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Abstract

The purpose of this paper is to examine the resource influences on knowledge sharing in teleconsultation. The study was conducted by interviewing 28 participants from 11 hospitals in the Ministry of Health, Malaysia. Top-down microanalysis of interview data was performed using a descriptive knowledge-sharing framework that focuses on resource influences. The results indicate that resources can influence knowledge sharing opportunities in teleconsultation in areas such as professional development and learning, greater training opportunities, having champions within the hospitals, IT support and the facilitation from administration.

Keywords

Knowledge sharing, teleconsultation, telemedicine, resources

INTRODUCTION

The positive impact of telemedicine to clinical outcomes has been indicated in previous reviews (Ekeland, Bowes & Flottorp 2010). Acceptance and adoption of telemedicine have been widely studied. The service need of telemedicine such as specialist access, reducing referral from primary health centres to tertiary centre and better utilization of resources such as travelling time and cost, hospital beds, ambulance have been identified as enablers for telemedicine acceptance (Maarop & Win 2012). While acceptance, adoption and outcome measures are important, the role of knowledge sharing in telemedicine should not be ignored.

The purpose of this paper is to examine how the resources provided in a teleconsultation system influence the knowledge sharing opportunities. As a lens for this process, we have selected the resource influences section from Holsapple and Joshi's threefold knowledge management (KM) framework (2000; 2002). While this framework has been used in the business and government domain, it has not yet been utilized in healthcare.

The research has a twofold purpose: to examine how the provided resources positively or negatively influence knowledge sharing in teleconsultation; and to test if the threefold KM framework be used in the health care domain?

TELEMEDICINE AND TELECONSULTATION IN MALAYSIA

Telemedicine involves the delivery of health services through use of ICT to health consumers or between health professionals in different locations. Telemedicine is defined as the integration of information telecommunication and health technologies to deliver health care, and to promote the health status of the patients (Mohan & Raja-Yaacob 2004). Pilot tests and demonstrations of telemedicine services located across the country in both acute and primary care have been conducted in Australia and elsewhere (Gill 2011).

Teleconsultation is one of the main components of telemedicine. Teleconsultation comprises a broad collection of information and communication technologies and services as part of health care facilities to deliver and manage long- distance clinical health services especially at the underserved areas enabling the health providers to consult with specialists (Maarop & Win 2012). Generally, teleconsultation interaction takes place where the required specialist is unavailable at the place where the patient is physically managed or a second opinion of another expert from similar health facility is not available to advise a difficult case (Asbach & Nerlich 2003).

Research has identified several benefits to teleconsultation implementation. The potential to supply cost-effective interventions for health care in developing countries is one powerful incentive driving adoption of teleconsultation. One significant benefit of teleconsultation is its ability to expand specialist services to under-served areas. The objective of this mode of health care delivery is for medical practitioners located at isolated primary hospitals to obtain specialist feedback concerning patient management. This feedback can include direction and consent from a specialist at the tertiary hospital in order for a physician at the primary hospital to immediately perform medical procedures on the patient. This reduces delays in the diagnosis and management of patients in remote and rural areas thereby reducing morbidity and mortality (Bynum et al., 2006). This approach to consultation includes guidance and direct supervision of a surgeon to guide trauma resuscitation (Latifi et al., 2005).

Al-Qirim (2007) suggests that clinical and administrative champions can play an important role in telemedicine success in healthcare organizations. Indeed, Chau and Hu (2002) found clinical administrators have considerable influence on technology implementation in both managerial and clinical aspects. In line with such support, Malaysia's implementation of a teleconsultation system represents a good example of a high profile project that has achieved considerable initial success (Maarop, 2013).

The Ministry of Health (MOH) Malaysia launched their telehealth project as one of the national flagship applications in April 2000 (MOH 2009). The MOH Malaysia has embraced teleconsultation as an innovative way to maximize the productivity of scarce health resources such as health manpower, specialisation services, tertiary emergency beds and other physical resources. The vision of the project was to link 38 MOH Malaysia hospitals across the country with teleconsultation network and services. The primary mode of operation for teleconsultation in Malaysia is consultation and referral over an electronic platform where two health professionals communicate about patient management. Each health professional is located respectively in primary and tertiary health care facilities separated by large distances (Maarop 2013). The Malaysian experience is consistent with the majority of developing countries where teleconsultation is regarded as a proxy to gaining direct access to specialist care or for a second opinion (Maarop & Win 2009).

