Accelerating MSC Telehealth Flagship Application through Adoption of Knowledge Management: Making Medical Knowledge Available With Windows Communication Foundation

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ABSTRACT

The MSC Malaysia was conceptualized in 1996 by the government of Malaysia to turn the nation into fast growing dynamic ICT-hub focussing on solutions, services and research and development. To further boost the growth of MSC, innovative flagship applications were derived which primarily focuses on E-Government, MyKad, Smart School, Telehealth and Technopreneur Development. One of the key problems across Malaysia is the inadequate sharing of tacit medical knowledge among medical practitioners which is vital to ensure the MSC Telehealth flagship application is successful. This paper will address the mechanisms to accelerate the MSC Telehealth flagship application through the adoption of a knowledge management framework implemented using Windows Communication Foundation. The adoption of knowledge management to further improve the management and sharing of disseminated medical information and healthcare knowledge will become the success criteria for medical practitioners to further enhance the point of care decision making process. In this paper, I will introduce the MSC Telehealth flagship application, Medical Informatics; Application of Knowledge Management in Healthcare and finally a conceptual model will be presented based on the Windows Communication Foundation (WCF) which will allow the sharing of medical information.

Keywords
Knowledge Management, Tacit Knowledge, Explicit Knowledge, Windows Communication Foundation (WCF), Medical Informatics

1.0 INTRODUCTION

A number of large corporate organizations such as Satyam Computing, Microsoft, IBM and other similar organizations have realized the importance of human capital or also referred to as knowledge to stay competitive in this face pace emerging world of economy and technology. As reported in (Hussain.F & Raza S.Ali, 2004) it appears that most organizations and industries have adopted and implemented knowledge management practices in some way or rather, but these does not seem to be the case for the health care sector. The primary goal of the MSC Telehealth flagship application is to ensure that all Malaysians have access to information related to healthcare management which can be accessed by doctors, nurses and the patient's it-self. With Telehealth, the aim is to foster the sharing of medical knowledge to all entities which includes the public, health care providers which involves government hospitals, private hospitals, clinics and manufacturer of pharmaceutical products, this would allow an improved decision making at the point of care. By initiating the Telehealth flagship application, it will transform the conventional healthcare system and processes to a one which is driven by the information and communication based system and processes. As mentioned in (MSC Malaysia, 2003), the two primary applications which will provide health related information are called the MCPHIE (Mass Customised / Personalised Health Information and Education and CME (Continuing Medical Education). MCPHIE will deliver health information to individuals and the CME component will benefit the healthcare professionals and increase knowledge and skills through sharing. At present as of March 2008 based on (MSC Malaysia, 2003), there are currently 4 (Four) Telehealth Application which comprises of Lifetime Health Record (LHR), MyHealth Portal which can be accessed at (http://www.myhealth.gov.my), Continuing Professional Development (CPD) and Teleconsultation (TC). In the case of MyHealth Portal, it is unable to present personalized health information for a particular individual. It would be of greater benefit if health information can be delivered to the audience instead of having them to search for health related information.

As reported in (MSC Malaysia, 2003), only four Government hospitals around the Klang Valley have implemented TeleHealth to ensure up-to-date patient information is available, and this figure has not changed as of the time of authoring. As of this year the patient information could not be accessed from rest of the

Government hospitals and clinics. This case even applied to private hospitals. For instance, if a patient is admitted in Hospital A regardless of whether it's Government of private, the fact remains that when a patient decides to go to Hospital B for a second opinion, the entire information will have to be manually located from the records department before being handed over to Hospital B. Such processes takes up unnecessary time in locating the records which in return could delay the decision making process by the medical doctor in particularly for emergency related medical cases where immediate action is required.

