statistics for all the subject hospitals from 1994 to 1999, gathered by the Statistics Division of the Department of Health, Taiwan.

Finally, three statistical techniques, including ratio analysis, regression analysis, and data envelopment analysis (DEA), were applied to analyze the influences of B2C e-Commerce on hospital productivity. Ratio analysis

examines how a single input and a single output are related. Ratios, particularly when tracked over time, can pinpoint changes in hospital operations. However, there are two major limitations involved in using ratio analysis to measure efficiency. First, it is difficult for ratio analysis to incorporate multiple factors, which is problematic since efficiency is multidimensional. Second, ratio analysis does not indicate how much variance from the industry mean is considered inefficient, or even if the mean itself is efficient. Regression analysis is highly effective in examining characteristics that impact costs but is not very useful in determining individual hospital inefficiencies because measures of efficiency are developed by comparing firms with the sample mean. DEA uses multiple inputs and outputs from a sample of hospitals to develop an efficiency frontier and evaluate the efficiency of the decision making unit (DMU) relative to all other DMUs in the sample. DEA provides better overall measures of efficiency (Craycraft, 1999).

**H<sub>1</sub>: The applications of B2C e-Commerce are positively related to hospital productivity**

**H<sub>1a</sub> : Implementation of Web sites providing online marketing is positively related to hospital productivity**

**H<sub>1b</sub> : Implementation of online registration system is positively related to hospital productivity**

**RESULTS AND DISCUSSION**

**Adoption of B2C e-Commerce in Taiwanese hospitals**

A questionnaire survey of webmasters of hospital Web sites was conducted to obtain the time of Web site and online registration system adoption. One-hundred and nineteen questionnaires were sent out to the target hospitals, including 13 medical centers, 56 regional hospitals, and 50 local hospitals. The results demonstrate that 90 hospitals have installed Web sites and 14 hospitals have not yet installed Web sites, while 15 hospitals had not yet responded. Additionally, 46 hospitals have installed online registration systems, 60 hospitals have not yet installed online registration systems, and 13 hospitals did not respond (Table 1). Thus 87% of hospitals have installed Web sites and 44% have installed online registration systems.

With the application of B2C e-Commerce in hospitals becoming more widespread, numerous channels are developing for hospital registration, including on-the-spot registration systems, telephone registration systems, and online registration systems. Hospitals need to develop well-planned information systems to connect internal and external registration systems. Those technical barriers of implementing online registration systems are why fewer hospitals have adopted online registration systems than have adopted Web sites.

Trend analysis indicates that the timing of Web site establishment and online registration system adoption both correlate with hospital size. For medical centers, the time of Web sites establishment ranged from 1996 to 1997, while that for online registration systems ranged from 1999 to 2000. For regional hospitals, the time of establishing Web sites ranged from 1998 to 1999, while the time of establishing online registration systems ranged from 1998 and 2000. Finally, for local hospitals, the time of establishing the Web sites ranged from 1997 to 1999, while that of establishing online registration systems ranged from 1998 to 1999. Furthermore, both number of hospitals with Web sites and online registration systems

