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## Feasibility and Critical Success Factors in Implementing Telemedicine

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**Abstract:** The objectives of this study are the evaluation of feasibility and critical success factors in the telemedicine implementation in Malaysian hospitals. A sample of hospitals located in Klang Valley, an area that surrounds the capital of Malaysia, Kuala Lumpur were contacted in order to seek their perspectives in this matter. A questionnaire survey was used to gather the data and descriptive analysis was performed to analyze the data. The results show that only small number of participating hospitals have telemedicine applications and suggest that many of Malaysians hospitals are not yet ready for the application. Feasibility evaluation based on four factors: operational, time, economic and technical criteria. The study finds that operational and technical component of feasibility factors are more important than time and economic dimension. The ability to attract customers and opportunity to acquire latest infrastructure and skills justify the need of telemedicine in hospital. Successful implementation of telemedicine is related to the availability of three factors: strong fundamental knowledge and infrastructure, planning and management of health information and technology and fulfillment of legal and ethical issues and constant evaluation of telemedicine implementation.

**Key words:** Telemedicine, health information system, success implementation

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### INTRODUCTION

The application of information technology in the health care industry especially in hospitals and medical centers offers great potential for improving the quality of services provided and the efficiency and effectiveness of the personnel (Scott, 2007). It also reduces the organizational expenses. However, the main question that arises according to the literature is whether hospitals are ready in implementing telemedicine. Among the questions raised are whether high investment in telemedicine projects is bringing intended results, are hospitals ready with the implementation of telemedicine and what are the critical success factors for implementing telemedicine.

This study attempts to address this issue by identifying the feasibility and critical success factors in telemedicine implementation from organizations' viewpoints. In this study, we will discuss the application of telemedicine and issues pertaining readiness of the implementation. Results from the survey will be presented and discussed.

The application of information technology is accepted widely in the health care sector. Hospitals are expected to adopt new information technology and systems in health care, otherwise they will be seen as inefficient organization and lose the trust of their patients

(Ammenwerth *et al.*, 2003; Lu *et al.*, 2005). Croll and Croll (2007) and Sucurovic (2007) reported that Hospital Information Systems (HIS) have gradually taken over traditional hospital operation. Telemedicine has attracted health care providers around the globe including developing countries for implementation (Chen *et al.*, 2001; Jahn *et al.*, 2005; Kifle *et al.*, 2005; Bagayoko *et al.*, 2006; Rao, 2009).

Telemedicine is defined as the use of information technologies to exchange health information and provide health care services across geographical, time, social and cultural barriers (Reid, 1996). Wootton (2001a) suggested telemedicine definition as an umbrella term that encompasses any medical activity involving an element of distance. According to Kifle *et al.* (2007), telemedicine technology includes both store-and-forward-asynchronous as well as live video conferences-synchronous transmissions via satellite networks.

The potential benefits of telemedicine for patients and healthcare providers have been discussed by Kifle *et al.* (2005, 2007). They involve socio-economic impacts of telemedicine including improving accessibility, containing costs and providing quality care. Telemedicine also conducting the role that ICTs play in supporting the complex interactions between patient, doctor or nurse, consultant and medical equipment (Baldwin and Clarke, 2002).

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Meidl *et al.* (2008) reported the use of telemedicine in small hospitals to overcome significant challenges in its operation to give timely and consistent delivery of critical care. Also, it supports the availability of highly experienced critical care pharmacists onsite within the ICU during all hours of the day. Telemedicine applications could offer a unique opportunity in abuse cases such as to raise the standard of care in child sexual abuse evaluations (Kellogg *et al.*, 2000). The system aims to provide expertise to less experienced clinicians primarily in rural areas; a method for peer review and quality assurance to build consensus of opinions particularly in sexual abuse cases and support for professionals involved in an emotionally burdensome area of pediatrics.

Not only hardware and software play important roles in telemedicine, the providers and users are also its main concern. Atkinson *et al.* (2002) proposed integration of development of health informatics, including the soft information systems and technologies methodology, participative simulation modeling and stakeholder analysis.

Bagayoko *et al.* (2006) evaluated the feasibility, potential, problems and risks of an Internet-based telemedicine network in developing countries of Africa. The telemedicine network was used productively and has enabled various collaboration channels, distance learning and teleconsultations. LaMonte *et al.* (2000) developed an integrated mobile telecommunications system application, TeleBAT to overcome the clinical problem of acute stroke. It aims to shorten time to treatment once the patient is known to the emergency medical system.