KNOWLEDGE MANAGEMENT FRAMEWORK

Frameworks provide a method of focus and can act as a lens for examining situations (Kumar 2005). Holsapple and Joshi's threefold knowledge management (KM) framework is a descriptive framework that seeks to better define facilitators and barriers to effective knowledge sharing (KS) (2000; 2002). This framework provides a useful description of the characteristics that affect and influence the management of knowledge within organizations (2000). The purpose of the framework is to provide a foundation for the evaluation of KM processes in an entity (a group or organization) and to stimulate investigation into KM issues by researchers. Holsapple and Joshi describe the framework as providing a language for discussion of KM and KS influences and to "*help researchers systematically identify constructs that may impact knowledge sharing*" (2000, p.254-255).

The selection of the threefold KM framework is due to the strength of its development and the subsequent application of the framework to analyse KS initiatives. The origins of the threefold framework are found in an extensive analysis of the KM literature. The resulting framework was subsequently validated through two Delphi processes with experts in both industry and academia. Since its development, the threefold framework has been used to analyse KS activities in both industry and government organizations. The framework has been utilized in an analysis of Nortel Networks KM processes (Massey et al. 2002), an in-depth examination of KM groups across the U.S. armed forces (Bartczak 2002) and to analyse KS barriers and influences in the U.S. Air Force (Myers 2006).

The key influences identified in Holsapple and Joshi's KM framework are managerial, resources and environmental. Holsapple and Joshi identify managerial influences as those that involve the administration of the knowledge processes in the organization such as leadership of the KS activities and participants and managerial control over knowledge channels (2000; 2002). Resource influences includes not just knowledge resources themselves such as the knowledge of personnel involved, but can also include traditional resources such as finances allocated and computer systems that can affect the way knowledge is managed and shared in an organization (2000; 2004). The managerial and resource influences on KS are predominantly internally focused on the organization. The framework also identifies a third, external influences on knowledge management and sharing as environmental. These external environmental influences include the competition, governmental climate and technology changes that an organization has little control over (2000; 2002; 2004).

While there are several potential avenues for the analysis to follow, this paper focuses on the resource aspects of teleconsultation systems towards KS. The provision of adequate resources is reasoned to be a logical first step in applying knowledge management theory to the case of the teleconsultation in Malaysia. For this reason, the use of the resource influences of the framework is the lens used in this paper.

Within the threefold KM framework outlined by Holsapple and Joshi, resource influences are defined as the resources that are used to execute and/or affect the conduct of KM and KS (2004). The resources of a KS entity (such as a group in an organization or the organization itself), can influence the conduct of knowledge management and sharing. Resource influences are divided into several factors: Financial; Human Skills (such as a participant's ability to manipulate knowledge); Material (such as use of technological systems); Knowledge Content (knowledge resources that are independent of the KS entity such as the provision of meeting space or the knowledge participants themselves can contribute); and Knowledge Schematic (knowledge resources that exist because of the KS entity such as its infrastructure and purpose for operating). Within each factor are a number of elements for deeper examination. Appendix I summarises the definitions of the factors and lists the elements within them.

KNOWLEDGE MANAGEMENT AND TELECONSULTATION

Understanding the success of the Malaysian teleconsultation project in bringing specialist expertise to remote areas has been largely viewed in terms of technology acceptance where technology is viewed in terms of the visible artefacts of the teleconsultation system. This is understandable given the perception that poor user acceptance was the cause of failure in earlier attempts in the deployment of teleconsultation in 2000. Underlying such perceptions is a deeper reality characterised by improved learning processes, improved access to health care and health information and improved communication and coordination of care. All of these areas of improvement fundamentally relate to knowledge sharing that are key to developing actionable and contextualized responses that work to the ongoing effectiveness of the teleconsultation system in Malaysia. The need to develop such responses at an institutional level, rather than on an individual basis, can be examined through Knowledge Management (KM).