If only patient medical records can be made electronically available to all healthcare providers for sharing, this will benefit every entity be it the patient, doctor or even a medical student. The major problem faced by the entities above within the Malaysian healthcare sector is lack of information sharing among medical professionals, medical centres and medical universities and this is quite evident when we visit hospitals where records are still paper based. Even though major hospitals throughout the nation have invested in Hospital Information Management Systems (HIMS), these systems are only being used for administrative functions and do not carry any critical information about the patient. Most HIMS implemented in the Malaysian hospitals be it in the public or private sector does not have the capability to capture, codify and store tacit medical knowledge.

2.0 MEDICAL INFORMATICS

In the past, medical studies are purely based on individual experiences and field of specialism. But today, this trend has changed and medical studies these days are based on rationalization of scientific support. The Information and Communication (ICT) industry is accelerating at a very fast pace in various sectors, nevertheless the availability of a full fledge system to overcome the problem of knowledge and information overload has yet to be looked at a greater depth and this has created a gap between medical research and general medical practice. The field of medical continues to grow and having just access to explicit knowledge is insufficient. Explicit medical knowledge comes in the form of books and practical clinical guidelines which is readily available from a variety of sources.

As stated in (Healthfield.H & Louw.G, 1999), medical informatics is the application of medical theory and knowledge coupled together with experiences putting together the advancement of information communications and technology to solve a medical case. The ultimate goal of medical informatics is to integrate tacit knowledge and explicit knowledge with the necessary tools and thereafter applying both tacit and explicit knowledge to carry out decision which is associated with the patient itself. Medical informatics can also aid in teaching and learning process of a medical student as it also carries past cases of patients which could be used as reference aids. One of the core areas of medical informatics are the decision support systems which are derived from tacit knowledge, explicit knowledge and Computerized Patient Records (CPRs) or also referred to as EMR (Electronic Medical Records).

2.1 Computerized Patient Records

It is important for medical institutes to provide good care to its patient and one of this is by ensuring that patient medical records are accurate and stored systematically. Patient records are the most important document as it contains all the cases in chronological order. Since patient records contain information of cases and drugs administered, these information is vital for all parties such as the doctor, medical researchers and even medical students. With the rising case of various medical cases, the adoption of Computerised-Based Patient Records (CPRs) or also known as (EMR) Electronic Medical Records will aid physicians in a number of ways. With EMRs, all medical related information of a patient can be shared among other medical professionals who could be geographically located in other countries, and this would help in obtaining additional opinions before deriving a conclusion. Since EMRs, store patient record electronically, the main objective is to form an integrated system which can be linked up by hospitals and clinics around the nation. Besides, just having patient information, EMR's must possess the ability to link information of related and similar data to provide a rich knowledge based of medical information.

One of the issues faced by most CPRs (Computerized Patient Records) implemented today is the non-standardization of data format. Due to this issue of non-standardization, most CPR's are not able to communicate with other CPR's and these results to the denial of access of patient data and thus the sharing of medical information is disrupted and not available.

2.2 Decision Support Systems

Decision support systems are complex knowledge base systems that aid physicians in their routine practice. With decision support systems in place, errors are reduced as the system warns the physician if an inappropriate task is carried out such as overdose administration of drugs and

other critical tasks. Based on my findings by visiting 4 (Four) hospitals in Kuala Lumpur, none of the hospitals have invested in having a decision support system. As mentioned in (Raghavan S, 2005), decision support systems are designed based on an agent based technology; these agents are autonomous which uses the patient's medical history stored within the CPR to aid the physician to diagnose the patient. In this case the EMR is collection of patient records which forms a part of the medical knowledge base.

DSS or CDSS (Clinical Decision Support System) are artificial knowledge based computer program which is specifically designed to aid medical professionals to carry out critical clinical decisions. Decision Support Systems are derived by having large quantities of data of similar cases, which will then be processed by complex mathematical algorithms to draw a probability of a specific medical diagnostic. DSS functions by getting clinical data from EMR (Electronic Medical Records) and by using the build in medical knowledgebase; it aids the physicians in deriving with an accurate medical advice. In order to implement a decision support system, HIMS must have the capability to feed the DSS with the appropriate data but from my findings the HIMS present currently at most of the hospitals in Kuala Lumpur does not have the integration feature to support DSS.