Tulu and Chatterjee (2008) investigated the Internet-based telemedicine with the goal of understanding the relationship between objective and subjective video quality measures and the decision making capability of medical professional using an ophthalmology video. Objective and subjective measures are calculated using PSNR and the perception of human viewers respectively. Results indicate that jitter and delay have significant effect on the objective quality values.

Telemedicine is implemented in Malaysia with a vision to ensure that Malaysian citizens are receiving the best medical treatment. Telemedicine is one of the flagships of Malaysia's Multimedia Super Corridor project (MSC). Generally, the telemedicine programmes involve development of local health information network, infrastructure to improve health treatment, teleconsultation, continuing medical education, mass customized/personalized health information and lifetime health plan.

Despite high hopes, however, telemedicine has been slow to come into routine use (Kifle *et al.*, 2007).

Numerous studies document problems related to telemedicine technology in general. These studies often point to scarcity of resource (Wootton, 2001b), poor telecommunication infrastructures (Bashshur *et al.*, 2002), human elements (Chau and Hu, 2002), policy-related changes (Vargneses and Scotte, 2004) and socioeconomic and cultural barriers (Straub *et al.*, 2001). Information and Communication Technology Transfer (ICTT) has intrigued information systems researchers (Dutta, 2001); still, few researchers have studied factors affecting telemedicine transfer within SSA.

The implementation of telemedicine should consider whether hospital personnel are willing to use state of the art information technology while performing their tasks (Aggelidis and Chatzoglou, 2009). Their study shows that perceived usefulness, ease of use, social influence, attitude, facilitating conditions and self-efficacy significantly affect hospital personnel behavioral intention. Training has a strong indirect impact on behavioral intention through the mediators of facilitating condition and ease of use.

Kellogg *et al.* (2000) identified a few factors contributing to the success of telemedicine: clinician motivation, appropriate infrastructure and ongoing funding and technical support. Wua *et al.* (2009) investigated the Healthcare Technology Management (HTM) competency required by healthcare IS professionals that encompass four skills/knowledge domains: healthcare organization overview, external knowledge networking, healthcare technology integration and management and interpersonal.

Bagayoko *et al.* (2006) reported a set of potential problems that were identified in telemedicine in African countries including the need for the development of local medical content management skills. The problem was improved through the collaboration between the various countries as professionals from the medical and the computer science field are sharing courses and resources.

## **MATERIALS AND METHODS**

The research, which starts in 2006 intends to identify factors relating to telemedicine implementation in hospitals around Klang Valley area. The selection of this area is due to strategic location and high population of the Malaysian capital, Kuala Lumpur and other big cities here that attract many health providers to conduct their services. The availability of health and information technology is likely to be better in urban area than in rural. The list of hospitals and medical centers was derived from the Malaysian Medical Council (MMC).

A set of questionnaire was developed for this study. The questionnaire raises many important issues that were identified from the literature review. A few case studies on telemedicine implementation both in Malaysian hospitals and abroad were studied. A number of important factors in the implementation were identified. The experience of one of the researchers in working in the health care services and telemedicine project is also invaluable input in understanding the research and developing the questionnaire.

The data collection process starts with testing the questionnaire to identified five hospitals. The pilot study takes two weeks and the feedback was used to improve the questions for better understanding and more precision. Later, an invitation letter and brief description of the study were sent via mail to a sample of 103 hospitals and medical centers in Klang Valley, targeting the manager. A modified questionnaire was attached together with a return envelop. Thirty three respondents (31% from the identified sample) give their responses. All of the responses were valid and none was wasted.

The responses were coded into SPSS data file by using SPSS software version 11.5. Descriptive statistics and factor analysis were conducted to the data.

**RESULTS**

Figure 1 shows that most of the respondents come from Clinical Department (37%), followed by Management (27%), Non-clinical Department (9%) and Human Resource (9%). Only 6% of respondents represent Information Technology Department. Respondents of this study were working at various departments in the hospitals and medical centers.

In Fig. 2, 58% of them were medical officer, 15% represent head of department and 9% were chief executive. A high percentage (12%) stated that their position was not listed in the options, i.e., other job position. The study has included laboratory technician, nurse and medical record officer in other position.