**Table 1: Time of the Web sites establishment and the online registration systems adoption.**

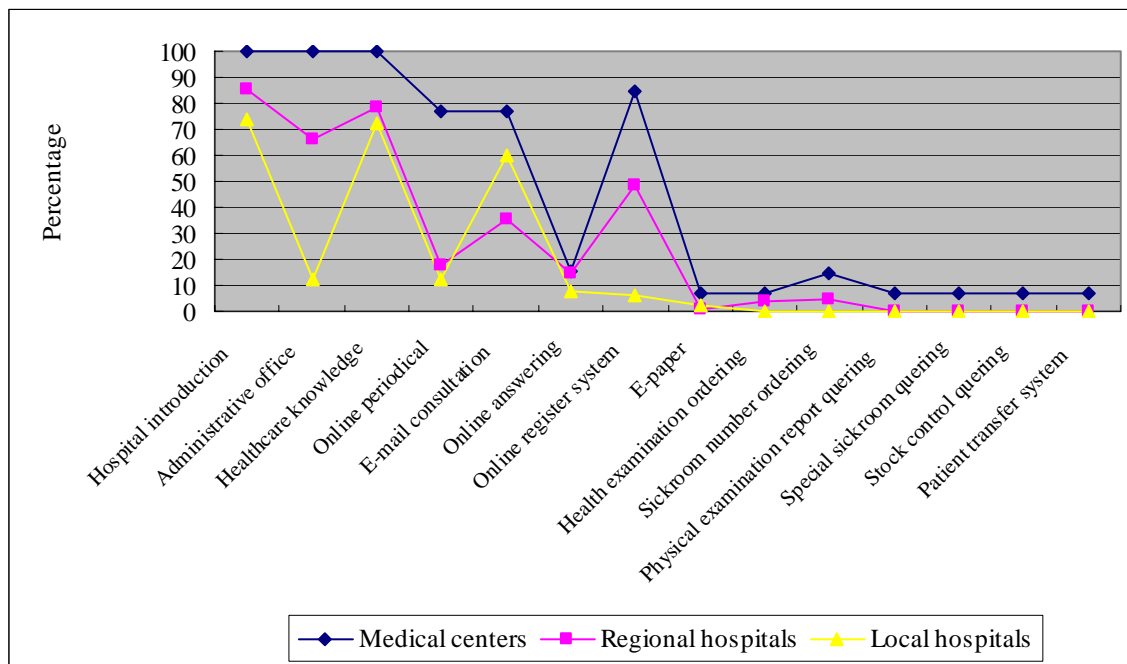
		1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Miss- ing	Un- returned
<b>Medical centers (13)</b>	<b>Web Site</b>												
	<b>Online Registration</b>												
<b>Regional hospitals</b>	<b>Web Site</b>												

(56)	Online Registration												
Local hospitals (50)	Web Site											11	
	Online Registration					1							

Table 2: Functionality of the hospital Web sites.

	Hospital introduction	Administrative offices	Healthcare knowledge	Online periodical	E-mail consultation	Online answering	Online registration
Medical centers	13	13	13	10	10	2	11
Regional hospitals	48	37	44	10	20	8	27
Local hospitals	37	6	36	6	30	4	3
	E-paper	Health examination ordering	Sickroom number querying	Physical examination report querying	Special sickroom querying	Stock control querying	Patient transfer system
Medical centers	1	1	2	1	1	1	1
Regional hospitals	1	2	3	0	0	0	0
Local hospitals	1	0	0	0	0	0	0

Figure 2: Functions and services provided on the hospital Web sites.



Correlated with the hospital size. Restated, larger-sized hospitals displayed higher willingness to adopt online registration systems and did so earlier.

### Functionality of the hospital Web sites

This work also conducted an observational study to analyze the functionality of hospital Web sites from September 2000 to February 2001 (Table 2). The observation results indicated that the services and functions most frequently provided by the hospital Web sites were hospital introduction, administrative or technical offices, healthcare knowledge, online periodicals, and E-mail consultation. Additionally, the larger hospitals provide more specialized functions and services on their Web sites. For example, 80% of the medical centers, 18% of the regional hospitals, and 12% of local hospitals provided online periodicals over their Web sites. From the Figure 2, the number of services and functions provided on hospital Web sites correlates with hospital size.

### Quantitative analysis results

This study used three methods to analyze the influences of B2C e-Commerce on hospital productivity. These three methods were ratio analysis, regression analysis, and DEA analysis. Hospital inputs include number of physicians, number of nurses, number of pharmacists and assistant pharmacists, number of medical technicians, and number of sickbeds, whereas hospital outputs include person-time of hospitalization, and person-time of emergency and outpatient service.