The identification of Knowledge Management (KM) as a strategy for improving the delivery of health care using Information and Communication Technology ICT) is factored on the benefits that business has derived from focusing on knowledge in managing complex organizational systems. KM is defined by Linger and Warne (2001) as being about "*the acquisition, construction, transfer and sharing of knowledge assets within an organization aimed at achieving the organization's objectives*" (pp. 1-2).

KM's relevance to health care can be argued on the basis of a number of factors including its high reliance on technology and the pace of change and the increasing need for efficiencies. Additionally, the delivery of appropriate medical knowledge plays a central role in improving patient outcomes. Kothari et al.'s (2011) systematic review of KM related papers in the period 2000-2009 identified 83 studies that could be applied to health care. They were able to further divide this literature on the basis of KM solutions and strategies and KM facilitators and barriers. The authors note that the time is ripe for further application of KM drawn from the business sector for the management of health care and related applications.

The aim of this paper is to build on the research of KM in healthcare by examining how the resources provided in teleconsultation systems can positively or negatively influence opportunities for knowledge sharing between the participants. This research could contribute to the development of additional metrics focused on KS and learning processes or the development of strategies for resource provision in the use of teleconsultation systems.

METHODOLOGY

The literature review of telemedicine was conducted through database searches. Purposive sampling using a key-informant approach was employed to obtain research data (Creswell, 1998; Kuzel, 1999). The key-informant approach is chosen because of its ability to elicit information that is not immediately obvious or obtainable by researchers (Le Compte & Goetz 1984). Interviews were held with key informants in the departments of radiology, neurosurgery, dermatology and cardiology from March 2010 till June 2010. Informants were chosen to provide diverse perspectives of the teleconsultation process as it applied locations that the informants were familiar with (Creswell 1998). These incorporated 28 participants from 11 MOH hospitals comprised of:

1. The senders (N=10; A sender is an individual who sends teleconsultation cases e.g. medical officers and medical assistants at the referring hospitals)

2. The receivers (N=5; A receiver is an individual who receives and responds to teleconsultation cases e.g. specialists, consultant, medical assistants and doctors in particular disciplines at the consulting hospitals)

3. Teleconsultation champions (N=5; A champion is defined in this study as an individual who plays a gatekeeper role similar to a technology provider who facilitates positive acceptance of the new technology (Eikelboom & Atlas 2005; Whitten & Mackert 2005))

4. Teleconsultation administrators (N=8; An administrator is an individual who is in charge in daily teleconsultation support).

Research ethics were approved by Institute for Health Behavioural Research (IHBR) MOH Malaysia, MOH Research and Ethics Committee (MREC) Malaysia and Economic Planning Unit (EPU) Malaysia.

A top-down microanalysis was applied to interview data (Strauss & Corbin 1998). The microanalysis was based on resource influence factors found in Holsapple and Joshi's knowledge management framework. These factors address issues influencing knowledge sharing activities and relationships within the entities. The analysis allowed us to identify new, emerging influences on knowledge sharing in teleconsultation that suggest modification to Holsapple and Joshi's framework. The analysis was performed by the researchers and verified by two independent researchers. Verification involved a comparison of the coding results between the researchers and clarifications made after review (Miles & Huberman 1994). The research sought to understand the phenomenon of teleconsultation knowledge sharing influences from the experience of key actors as well as documentary evidence pertaining to the history of the program since 2000.

RESULTS

Using the framework as a lens, we examined the resource influences on knowledge activities amongst a number of hospitals in Malaysia's health care system. These hospitals participate in a teleconsultation scheme to improve consultation services, online health services, continuing professional development and lifetime health record services for urban and rural hospitals (MOH 2009).

Applying the framework for the examination of the teleconsultation services has two purposes: firstly, to examine resource influences on KS in teleconsultation; and secondly, to test the framework in the health context.

Financial

Financial factors are about the financial assets of the entity and their influence or limitations in performing knowledge activities (Holsapple & Joshi 2000).

Due to the financial backing of the Malaysian government for the Malaysian teleconsultation process, many of the constraints on knowledge sharing found in private sector organizations were not obvious in the study's research data. With the strong financial support of the government, the participants did not indicate that financial issues presented much of a barrier to their involvement and usage of the system. Each of the hospitals has been provided with the required equipment to carry out online health consultations.