The study also investigates respondent's computer skills (Table 1). More than half of the respondents (58%) assume they have the skills whereas 16.7% feel they are very skillful and the rest (25%) are not skillful at all. Regarding their knowledge on telemedicine, 83.3% of the respondents say they have that knowledge but the remaining 16.7% say they don't. Crosstabulation reveals that among those have computer skills, some don't have knowledge on telemedicine. This raises some questions, since a skillful person in computer should have some knowledge in telemedicine. Though the computer skills and telemedicine knowledge are not uniform among

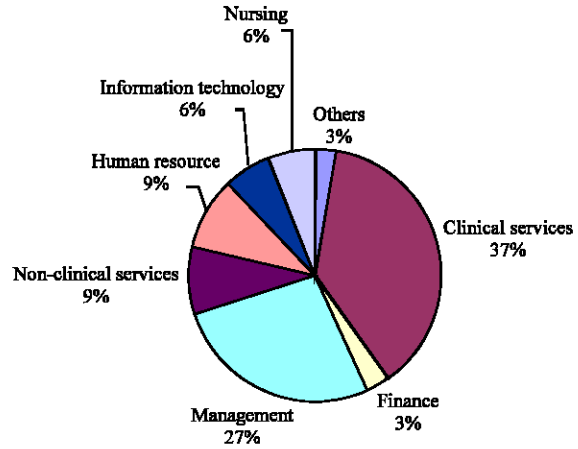


Fig. 1: Respondent's department

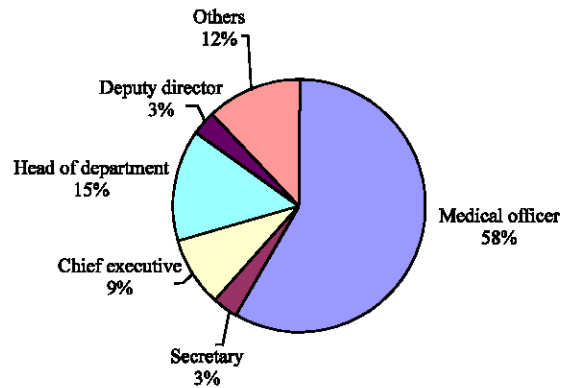


Fig. 2: Respondent's job position

Table 1: Computer skills and knowledge on telemedicine

Computer skills (%)	Knowledge on telemedicine (%)		
	Yes	No	Total
Very skillful	16.7	0.0	16.7
Skillful	41.6	16.7	58.3
Not skillful	25.0	0.0	25.0
Total	83.3	16.7	100.0

respondent, the study findings are not affected, because this study explore respondents' view only, not involving any development of telemedicine tools.

**Feasibility factors in telemedicine:** Conducting a careful planning and readiness study is a critical activity in any organization before developing and implementing any information system. Success in the development and implementation of information system depends very much on this feasibility study. There are four aspects to be studied in evaluating the feasibility in using telemedicine and health informatics i.e., operation, technical, finance and time. Analysis on importance level of these four

Table 2: Importance level of feasibility aspect in telemedicine

Feasibility aspect	Importance	Frequency	Mean (truncated)
Operation	Very important	19	4.60 (5)
	Important	10	
	Quite important	1	
Technical	Important	16	4.40 (4)
	Very important	13	
	Quite important	1	
Time	Very important	18	4.40 (4)
	Important	8	
	Quite important	2	
	Less important	2	
Economy	Important	14	4.17 (4)
	Very important	11	
	Quite important	4	
	Less important	1	

Scale: 1 = Not important, 2 = Less important, 3 = Quite important, 4 = Important, 5 = Very important

Table 3: Feasibility aspects in telemedicine

Item	Feasibility aspects and details	Mean (truncated)
<b>Operation</b>		
C	Improves hospital's image	4.35 (4)
G	Needs enough training	4.23 (4)
J	Have positive feedback from customers	4.06 (4)
D	Supports management systems	3.97 (4)
I	Considering etiquette issue	3.90 (4)
E	Fulfills user's needs	3.87 (4)
B	Achieves hospital goals	3.81 (4)
H	Involving the whole employees	3.77 (4)
A	Solves the hospital problems	3.74 (4)
F	Reduces workforce and overtime	3.19 (3)
<b>Technical</b>		
A	Needs software and hardware resources	4.23 (4)
D	Emphasizes on the future needs	4.20 (4)
G	Needs specific technology application	4.07 (4)
C	Needs special supports and expertise	4.06 (4)
F	Emphasizes on user interface design	3.83 (4)
E	Integrates other departmental systems	3.73 (4)
H	Needs external resources	3.63 (4)
B	Acquisition of resources without difficulty	3.45 (3)
<b>Time</b>		
C	Needs a specific management unit	4.00 (4)
D	Critically affected by time factor	3.87 (4)
B	Needs a comprehensive schedule	3.84 (4)
A	Involving long period of time	3.52 (4)
<b>Economy</b>		
E	Gives satisfaction to customer	4.00 (4)
C	Gives future benefits and revenue	3.97 (4)
I	Needs reimbursement from responsible party	3.84 (4)
B	Involving total hospital costs and savings	3.81 (4)
A	Using revenue analysis	3.80 (4)
F	Regards as organization's investments	3.70 (4)
D	Considering intangible benefits	3.63 (4)
G	Reduces overtime work	3.39 (3)
H	Saving expenses	3.39 (3)