#### Ratio analysis

Ratio analysis was employed to compare hospital inpatient and outpatient productivity before and after Web site adoption. Ratio analysis indicated that: First, only the ratio of “Person-time of emergency treatment and outpatient services / the number of physicians” was higher following Web site adoption compared to before Web site adoption from 1995 to 1998 (Table 3). Second, all nine ratios were higher after the Web site adoption than before Web site adoption in 1996 and 1998. Specifically, the ratios of “Person-time of hospitalization / number of sickbeds”, “Person-time of hospitalization / number of physicians”, “Person-time of hospitalization / number of nurses”, “Person-time of emergency treatment and outpatient services / number of physicians”, and “Person-time of emergency treatment and outpatient services / number of nurses” in 1996, and the ratios of “Person-time of hospitalization / number of physicians” and “Person-time of emergency treatment and outpatient services / number of physicians” were statistically significant.

Following the adoption of online registration systems, almost of the nine ratios were higher than before the adoption of the online registration system during 1997 and 1998 (Table 4). Additionally, the ratios of “Person-time of hospitalization / the number of sickbeds”, “Person-time of hospitalization / number of physicians”, and “Person-time of emergency treatment and outpatient services / number of physicians” generally performed better than other ratios.

In sum, this study found that the ratios of “Person-time of hospitalization / number of sickbeds”, “Person-time of hospitalization / number of physicians”, and “Person-time of emergency treatment and outpatient services / number of physicians” increased following Web site and online registration system adoption. Consequently, applications of B2C e-Commerce in hospitals can improve physician productivity and sickbed utilization.

**Table 3: Change of the hospital productivity before and after the Web site adoption.**

	1995	1996	1997	1998	1999
Ratio	Sig. (2-tailed)	Sig. (2-tailed)	Sig. (2-tailed)	Sig. (2-tailed)	Sig. (2-tailed)
Person-time of hospitalization / the number of sickbeds	0.828	0.040**	0.553	0.227	0.530
Person-time of hospitalization / the number of physicians	0.221	0.037**	0.748	0.063*	0.168



Person-time of hospitalization / the number of pharmacists and assistant pharmacists	<i>0.521</i>	<b>0.616</b>	<i>0.553</i>	<b>0.423</b>	<i>0.159</i>
Person-time of hospitalization / the number of medical technicians	<i>0.828</i>	<b>0.400</b>	<i>0.116</i>	<b>0.973</b>	<i>0.015**</i>
Person-time of hospitalization / the number of nurses	<i>0.888</i>	<b>0.095*</b>	<i>0.202</i>	<b>0.685</b>	<i>0.045**</i>
Person-time of emergency treatment and outpatient services / the number of physicians	<b>0.065*</b>	<b>0.057*</b>	<b>0.082**</b>	<b>0.023**</b>	<i>0.519</i>
Person-time of emergency treatment and outpatient services / the number of pharmacists and assistant pharmacists	<i>0.304</i>	<b>0.230</b>	<i>0.493</i>	<b>0.216</b>	<b>0.709</b>
Person-time of emergency treatment and outpatient services / the number of medical technicians	<i>0.841</i>	<b>0.123</b>	<i>0.064*</i>	<b>0.833</b>	<i>0.050**</i>
Person-time of emergency treatment and outpatient services / the number of nurses	<i>0.345</i>	<b>0.028**</b>	<i>0.237</i>	<b>0.123</b>	<i>0.541</i>

\*\* :  $p < 0.05$ ; \* :  $p < 0.10$

Boldface: Mean ratio after the Web sites adoption  $\geq$  Mean ratio before the Web sites adoption

Italic: Mean ratio after the Web sites adoption  $<$  Mean ratio before the Web sites adoption

Table 4: Change of the hospital productivity before and after the online registration system adoption.