3.0 KNOWLEDGE MANAGEMENT IN HEALTHCARE

"*Knowledge Management (KM) can be defined as gathering, organizing, refining and distributing of knowledge* (Hussain.F & Raza S.Ali, 2004)". The healthcare sector has always been knowledge-intensive and will continue to do so with physicians coming across new medical cases every moment. At the point-of-care when facing the patient, it's the knowledge and experience of the physician that determines what is best to be given to the patient. As mentioned in (Warren J, 2003; Kols A, 2004), the healthcare industry has not done sufficient of converting valuable health related data into usable knowledge, and this is something very serious to be looked as this affects the quality of diagnosis the patients receives. There is wide difference between knowledge and information. The important term in knowledge management is data and information. Data is defined as unprocessed or raw information and it does not constitute to any meaning without a proper context. An example, "80 mm/mol" is a meaningless data if not associated with a context.

In the past knowledge management is commonly associated with manufacturing and service oriented industry, but today as mentioned in (Beveren. J, 2003), knowledge management has triggered interest among healthcare professionals that a successful treatment of a patient is the result on how healthcare professionals apply their medical knowledge and medical experience. Based on what is mentioned above, it's obvious that, there is relationship between knowledge management and healthcare which could result in a better service to the patients. There are two main areas of knowledge management namely the level of knowledge among healthcare professionals and the service level where information is disseminated for sharing among healthcare professionals.

As mentioned in (Shepherd M & Zitner D, 2004), the clinical decision made by the physician can be further improved when the right medical knowledge is available at the right time especially during the point of care. But this is not always the case and as a consequence, medical errors have increased due to the fact that clinical evidence can't be access just-in-time. Tacit medical knowledge is an important medical resource for physicians as it contains solutions to real world cases; such information is attached individually within the electronic medical record of the patient.

The medical knowledge can be categorized into explicit medical knowledge and tacit medical knowledge. Explicit medical knowledge refers to written and published guidelines on how procedures should be carried out and this is commonly available in the form medical literatures, where else tacit knowledge is the inborn knowledge of a medical expert gathered from years of service. Medical experts who possess tacit knowledge are senior healthcare professionals who are able to make critical medical decisions at the point of care. In the field of medicine, tacit knowledge is recognized as a valuable piece of information (Warren J. Heard & Bird L, 2003). The conceptual framework will be presented in section 4, by extracting tacit knowledge from EMR and presenting it as explicit knowledge. At present such mechanism is not part of the MSC Telehealth flagship application. Figure 1 illustrates the relationship between tacit medical knowledge and explicit medical knowledge.

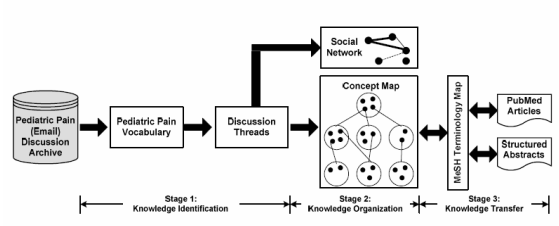

Figure 1: Linking Tacit Knowledge with Explicit Knowledge (Shepherd M & Zitner D, 2004)

3.1 Level of Knowledge among HealthCare Professionals

It is quite evident that a quite a large number of healthcare professionals in Malaysia tend to move from the government sector to the private sector after a number of years or service and this is an issue whish needs to be seriously looked at , when experience healthcare professionals move, experience and knowledge tends to also go with them, which in fact should not be the case. The concern here is not much of the movement of healthcare professionals from the government sector to the private sector but rather how can the experiences and knowledge of this professionals be retained. It is important to extract the tacit knowledge from these experience healthcare professionals. Tacit knowledge is important as it provides a rich source of information especially for case-based medical decisions. At present the best source of patient medical evidence and medical history is from the CPR. Most healthcare providers has not attempted to do so, as the currently implemented HIMS by most healthcare providers does not provide the support for integration with knowledge management system such as the CDSS.