Scale: 1 = Not important, 2 = Less important, 3 = Quite important, 4 = Important, 5 = Very important

aspects is presented here, as in Table 2. The results show that operation is the most important aspect according to respondents (mean 4.60), followed by technical (mean 4.40), time (mean 4.40) and economy (mean 4.17).

To examine respondent's specific view on the evaluation of telemedicine feasibility, a detailed item list is presented to them. They were requested to evaluate the agreement level in each item. The results are presented in Table 3.

For operation aspect, respondents agree that the implementation of telemedicine and health information system be able to enhance the image of these hospitals (mean 4.35). Respondents feel that organization should be providing sufficient training and supports to medical officers in operation of telemedicine (mean 4.23). Next, implementation of telemedicine should receive positive responses from patient (mean 4.06), which represent the main customer in any hospital. Other operation issues that require attention in implementing telemedicine are the content in which has important features that support the management team (mean 3.97) and to fulfill the medical services ethics in any condition (mean 3.90).

Regarding technical aspects in conducting telemedicine, respondents agree that the most important element is in fulfilling basic infrastructure needs, both software and hardware requirements (mean 4.23), followed by plan to acquire advanced telemedicine tools in future (mean 4.20). Respondents feel the importance of specific technology in supporting telemedicine (mean 4.07). Also, the availability of expert in implementing information system in telemedicine (mean 4.06) should be given attention in technical aspects.

Telemedicine feasibility factors that related to time should concern the involvement of specified time management team (mean 4.00). Respondents agree that time is a critical factor to execute information system in telemedicine (mean 3.87) and require a complete activity table (mean 3.84).

As regards economic and financial plan, respondents believe that telemedicine should be able to give emotional satisfaction to patients and other hospital stakeholders (mean 4.00). It seems that respondents concern more about long term gain by winning patient emotions rather than cost and time benefit. This is consistent with respondents' opinion that long term yield should be prioritized (mean 3.97). Not only enough financial funding from responsible party should be given concern (mean 3.84), but also the total hospital costs and savings as a result from telemedicine implementation (mean 3.81) and conducting revenue analysis in hospital activity (mean 3.80).

**Success factor in telemedicine implementation:** There are a few components that contribute to efficient implementation of telemedicine, as was found in literature. The list of item is presented in Table 4, together with the analysis of importance level. The results show that leadership and management is the most important (mean 4.55), followed by data security (mean 4.48), acceptance towards change (mean 4.45), support from medical team (mean 4.39), enough funding (mean 4.39),

Table 4: Important components in telemedicine implementation

Item	Components in telemedicine implementation	Mean (truncated)
A	Leadership, planning and management	4.55 (5)
K	Data security and privacy	4.48 (4)
F	Acceptance towards changes	4.45 (4)
B	Supports from medical personnel	4.39 (4)
G	Sufficient allocation	4.39 (4)
L	Broad telecommunication network	4.35 (4)
D	Adequate expertise and support resources	4.29 (4)
I	Rapid technology development	4.23 (4)
E	Testing on the new system	4.16 (4)
H	Standardized information management	4.13 (4)
J	License, etiquette and laws issue	4.13 (4)
C	Immediate implementation	2.84 (3)

Scale: 1 = Not important, 2 = Less important, 3 = Quite important, 4 = Important, 5 = Very important

Table 5: Factor analysis on telemedicine implementation

Item	Components in telemedicine implementation	Factor		
		1	2	3
L	Broad telecommunication network	0.716		
F	Acceptance towards changes	0.712		
B	Supports from medical personnel	0.620		
D	Adequate expertise and support resources	0.557		
I	Rapid technology development		0.697	
H	Standardized information management		0.649	
G	Sufficient allocation		0.577	
A	Leadership, planning and management		0.501	
J	License, etiquette and laws issue			0.798
C	Immediate implementation			0.660
E	Testing on the new system			0.627
K	Data security and privacy			0.446

sufficient telecommunication network (mean 4.35), enough expertise (mean 4.29) and rapid technological development (mean 4.23).