	1996	1997	1998	1999
Ratio	Sig. (2-tailed)	Sig. (2-tailed)	Sig. (2-tailed)	Sig. (2-tailed)
Person-time of hospitalization / the number of sickbeds	<i>0.605</i>	<b>0.775</b>	<b>0.485</b>	<b>0.011**</b>
Person-time of hospitalization / the number of physicians	<b>0.391</b>	<b>0.580</b>	<b>0.293</b>	<b>0.517</b>
Person-time of hospitalization / the number of pharmacists and assistant pharmacists	<i>0.686</i>	<b>0.882</b>	<b>0.457</b>	<i>0.655</i>
Person-time of hospitalization / the number of medical technicians	<i>0.730</i>	<i>0.919</i>	<b>0.832</b>	<i>0.111</i>
Person-time of hospitalization / the number of nurses	<i>0.760</i>	<b>0.000**</b>	<b>0.555</b>	<i>0.087*</i>
Person-time of emergency treatment and outpatient services / the number of physicians	<b>0.165</b>	<b>0.260</b>	<b>0.018**</b>	<b>0.944</b>
Person-time of emergency treatment and outpatient services / the number of pharmacists and assistant pharmacists	<i>0.972</i>	<b>0.168</b>	<b>0.292</b>	<i>0.708</i>
Person-time of emergency treatment and outpatient services / the number of medical technicians	<b>0.840</b>	<i>0.965</i>	<i>0.418</i>	<i>0.143</i>
Person-time of emergency treatment and outpatient services / the number of nurses	<i>0.920</i>	<b>0.631</b>	<b>0.310</b>	<i>0.275</i>

\*\* :  $p < 0.05$ ; \* :  $p < 0.10$

**Boldface:** Mean ratio<sub>after the Web sites adoption</sub>  $\geq$  Mean ratio<sub>before the Web sites adoption</sub>

**Italic:** Mean ratio<sub>after the Web sites adoption</sub>  $<$  Mean ratio<sub>before the Web sites adoption</sub>

### **Regression analysis**

The study used five independent variables, including number of sickbeds, number of physicians, number of pharmacists or assistant pharmacists, number of medical technicians, and number of nurses, to explain the dependent variable person-time of hospitalization. Additionally, this study also used four independent variables, including number of physicians, number of pharmacists or assistant pharmacists, number of medical technicians, and number of nurses, to explain the dependent variable person-time of emergency treatment and outpatient services.

### **Influence of the Web site adoption**

Regression analysis results indicated that website adoption clearly influences person-time of hospitalization. The  $\beta$  coefficients of number of sickbeds, except for hospitals that adopted Web sites in 1997, become significant after website adoption. Additionally, the  $\beta$  coefficients of the number of nurses, except for those hospitals that adopted Web sites in 1997, become significant following Website adoption.

Significant factors for the influences of the Web sites adoption on person-time of emergency treatment and outpatient services, include number of physicians, number of nurses, and number of pharmacists or assistant pharmacists. First, the  $\beta$  coefficients of number of physicians became significant after those hospitals adopted Web sites in 1996 and 1998. Next, the  $\beta$  coefficients of the number of nurses became significant after those hospitals adopted Web sites in 1995 and 1996. Finally, the  $\beta$  coefficients of number of medical technicians became significant after those hospitals adopted Web sites in all years.

### **Influence of online registration system adoption**

Regression analysis results also indicated that online registration system adoption significantly influences hospital productivity. For hospitals that adopted online registration systems in 1998, the  $\beta$  coefficients of the number of nurses on person-time of hospitalization become significant after online registration system adoption. Furthermore, the  $\beta$  coefficient of number of nurses is higher in 1999 than in 1996. Comparing before and after online registration system adoption also demonstrates that number of nurses markedly influences on person-time of emergency treatment and outpatient services.

In sum, ratio and regression analysis achieve consistent results. Hospitals aim to provide health care services, and thus physicians and nurses are the key players in hospitals. Hence, the changes in physician productivity significantly influence hospital productivity. Regression analysis results also demonstrate that the changes of the  $\beta$  coefficients of the number of physicians and number of nurses are significant for all hospitals that adopted Web sites and online registration systems from 1994 to 1999.

### **DEA Analysis**

Malmquist Productivity Index (Fare et al., 1989) was employed to measure changes of hospital productivity after adopting Web sites and online registration systems. The DEA results indicated that the productivity of all hospitals decreased in 1995 and 1997 and increased in other years. This finding is consistent with those of numerous studies on the impacts of implementation of the National Health Insurance Program. These other studies found a clear decrease in hospital productivity in the first year after the implementation of the National Health Insurance Program (namely in 1995).