3.2 Knowledge Sharing Among HealthCare Professionals

Automating the process of healthcare with the introduction of DSS and EMR is the first step of success towards providing an improved healthcare services to the patients, but what is more important here is the ability to share this information with all other healthcare providers regardless of system platform. One of the most important aspects for healthcare professionals is the ability to locate critical medical references from any sources and it must be presented in a format which could be easily interpreted. The MSC TeleHealth flagship application document addresses the importance of sharing but does not provide a clear framework on how this can be achieved. In the next section, a conceptual framework will be presented based on the Microsoft Windows Communication Foundation (WCF) which will allows seamless sharing on medical information from multiples sources regardless of the HIMS operating platform.

4.0 KNOWLEDGE SHARING FOR MSC TELEHEALTH FLAGSHIP APPLICATION

The framework proposed here is based on the Microsoft Windows Communication Foundation (Part of .Net Framework 3.0) platform, which is a SOA (Service Oriented Architecture) Technology. The objective of this framework is to allow existing HIMS to share and access external medical data of patients without having to invest in costly solution. As mentioned in (Smith J, 2007) Windows Communication Foundation is a set of related technologies which is service-oriented, loosely-coupled and platform independent. With WCF, information and service can be accessed from different types of network protocols. Due to the fact that WCF is centred on SOA, business functions are shared and reused and thus the developer needs to only focus on interfacing two or more different systems. In order to achieve the functionality above, the next few sections will briefly introduce the fundamentals of Windows Communication Foundation followed by the conceptual design of the framework for knowledge sharing by healthcare professionals.

4.1 Windows Communication Foundation

Windows Communication Foundation (WCF) is a new distributed messaging technology that is entirely service oriented and able to communicate across multiple platforms. With WCF, Common Language Runtimes (CLR) are exposed as service and consumed as CLR type as well. The key point in WCF is the capability to interoperate between service using XML as XML is an open standard for data transport and storage. There are four main key components for a WCF service, namely the contract definition, endpoint definition, hosting code and the implementation code. WCF services are components that can be re-used and these components define clearly the contact policies. All policies and practices of a service are described within a XML file. A WCF service is said to be loosely coupled as the service consumer is not required to have any knowledge about the service other then what is encapsulated in the published contract. When an application invokes the WCF service, the service is invoked regardless of language, application and environment specific features. (Smith J, 2007). The fundamental difference between the traditional ASMX based web service and the current WCF is that traditional ASMX based services used only the HTTP protocol, where else WCF can utilize any sort

of protocols. WCF provides a complete set of classes to build SOA (Service Oriented Architecture) based applications which can be build on any technology and platform.

4.1.1 Windows Communication Foundation - Service Contract

In WCF, the service contract defines the methods of what a service can perform. In order for a service to function, there should be a minimum of one service contract being defined. Without a service contract, it is not possible for independent HIMS platform to communicate as service contracts define the mapping of interface, methods and message exchange patterns in a platform-independent description. To simplify it, the service contract basically states what is to be shared as the data contract defines the data structure and message contract defines the information to be shared. In a nutshell, services are components or program that response to the request of a client. Figure 2 illustrates the anatomy of a service.

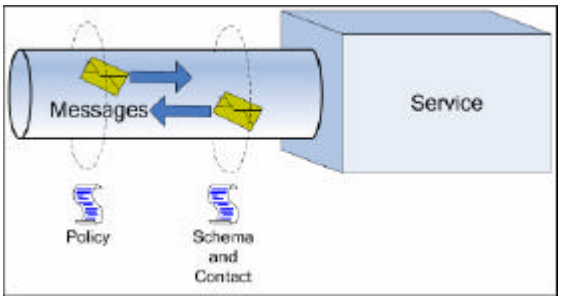

Figure 2: Windows Communication Foundation Service Anatomy (Smith J, 2007)

4.1.2 Windows Communication Foundation - Binding

Upon defining the service contract, the next task is to bind the contract as the endpoint of the service which has been exposed. Binding of the service is important as it defines the communication of an endpoint. Without the binding, the requesting client will not be able to access the service. Binding determines the transport protocol, encoding methods and security options (Bustamante, 2005). Figure 3 illustrates the client bindings with the endpoint.