Human Skills

The human skills factor examines the skills of the participants in the organization to manipulate and analyze knowledge that is key to function at hand (Holsapple & Joshi 2000).

The knowledge profile of key participants reveals educated medical and IT practitioners. These are professionals who are able to undertake a high level of analysis as well as operate related equipment. However, there was indication that training in use of the system did help influence acceptance and usage of the system, "...*even though the technology is good, humans should also be instilled with ...training*".

Another need for ongoing training was seen in the high turnover of staff through promotion or job movement and the effects on new members who experienced a steep learning curve in becoming familiar with the system, "...*there was a high turnover of staff. Those staff were trained to use the system but then moved to other hospital due to promotion...There was replacement but the replacement was not trained soon or before to use the system.*" This lack of training provided a problem of continuity in knowledge and participation. This was most prevalent in the earliest roll out of the teleconsultation system but in the newer roll out, periodic training has been introduced to aid new personnel in learning the system.

An unforeseen consequence of the teleconsultation system was the ease by which referring doctors were able to refer cases thereby denying themselves opportunities to develop clinical experience. The ability to use and distribute the case backgrounds to the specialists was well handled in terms of providing relevant information. However, the specialists did indicate that the abilities of the referring doctors in terms of analysis of a case before consultation did influence the learning process. A lack of assessment does not improve their ability to learn from the use of the consultation services and can waste time and resources, "...*if the referring doctor just simply sends the case without trying to learn on how to manage the case locally...the sender should make a simple remark after reading and interpreting the CT scan and assess whether it can be managed or not at the referring site before referring the case to us.*"

Material

Material resources are identified as the capabilities of the entities material assets for knowledge sharing. The focus of these assets is on the use of computer systems to facilitate sharing (Holsapple & Joshi 2000).

The importance of material resources for knowledge sharing can be seen in increasing utilization of multimedia over time. The roll out of equipment for the teleconsulting has been in two stages, an early roll out in 2000 and then a further development of the project in 2010. The newer equipment in the 2010 roll out provides the ability to send images and multimedia along with the patient history, "*...teleconsultation is a medium to send CT scan image together with necessary description about the patient including patient history.*" The system also provides for follow up from the specialist through the system. However, phone calls are still utilized at times for further discussion between the referring doctor and the specialist after the initial referral information is transferred rather than or in conjunction with the teleconsultation workstations.

While there is the opportunity with the equipment to provide both imaging data and patient histories, the ability to participate in all areas of teleconsultation is dependent on the technological and physical infrastructure in the referring hospital. Services provided through the teleconsulting system include the disciplines of neurosurgery, cardiology, radiology and dermatology. Consultations are only carried out in the referring hospital that has the imaging diagnosis equipment facilities to help the discipline specialist perform any necessary diagnosis. Different imaging diagnoses are carried out by the different consulting specialist disciplines, "*...types of machines and workstations in the involved hospitals differ across specialties thus (consultancy) will be based on types of hospitals predefined in the teleconsultation community.*"

To aid the transfer of knowledge between the referring doctor and the specialist, workstations have been established in the participating hospitals. The workstations are comprised of a desktop computer linked to the centralised national teleconsultation network. The workstation is usually placed in a strategic room in the hospital to help the participating users have easy access (Maarop 2013).

However, the placement of workstations has caused some restrictions in the usage and ability to effectively transfer the medical knowledge particularly in the receiving hospitals. In the receiving hospitals where the specialists are located, there is only one workstation for the teleconsultation, yet this might be shared between several specialists across the different teleconsulting disciplines, "*...let us say there are five specialists on duty, only one workstation was being used and shared by these specialists*". Additionally, the rooms selected for the workstations may not be in a desirable location causing the users to leave their regular work area to utilize the workstation and consuming time in their busy schedules, "*......as far as I am concerned, previously the workstation is put in one area like most in ED (emergency department). So, the surgical officer has to go to ED to use it and this is time consuming*". Increasing the number of workstations or providing discipline specific workstations could aid the knowledge transference, "*...in our case, if we have the teleconsultation room which is located inside the cardio clinic itself, it will be better.*"

The teleconsultation process has been improved through the introduction of mobile phone alerts that allows the specialist on call for consultations to receive alerts and also to review the images over the phone quickly. While the images on the phone are not suitable for proper consultation, needing confirmation from the proper images, they can allow the consultant to see anything that stands out quickly and be able to "*...have the first opinion to determine the severity of trauma*".