For hospitals that adopted Web sites, productivity decreased only in 1995 and increased in subsequent years. The decrease in productivity during 1995 may result from the influence of the implementation of the National Health Insurance Program. Hospital productivity increased following the adoption of Web sites in 1995. Overall, hospital productivity increased after adopting Web sites, although it decreased at the beginning of the implementation of the National Health Insurance Program.

Another notable finding is that the hospitals adopting Web sites in 1995 and 1996 included more Medical Centers and Regional Hospitals than in other years. The influence of the implementation of the National Health Insurance Program was greater on small hospitals than on big hospitals. This various degree of impacts may be why the productivity of hospitals that adopted the Web sites in 1995 and 1996 did not decrease in 1995.

Regarding the influence of the adoption of online registration systems, hospital productivity generally increased following the adoption of online registration, but the effects were not very significant.

To clarify the cause of the productivity changes, this study noted hospital productivity changed from the technical efficiency and efficiency frontier. All of the hospitals that adopted Web sites and online registration systems from 1995 to 1999 achieved increased technical efficiency, but the efficiency frontier reduced in 1995. The implementation of the National Health Insurance Program might have produced this result. This situation affected all hospitals, not merely one specific hospital. In the other years, most hospitals became more productive owing to implementing B2C e-Commerce, but some did not.

Overall, hospital productivity may change because of external environmental impacts, for example technical advancement, economical fluctuation, law and regulations, and so on. The results of DEA analysis indicated that the productivity of some hospitals reduced owing to the implementation of the National Health Insurance Program or the inefficient use of resources. However, most hospitals can increase their productivity through B2C e-Commerce applications.

## CONCLUSIONS

A growing tendency exists for hospital Web sites in Taiwan to provide useful information and also online registration. Some leading hospitals are even providing advanced functions on their Web sites, such as querying number of inpatients and performing patient transfer with allied hospitals. This study shows that most of the Taiwanese hospitals are taking advantage of B2C e-Commerce, and that hospital productivity accordingly is increasing.

Internet technology adoption occurred relatively late in the healthcare industry. The healthcare industry involves matters of life-and-death and hospitals must protect patient rights. This is why hospitals consider carefully before adopting new information technologies. Additionally, most administrators of the Taiwanese hospitals are physicians. The attitude of these administrators towards Information Technology naturally strongly influences the adoption and usage of B2C e-Commerce in hospitals.

Owing to the specificity and legal and regulatory constraints in the healthcare industry, the applications of B2C e-Commerce in hospitals tend to provide only limited functions and services. However, with increasing maturity of Internet technology, the applications of B2C e-Commerce in hospitals will become more widespread and diverse in the future.

## ACKNOWLEDGMENT

The authors would like to thank the National Science Council of the Republic of China, Taiwan under Contract No. NSC 90-2416-H-194-032 and MOE Program for Promoting Academic Excellent of Universities under the grant number 91-H-FA08-1-4 for their financial support.

## REFERENCES

- Arthur, A.G. and Hagel, J. III (1996), The Real Value of On-line Communities, *Harvard Business Review*, May-June, 134-136.
- Craycraft, C. (1999), A Review of Statistical Techniques in Measuring Efficiency, *Journal of Public Budgeting, Accounting and Financial Management*, Spring 11(1), 19-27.
- Fare, R., Grosskopf, S., and Kikkelenberg, E.C. (1989), Measuring Plant Capacity, Utilization and Technical Change:

- A Nonparametric Approach, *International Economic Review*, 30(3), 655-666.
- Ho, J. (1997), Evaluating the World Wide Web: A Global Study of Commercial Websites, *Journal of Computer Mediated Communication*, June 3(1),.
- Holmes, S.C. and Miller, R.H. (2003), The Strategic Role of E-commerce in the Supply Chain of the Healthcare Industry, *International Journal of Services Technology and Management*, 4(4-6), 507-517.
- Hsieh, P.J., Tan, B., and Lin, C. (2003), An Integrated Approach to Determine Hospital Outpatient Staffing Needs, *International Journal of Healthcare Technology & Management*, 5(1/2), 96-122.
- Javalgi, R. (1991), "Physicians' Attitudes and Behaviors toward Home Health Care", *Journal of Health Care Marketing*, December 11(4), 14-22.
- Kalakota, R. and Whinston, A.B. (1996), *Frontier of Electronic Commerce*, Reading, MA: Addison Wesley.
- Ko, M. and Osei-Bryson, K.M. (2004), The Productivity Impact of Information Technology in the Healthcare Industry: An Empirical Study Using a Regression Spline-based Approach, *Information and Software Technology*, January 46(1), 65-71.
- Kohli, R., Piontek, F., Ellington, T., VanOsdol, T., Shepard, M., and Brazel, G. (2001), Managing Customer Relationships through E-business Decision Support Applications: A Case of Hospital-physician Collaboration, *Decision Support Systems*, December 32(2), 171-187.
- Lee, S.M. and Asllani, A.A. (2003), Implementation of Simulation Software Packages for Healthcare Scheduling, *Journal of International Technology and Information Management*, Spring 12(1), 1-14.
- Lin, B. and Umoh, D. (2002), E-healthcare: A Vehicle of Change, *American Business Review*, June 20(2), 27-32.
- Lin, C., Yang, T.C., Tan, B., and Chang, I. (2002), Hospital Electronic Commerce Applications in Taiwan: A Value Chain Analysis, *International Journal of Healthcare Technology & Management*, 4(1/2), 106-117.
- Lin, C.S. (1995), *Applications of the Information Superhighway to Customer Service*, Department of Information Management, National Sun Yat-Sen University, Taiwan.
- Menon, N.M., Lee, B., and Eldenburg, L. (2000), Production of Information Systems in the Healthcare Industry, *Information Systems Research*, March 11(1), 83-92.
- More, E. and McGrath, M. (2002), An Australian Case in E-health Communication and Change, *Journal of Management*, 21(7/8), 621-632.
- Narver, J.C. and Slater, S.F. (1990), The Effect of Market Orientation on Business Profitability," *Journal of Marketing*, October 54, 20-35.
- Peng, Q.Z. (1995), *An Empirical Study on the Critical Factors Influencing the Use of Information Technology in Clinics in Taiwan*, Department of Business Administration, National Cheng Kung University, Taiwan.
- Raju, P.S., Lonial, S.C., and Gupta, Y.P. (1995), Marketing Orientation and Performance in the Hospital Industry, *Journal of Health Care Marketing*, Winter 15(4), 34-41.
- Rao, S., Nord, J.H., and Nord, G.D. (2002), Analyzing Behavior Patterns of Internet Consumers Through Database Integration, *Journal of International Technology and Information Management*, 11(1), 1-26.
- Sower, V., Motwani, J. and Mirchandani, D. (2001), User Perceptions of the Benefits of Implementing an ERP System: A Case Study, *Journal of International Technology and Information Management*, 10(2), 1-12.

- Tsaur, S.M. (1999), *Factors Affecting the Use of Internet in Taiwan's Hospital*, Department of Information Management, National Chung Cheng University, Taiwan.
- Tseng, S.F. and Chang, L.M. (1997), The Development and Application of Medical Consulting Internet in Taiwan, *Proceedings of the 2nd Annual Meeting of Information Technology and Social Transformation*.
- Walter, Z. and Tung, Y.A. (2002), E-healthcare System Design: A Consumer Preference Approach, *International Journal of Healthcare Technology & Management*, 4(1/2), 53-70.
- Zhang, L. (1998), *Medical Care and Society: The Exploration in Sociology*, Taipei, Taiwan: Liwen.
- Zhu, Y.F. (1998), The Opinions on WWW Home Pages of Hospitals, *Hospital Magazine*, 31(3), 60-63.
- Zwass, V. (1996), Electronic Commerce: Structure and Issues, *International Journal of Electronic Commerce*, Fall 1(1), 3-23.