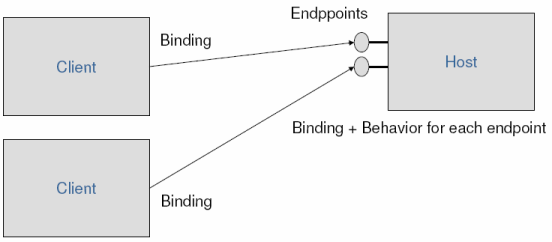

Figure 3: Client-Binding-Endpoints with Host (Smith J, 2007)

4.1.3 Windows Communication Foundation – Address

The get WCF working, it has to be hosted and made available. The four hosting mechanism for WCF are IIS (Internet Information Service), Self-hosting, WAS (Windows Activation Service) & Managed Windows Service (MWS). Without hosting the service, the client application will not be able to bind and consume the service. Figure 4 illustrates the ABC's of WCF. (Smith J, 2007)

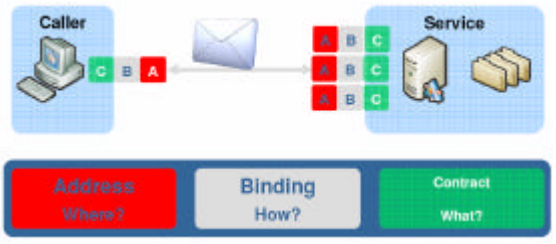

Figure 4: The ABC's (Address, Binding, and Contract) of Windows Communication Foundation (Bustamante, 2005)

4.2 WCF Based Conceptual Framework for Medical Knowledge Sharing for the MSC Telehealth Flagship Application.

The proposed conceptual framework will allow the extraction of tacit knowledge stored within the Electronic Medical Records from any source followed by linking and organizing the extracted information and lastly presenting this information to the physician for decision making. At present, research works and requirement gathering for the following components are being carried out.

Component 1: Electronic Medical Record (EMR) Data Cleansing

Electronic Medical Record (EMR) structure varies from one system to another system. Sophisticated content analysis algorithms will be used to extract relevant

medical terms within the EMR of the patient. Electronic Medical Records consist of diagnosis outcomes recorded by medical doctors and this sort of information is commonly referred to as tacit knowledge.

Component 2: Medical Term Extraction

Natural Language Processing will be implemented as an http service will be used to extract specific medical terms. The idea behind this extraction is to further refine the vocabulary which will result in better link with other sources of electronic medical records. Information available in electronic medical records is commonly referred to as explicit knowledge.

Component 3: Linking Extracted Term With Literature And Similar EMR.

Upon extraction of specific medical terms from the EMR, a method will be written to perform queries from the other sources of EMR. Relevant information will be extracted and published in a user-friendly web interface which can be accessed by any sort of device, be it mobile of desktop.

Component 4: User Interface Based On Web Technology

The friendly web-based user interface will ensure healthcare professionals are presented with the extracted information clearly. Extracted patient information will be linked with other information which could have solutions to a particular medical case. Figure 5 illustrates the proposed WCF conceptual Framework for Knowledge Sharing. The service agent will carry out the tasks of component 1, 2, 3 & 4. Users which will benefit from this framework will include healthcare professionals and researchers in the medical field, which also includes medical students too.