Artifacts

Artifacts are resources that hold or convey knowledge but have no knowledge processing capabilities themselves (Holsapple and Joshi 2000). There are two key elements in artifacts, the office facilities and the computing facilities.

In terms of office facilities, this is limited to the provision of a room to host the teleconsulting workstation. Doctors and staff use their own office facilities, but the workstation is located in a centralised place within the hospital.

However, the computing facilities provide a number of functions for holding and distributing knowledge between the hospitals. The teleconsultation system provides a centralised application service and also provides a data repository. This virtual network and repository operates over the nation-wide teleconsultation network providing cost effective referrals, avoid the duplication of personnel and facilities and can cross regional boundaries.

Time was not an element of artifact resource influences in the framework developed by Holsapple and Joshi (2000). However, time can be an artifact in conveying knowledge, the need to have time to process, learn and transfer relevant knowledge (O'Driscoll & Rizzo 1985). We discovered that participants found it difficult to find time to fully process the knowledge conveyed. In the teleconsultation system, the participants have strict

policies that determine the response time to a consultation depending on the classification of the medical condition. For example, acute emergency consultations must be viewed and the referring hospital contacted within three hours of the consultation being posted while minor emergency consultations have between three and 48 hours for reply and non-emergency cases have one to five working days.

Specialists strive to meet these time policies or even reduce them. However, their efforts can be difficult where they need to wait for access to utilize the workstations (Maarop 2013).

Participants

The participant factor considers the knowledge that the human members involved have themselves, their background experiences and knowledge they can bring to the entity (Holsapple & Joshi 2000). This is different to the Human Skills factor discussed above that examines their skills with collecting and analyzing the knowledge as the focus here is on their actual knowledge rather than how they manipulate that knowledge. The key element of this factor is the beliefs and experiences of the participants towards knowledge sharing.

On examination of those participating in the teleconsultation system, members were overall positive (24 out of 28 participants) towards utilizing the system and sharing knowledge about the best approaches to treating patients in the particular disciplines (Maarop 2013). Comments towards use of the system included "*:..we specialists in this hospital are excited about using teleconsultation*", "*...I am positive to make use of it*", "*motivated to use it*" and "*it is a value added*".

In addition, we found that the development of the teleconsulting system has also provided the users with a broad knowledge domain that would otherwise not be available. This is particularly true for the rural and urban hospitals in the system. For many of these hospitals, there is no consulting specialist in-house. Specialists that may have begun in more rural hospitals eventually move to the larger city hospitals due to career and money opportunities not available in the smaller rural hospitals. Utilization of the teleconsulting system allows the hospitals and, in turn, the doctors access to knowledge in the specialist disciplines that they would not normally have access to. This element of broad knowledge domain has not been considered in the original framework.

Culture

Holsapple and Joshi (2000) define culture as the basic assumptions of the organization towards promoting knowledge sharing interactions between personnel.

In this case, the culture to consider is not just that of the participating hospitals but also the government oversight that helps administer the project. From both perspectives, there was a positive reception to the use of teleconsultation to share knowledge on patient diagnoses, "*...without the support and facilitating conditions from organization (administration) and collective positive attitude of health care providers, the uptake (of teleconsulting) will still not be that apparent*".

Infrastructure

Infrastructure focuses on the knowledge that defines the roles relationships and regulations that support the knowledge activities and allow it to develop (Holsapple & Joshi 2000). The key elements of this factor are the channels of communication provided for interaction, the regulations of the knowledge entity, roles and responsibilities of participants.

In terms of channels of communication, there are some limitations based on the type of imaging facilities available in each hospital as discussed in Material resource influences above. However, the technology choices provide several different channels for the consultation process. Participants can provide the initial referral including images and multimedia through the teleconsultation system. Specialists are able to receive the patient details and images through both the workstations provided and through mobile phones provided. Follow up discussions between the specialist and the referring doctor can be performed through the workstations and/or through direct phone calls.

