A Study on Knowledge Dissemination of Hospital Web-based Application

Noraini Che Pa
Department of Information Systems
Faculty of Computer Science and Information Technology
Universiti Putra Malaysia, 43400, Serdang
Selangor, Malaysia
norainip@fsktm.upm.edu.my

Rozi Nor Haizan Nor
Department of Information Systems
Faculty of Computer Science and Information Technology
Universiti Putra Malaysia, 43400, Serdang
Selangor, Malaysia
rozinor@fsktm.upm.edu.my

Yusmadi Yah Jusoh
Department of Information Systems
Faculty of Computer Science and Information Technology
Universiti Putra Malaysia, 43400, Serdang
Selangor, Malaysia
yusmadi@fsktm.upm.edu.my

Abstract— **Websites have become a requirement for Malaysian hospitals today as an information channel to inform the public about their facilities and services. It is therefore necessary for hospitals to design websites for online knowledge dissemination. Thus, the success of a hospital's web-based application depends critically on the knowledge dissemination approach used. In this research, a study was conducted on the extent of knowledge dissemination achieved by a hospital's web application, measured based on the approach of knowledge sharing and knowledge collaboration. The objectives of this study are to identify the characteristics of a hospital's web-based application and propose an architecture for knowledge dissemination based on the concept of knowledge sharing and knowledge collaboration. Knowledge sharing allows the dissemination of information on the hospital's services and facilities, including the types of healthcare and treatments available to the public. Knowledge collaboration requires communication through forums, appointments and notifications. A study was conducted on the web-based applications used in state hospitals around Malaysia. It is hoped that the proposed knowledge dissemination architecture may assist hospitals plan for knowledge sharing and knowledge collaboration requirements in developing their web-based applications.**

Keywords- knowledge dissemination; hospital web-based application; knowledge sharing and knowledge collaboration.

I. INTRODUCTION

Hospitals have increasingly tried to create awareness of healthcare in the community through information technology. The concept of e-health or web-enabled systems was introduced to accomplish some combination of the objectives, such as to save cost, to increase revenue, to simplify operations, to improve patients' satisfaction and to contribute to the enhancement of medical care [1]. Hospitals in Malaysia have now started using web-based applications to showcase their services and reach out to the public. Many web-based applications are now available, targeted at assisting healthcare providers and the public by disseminating information, making appointments, managing and monitoring treatments related to procedures, and providing information on the hospital's processes, facilities and services.

A hospital's web-based application has become an important access portal to its services from virtually anywhere and at any time, thus facilitating online communication among its users. Information from all the various sources is conveniently stored in a centralized location that is accessible over the network.

The advantages of using a web-based application are numerous, such as better efficiency, interactivity and productivity for providers and the public. Therefore, a web-based application would soon become inevitable for hospitals. The issues that must be discussed are the software requirements, system design and applications development in order to ensure that the hospital's application fulfills the needs of providers and the healthcare needs of the public.

In the healthcare industry, the public searches for potential healthcare providers, receives care and treatment, then gives their feedback on the services received. The service provider administers and monitors care and treatment, provides healthcare services and responds to the feedback received from the public. Collective and cooperative information can be obtained by implementing knowledge sharing and knowledge collaboration in a web-based application. To enable knowledge sharing and knowledge collaboration between the provider and the public, the development process of a quality web-based hospital application must incorporate attributes such as data drivability, availability, concurrency and network intensiveness

in its design. A hospital deals with huge numbers of records containing the medical, surgical or health information that it creates, collects and manages. A patient may have treatment records, a medical history, scheduled appointments and test results. All this information can be shared on a website. Therefore, to develop a quality web application and improve hospital services, web technology must be utilized. Web technology is a modern and emerging field that uses computers and telecommunications to store, retrieve and transmit information via the Internet. Several key issues on health-associated information need to be deliberated, for example timeliness, adequacy and usefulness. With that in view, the proposed web application will use knowledge sharing and knowledge collaboration to address these issues.