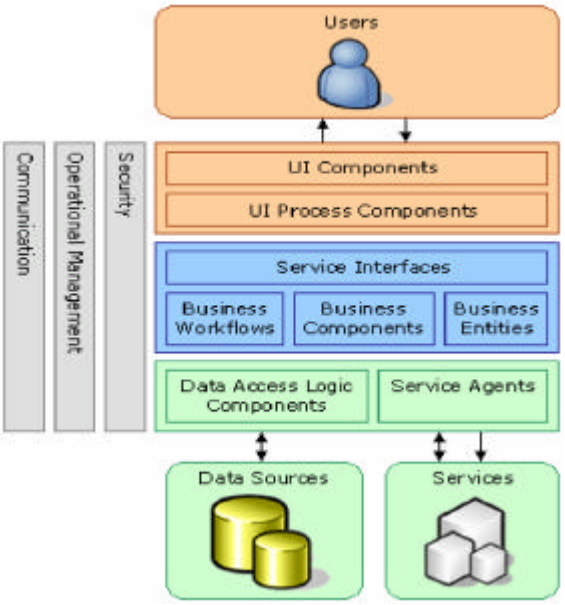

Figure 5: Proposed WCF Framework for Knowledge Sharing

5.0 FURTHER WORK

At the time of authoring, the author was not able to present all elements of WCF and its relation to knowledge management. WCF is relatively a new technology and work is still in progress in studying how it can be used to build a clinical knowledge management application which will facilitate sharing of decimated medical knowledge. Prototype framework to be implemented using WCF is expected to be released in the final quarter of 2008.

6.0 CONCLUSIONS

In this paper, I have presented the conceptual framework on how tacit knowledge can be extracted from the EMR and further present it to the healthcare professional upon processing. This framework is vital for the MSC Telehealth Flagship to be successful as knowledge management will be the key element success in carrying out accurate clinical decisions. Telehealth focuses on providing medical advice where geography separates the healthcare professional with the patient. In such situation, access to accurate patient information is vital and therefore the WCF based framework for electronic patient medical data extraction will promote medical knowledge sharing among healthcare professionals regardless from the organization the healthcare professional belongs to.

REFERENCES

Beveren. John Van (2003) Does Health Care For Knowledge Management? *Journal Of Knowledge Management* Vol 7 No 1 pp.90-95

Healthfield.H & Louw.G (1999) New Challenges for Clinical Informatics: Knowledge Management Tools, *Health Informatics Journal*

Hussain, F & Raza S.Ali (2004). *Knowledge Management Framework to Operationalize Experiential Knowledge: Mapping Tacit Medical Knowledge With Explicit Practice Guidelines:* National Conference On Emerging Technologies

Hsia, Tzyh-Lih & Lin Li—Min (2006). A Framework For Designing Nursing Knowledge Management Systems. *The Interdisciplinary Journal Of Information, Knowledge, & Management.*

Kols A (2004). Managing Knowledge To Improve Reproductive Health Programs. *Knowledge Management Paper Working Group*.

MSC Malaysia (2003). *Taking Charge of Our Health.*

Microsoft Server Product Portfolio, Customer Solution Case Study (2004). *Doctors Improve Patient Healthcare With Knowledge Management System.*

Patel BL, Arocha JH, Kaufman. Expertise and tacit knowledge in medicine. *Tacit Knowledge In Professional Practice – Researcher and Practitioner Perspectives.* Lawrence Erlbaum Associated, Inc, 1999

Raghavan S. *Medical Decision Support Systems and Knowledge Sharing Standards.* Krea Corporation, USA (2005)

Shepherd M, Zitner D, Milios E. *Knowledge Management In Paediatric Pain: Mapping On-Line Expert Discussions To Medical Literature,* (2004)

Smith J., 2007, Inside Windows Communication Foundation, Microsoft Press.

Warren J Heard S & Bird L (2003). Knowledge Management in HealthCare. *Journal of Research and Practice in Information Technology.*

Weed, L.L (1997) New Connections Between Medical Knowledge & Patient Care, *British Medical Journal.*