As discussed above, a set of guidelines have been established that outline the time frames for specialists to act on a referral through the system. In addition, as there are several services provided (neurosurgery, cardiology, radiology and dermatology), each of these services has parameters for interaction that define how cases being sent through the teleconsultation system are delivered to and what types of cases can be referred (Maarop 2013). The reason for these guidelines to be defined for each service is that the equipment and medical practice constraints can differ (Maarop 2013).

There are a number of roles and responsibilities for participants. The two main are those of the referral doctor (the sender) and the specialist consulted (the receiver). However, within each participating hospital there are

teleconsultation administrators who provide support for the system in-house. These administrators include IT support staff and the teleconsultation project implementer. Additionally, the heads of the different services play a role in coordinating the implementation of the workstations and developing the policies for that system.

Within each hospital, a number of personnel involved have taken on the role of champion of the project that help in promoting and training staff in the system, *"...the champions will then disseminate about how to use the system...the role of champion is very important, to give one-to-one informal tutorial to the potential end user"*. Teleconsultation champions are individuals who are nominated as champions of the technology and selected among doctors and medical assistants by the MOH Telehealth Steering Committee.

External to the participating hospitals, additional participants are the Malaysian Ministry of Health personnel that aid in the development of the project. These members have provided oversight, help in vendor selection and defining the purpose of implementing the teleconsultation system (Maarop 2013).

Purpose and Strategy

The purpose and strategy factors of resource influences focuses on the development of a clear goal or reason for existence of an entity and determining what steps are required to achieve this goal.

In the case of the teleconsultation service in Malaysia's health care system, the purpose and strategy for this system were defined by the Ministry of Health. Initially, when first established in 2000, the purpose of the system was to expand clinical services and expertise to rural and remote areas and thus in turn, improve the quality of national health care. The proposed method to accomplish this was a virtual method through the use of online and telecommunications technology (MOH).

This purpose was still the main point in the subsequent roll out of the system in 2010. However, the strategy at this time was to reduce some of the adoption barriers and infrastructure issues from the initial implementation to provide a more stable system. The key goals of the system are: to provide the ability to extend the knowledge base and optimise the access of specialist consultation on cases; to provide a single portal dissemination of information and knowledge; to provide continuing professional development for doctors with access to up-to-date knowledge and skills in health care; and to provide constituents with lifetime health plans (MOH 2009).

DISCUSSION

Our aim in this research was to examine the resource influences on knowledge sharing in the use of teleconsultation systems. Additionally, we have tested the threefold knowledge management framework in the healthcare domain; an area not previously explored using this framework.

Resource Influences on Knowledge sharing

In terms of examining the resource influences on knowledge sharing we found that the factors of Human Skills (through training), Material and Artifacts (technology access), Culture (roles and regulations) and Infrastructure (flexible channels) had the most impact on the KS activities of the teleconsultation participants.

Training was found to be an important facilitator of user acceptance and sustained usage of the teleconsultation system. The improved training has resulted in greater acceptance and usage of the system by staff and improves continuity (Ferguson 2006; Jennette et al. 2003). This improvement in continuity reduces gaps in the knowledge sharing and improves the ongoing archive of treatment approaches within the system. The skills of participants at collecting and transferring knowledge have improved through the use of the ongoing training scheme brought in as part of the newer roll-out of the teleconsultation system. This training was implemented after the initial roll-out when it was recognised that the high turnover of staff meant new staff might have to wait sometime for training and lose interest or not utilize the teleconsultation process.

While training has improved acceptance of the technology, ease-of-use has inadvertently created a context in which opportunities for learning are undermined if Doctors prematurely refer less complex cases to Specialists. A key goal of the teleconsultation system was the opportunity to improve learning processes such as analysis of the cases by referring Doctors. It was identified that some referring doctors took little time to consider the case first and what could be done locally before referring it on to a specialist. By improving the analysis skills of the local doctors, there can be greater immediate knowledge interaction between the referring doctor and the specialist and a reduction in time to process and provide feedback. The lack of analytical skills displayed in some cases means that the project is not yet meeting the project goal of providing a continuing learning environment for the Doctors participating (Maarop 2013). Improving the analytical skills of the referring Doctors fosters more focused knowledge sharing and reduces the time needed for the consulting Doctors to process, learn and develop feedback.