In order to give a clear illustration of the critical success factor for telemedicine implementation, factor analysis was conducted. The objective is to identify a few important factors that could describe the implementation success. The total 12 items were considered as inputs in factor analysis. The correlation matrix of these items shows that their relationship values are greater than 0.30. This result shows that the data set is suitable for conducting factor analysis.

To get the important factors from the analysis, item's loading was generated by using Varimax method. As a guideline, loading values over 0.45 will be considered to represent each factor. There are three factors to be considered from the data set by identifying three respected factors with eigen value more than 1 (Table 5).

The first factor contains items relating to telecommunication, change acceptance, support from medical team and enough expertise support. The second factor involves issues on technological development, information management, enough funding and planning. The final factor is related to legal issues, rapid implementation, system evaluation and data security.

The three factors generated from the analysis will be named based on the component. By considering readiness of hospital team to accept changes and expertise availability in the service, together with telecommunication as important elements, the first factor is named as support from employee and network. The second factor involves four items about hospital management and planning team and information technology. Therefore it will be known as planning and management of information. The third factor contains four items regarding legal issues, data security and execution and evaluation of system. As a result, the third factor is known by system implementation and security.

## DISCUSSION

Descriptive analysis on four feasibility factors of telemedicine implementation shows that operational is the most important aspect according to respondents, followed by technical aspect. In operational feasibility, respondents feel that telemedicine is an important strategy to enhance the image of hospital and consequently be able to attract more customers (patients). This finding follows the latest trend in this industry, hospitals are expected to adopt new information technology and systems in health care, in order to be seen as an efficient health service provider and to gain trust from patients (Ammenwerth *et al.*, 2003; Lu *et al.*, 2005).

Regarding technical feasibility, sufficient basic infrastructure and training for medical team needs to be considered to develop their knowledge and skills in telemedicine. The training does not only provide ongoing technical support, but also motivate clinician to participate in telemedicine programme, which are important for the implementation (Kellogg *et al.*, 2000). It shows that both hardware and software availability and clinicians readiness play important roles in telemedicine, as suggested by Atkinson *et al.* (2002).

Analysis on critical success factor shows clearly from respondents' feedback, that management plays very important role in ensuring in implementing telemedicine in hospital. In addition, security and privacy also contributes to the success of telemedicine application. Human factor comprising of employees' readiness in accepting change in their working procedure and routine, together with support from medical people are also responsible in the success. Readiness of infrastructure and enough funding from responsible party including to provide telecommunication network are critical to ensure the functions in telemedicine application could be executed efficiently. Also, one of the heat debating questions in implementing telemedicine is whether

hospital personnel are willing to use state of the art information technology while performing their tasks (Aggelidis and Chatzoglou, 2009).

Factor analysis on telemedicine critical success factors reveals three issues: support from hospital personnel and network, planning and management of information and technology and health information system implementation and security. To be success in telemedicine, hospitals need to have a strong fundamental knowledge and infrastructure, be able to plan and manage health information and technology according to latest development and fulfilling legal and ethical issues while constantly evaluating the telemedicine implementation.

### CONCLUSIONS AND FUTURE WORKS

The study intends to identify feasibility and critical success factors in telemedicine from practitioners' viewpoint. Operational and technical component of feasibility factors are more important than time and economic dimension. Hospital competitiveness in terms of good image and ability to attract customers operationally justify the need of telemedicine in hospital. Rapid development in health informatics and technology motivate hospital to acquire the infrastructure and skills, in order to provide better and modern medical treatment to patients, as an enhancement to life quality. Successful implementation of telemedicine is related to the availability of three factors: strong fundamental knowledge and infrastructure, planning and management of health information and technology and fulfillment of legal and ethical issues and constant evaluation of telemedicine implementation.

The findings from the study would be useful for medical practitioners and could serve as a guideline in implementing telemedicine in Klang Valley area and Malaysia in general. Future research is needed to complete and improve the study. Some limitations in the current study such as the small sample could be improved by involving bigger sample number and cover wider location, i.e., the whole Malaysia instead focusing on Klang Valley.

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