As a significant resource influence from the framework, the improvement of technology has had a marked effect in the knowledge that can be conveyed. The material resources provided are based on the imaging technology in the cooperating hospitals and the workstation system used to send the consultation information between referring and consulting hospitals. The improved technology in the second roll-out of the teleconsultation system has improved the knowledge shared by providing the ability to send images along with case notes and patient history. However, the utilization of mobile phones as well to provide alerts and allow the specialists to 'scan' incoming images has helped in reducing the time to process and provide feedback. The use of the mobile technology and increased imaging provides for flexibility in the opportunity to engage in the knowledge sharing and the type of knowledge that can be communicated.

The success of the technology in facilitating knowledge sharing is perhaps best seen in emerging resource constraints that were not previously evident. The constrained access to the teleconsultation system because of insufficient numbers of workstations highlights the related resource influence from Holsapple and Joshi's model called Artifacts.. What could improve the knowledge sharing process and improve the time to consult would be the introduction of several workstations in the consulting hospitals. The implementation of one teleconsulting workstation in the consulting hospitals, especially when there are several specialists and different disciplines, reduces the availability for the consultants to review and provide feedback (Maarop 2013). The result is that specialists turn to other options for providing feedback such as phone calls. While these are useful, to get greater benefit out of the teleconsultation system and its ability to act as a data repository, having more workstations for the specialists would ensure utilization and that the feedback is logged into the system at the same time (Edirippulige 2005). This has the added benefit in building on the knowledge archive that has been developed through implementation of the teleconsultation system.

Despite the increased efficiencies enabled by the teleconsultation system some aspects of medical diagnosis remain constrained by factors not explicitly described by the framework such as human cognition. Consideration should also be made towards the time it takes to review incoming teleconsultations and provide effective feedback (O'Driscoll & Rizzo 1985). While the implementation has made the transfer of relevant knowledge more convenient and quicker, the specialists still need time to review and provide effective feedback on referred cases. Increasing the number of specialists that can be involved or improving the mobile technology so specialists don't always have to access the workstations for can aid this.

The importance that Holsapple and Joshi attribute to an organisational culture that facilitates knowledge sharing is supported by the observations in this study. The positive acceptance and utilization of the teleconsultation system has also been promoted through the strong support and culture of the hospitals and the government departments involved (Whitten & Mackert 2005). The use of champions within the hospitals to promote use of the system, the strong training and IT support and the facilitation from administration has all contributed to the success of the system as both a channel and repository of knowledge exchange.

Indeed, organisational culture was difficult to distinguish from the positive attitude that participants (as a resource influence) brought to knowledge sharing. The adoption and utilization of the teleconsultation system has been aided by the positive opinion of those who have experienced first hand the capabilities of the technology. The ability to access and utilize knowledge resources across a network of hospitals can help span boundaries and provide a broad knowledge domain to participants that would not otherwise be available. This not only has the benefit of providing rural doctors with greater knowledge but benefitting the patients as well in their treatment.

The utilization has also been supported by a considered approach to the infrastructure requirements. As discussed above, the training, the use of mobiles to provide a secondary channel of communication, the ability to send quality images with patient histories all provide a supportive infrastructure that aids in the communication of knowledge between the referring and consultative doctors. This has been supported also by clear purpose and strategy in implementing the system across the Malaysian Health system.

The Threefold KM Framework in the Healthcare Domain

With regard to the testing of the framework in a different domain we found that the framework does work in the healthcare context. In exploring the KS activities undertaken in the teleconsultation process, the factors provided in the resource influences were able to be identified.

Key resource influence factors that made impact on the KS included the Human Skills, Material and Artifact, Culture and Infrastructure resources. The other factors were present and able to be identified but had less influence on the KS activities undertaken. For example, Financial resources were identified but due to the provision of funds through a government initiative, resources were provided without the usual constraints identified in private sector organizations.

Through the analysis of the framework and the KS activities within the teleconsultation system, a recurring theme of time was found. The issue of time was raised by the study participants as a barrier to their KS opportunities. Time is addressed in the threefold framework but is a part of the external Environmental Influences not studied in this research paper. The influence of Time in the framework addresses the influence of externally defined timeframes such as the need to react due to government regulations (Holsapple & Joshi 2000; 2002; 2004). However, when examining the time issue raised by participants, it was not an external influence but instead about the lack of time to reflect and transfer the knowledge required. This corresponds to the use of computer and office facilities to aid in the conveyance of knowledge, an Artifact factor in the resource influences. This perception of time as an artifact has been utilized in economic research where time is considered a variable that helps to convey knowledge (Driscoll & Rizzo 1985). Participants need time to process and learn from knowledge received and to transfer knowledge to others. We propose that time can be placed as an element of the resource influences when looking at resources to aid KS and also as an environmental influence in acting on factors external to the KS entity.

There was some consideration of overlap in the resource factors found in the utilization of the framework developed by Holsapple and Joshi. There can be conflict in understanding the difference between the factor 'Human Skills' and the factor 'Knowledge Content: Human Participants'. However, in-depth review of the literature on the framework and in those studies that have used the framework (Bartczak 2002; Massey et al. 2002; Myers 2006) can clarify the difference. Human Skills refers specifically to the skills participants in the KS entity have to manipulate, collect and transfer knowledge while the Knowledge Content: Human Participants factor is about the knowledge the participants themselves possess and can contribute to the KS entity. A similar issue occurs with the perception of Material and Artifact with the focus being on the technology utilised. Further research on the terminology needed and use of these terms in other domains could assist in clarifying the framework.

CONCLUSION

The purpose of this paper was to examine how the resources in a teleconsultation system influenced the KS that occurred. As a lens for this process we utilized the threefold knowledge management framework by Holsapple and Joshi (2000; 2002). Our research has a twofold purpose, to examine the resource influences on KS and to provide evidence of the application of the framework in a different context that of health care.

As outlined in the discussion above, several key resource factors that influence KS in teleconsultation were identified. These main influences are: (1) development of the skills of participants in use of technology to improve continuity and archiving of knowledge (2) development of analytical abilities to improve the collaborative interaction between participants; (3) the ongoing use of new technology to provide a greater flexibility in the type of knowledge that can be shared and archived, though access can be constrained through limited access to the technology; (4) the cultural acceptance through defined champions to support use of the teleconsultation system; (5) the need to provide time for participants to reflect, learn and transfer knowledge.

Our research has shown that the Resource influences of the threefold KM framework developed by Holsapple and Joshi for use in examining organizational KM and KS can also be applied in the healthcare domain. All factors had of the resource influences were able to be utilized to examine the KS activities in the teleconsultation system. However, not all factors had the same amount of impact. We also identified that time can be considered an Artifact that can influence the KS activities and included as a resource influences.

Future research for this work includes examining the teleconsultation process in Malaysia addressing the other two influences of the framework: managerial and environmental. Additionally research on the new element of time as an artifact in the framework needs to be carried out in the original business domain to determine the validity of this potential extension.

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APPENDIX 1

Factors	Resource Influence Factors								
	Financial	Human Skills	Material	Knowledge Content Knowledge resources that exist independent of the entity		Knowledge Schematic Knowledge resources that exist dependent on the entity			
				Artifacts	Human Participants	Culture	Infrastructure	Purpose	Strategy
Definition	The entity's financial assets. Financial resources can limit what can be expended on an entity's knowledge activities	The skills possessed by the participants in the entity such as their ability to manipulate knowledge	The capabilities of the entity's material assets including technology	Items that hold or convey usable knowledge but have no knowledge processing capabilities themselves	Knowledge of the human participants themselves	The basic assumptions and beliefs of the members of the entity, and/or the values and principles of the organization that the entity is a part of, towards knowledge and knowledge sharing	Knowledge that defines an organizations roles and interrelationships and the regulations that govern the use of those roles and regulations	Defines an organizations reason for existence, what is the mission, vision, objective and/or goals of that organisation	Knowledge that defines what to do to achieve the organizations purpose
Elements	Limitations of financial requirements	Personal knowledge collection skills Personal knowledge analysis skills	Use of computer systems to facilitate sharing	Office facilities Computing facilities	Beliefs and experiences of sharing	Organizational culture	Channels of communication Regulations of entity Roles of participants Responsibilities of participants	Clear objective of entity	Strategy development

Sourced from Holsapple and Joshi (2000; 2002; 2004)