This paper will focus on knowledge sharing and knowledge collaboration for web-based application designs in order to assist the hospital institution. Its features were constructed based on literature study by the researcher. The results of a preliminary study conducted by observation of existing hospital websites are reported.

The paper is structured as follows: Section II reviews related research and issues on web-based application design, knowledge sharing and knowledge collaboration; Section III presents the results of a study conducted on existing web-based applications used in hospitals around Malaysia; Section IV proposes the knowledge dissemination approach for a web-based hospital application; and Section V concludes the study.

II. RELATED RESEARCH

A. Web-based Applications

To enable effective information sharing and collaboration, applications must be running on both the provider's and the client's servers. The user interface must provide for communication of health-related information between the provider and the public via Internet or Intranet.

Modern web architectures are concerned about the scalability of component interactions, the generality of interfaces, independent deployment and intermediary components. Most web applications are created under the control of one entity, which means that all participating entities within the system are acting towards a common goal instead of having cross-purposes [2]. The scalability of component interaction refers to the need for architectural elements to continue operating since they may be communicating with elements outside their organizational control. The architecture must be parallel to mechanisms that allow visibility and scalability, which are applicable to all architectural elements. Security of the architectural elements, and the platforms on which they operate, also becomes a significant concern in developing web applications. Multiple trust boundaries could be present in any communication, hence intermediary applications, such as firewalls, virtual private networks (VPNs), and certifications should be able to inspect the component interactions. Since the information received is from various sources, it needs to be validated using additional authentication. The architecture must also be capable of communication, data authentication and authorization controls. The challenge is to build a system that would provide a universally consistent interface to this structured information, available on as many platforms as possible and incrementally deployable as new people and organizations join the project.

Furthermore, web applications must consider independent deployment and intermediary components. This means that the system must be flexible enough to accommodate gradual and fragmented change for maintenance and extended capabilities, without preventing new implementations. Architectural elements need to be designed with the expectation that later architectural features will be added. The architecture as a whole must be designed to ease the deployment of architectural elements in a partial, iterative fashion, since it is not possible to force deployment in an orderly manner.

Web applications are evolving into sophisticated computing environments that not only provide stand-alone features, computing functions, and content to the end-user, but are also integrated with corporate databases and business applications. From the software engineering point of view, the concerns of many web applications are similar: have a user interface, based in a browser that interacts with the user and manages a possibly large amount of data, stored on the server, on behalf of the clients. It took a number of years before web developers realized that the standard Model-View-Controller (MVC) pattern, well-known in software engineering, applies just as well to such web applications. Once this realization was made, a number of frameworks have been developed to support the design and development of web applications.

The early Web consisted of a set of documents that could freely link to each other. These were simple text files containing static content and static links to pages. Very early on, software engineers realized that the client-server architecture of the Web provided a powerful platform on which the browser could be a universal user interface to applications that may run locally or remotely on a server. To maintain the browser-sever relationships, the server always returns a webpage to the browser, but this webpage could be generated programmatically as the result of processing on the server. For example, the server could retrieve data from a database, format them into an HTML page, and send the page to the client. In spite of these advances made, there are needs for knowledge sharing and collaboration requirements relating to a web-based application in healthcare, such as viewing information on services, facilities, current treatments on offer, communication through forums, appointment notifications and message notifications. The typical structure of a web application consists of HTML data displayed to the user, client-side scripts that run on the client's side and may interact

with the user, and server-side scripts that perform processing on the server and typically interact with databases.

In the context of web applications, there is typically a set of object-oriented classes that interact with the database. In addition, the consideration of an Open System Interconnection (OSI) layer needs to be considered in web application designs [3]. Every layer supports the physical construction, hardware, software, operating system, programming, data and communication. The OSI model defines a networking framework for implementing protocols in seven layers. Control is passed from one layer to the next, starting at the application layer in one station, and proceeding to the bottom layer, over the channel to the next station and back up the hierarchy. The goal of the OSI layer is to define the functions in the various layers that connect electronic devices to communicate data. Web applications consist of a number of basic layers, which are the Presentation layer, the Business layer and the Integration layer, as shown in Figure 1.
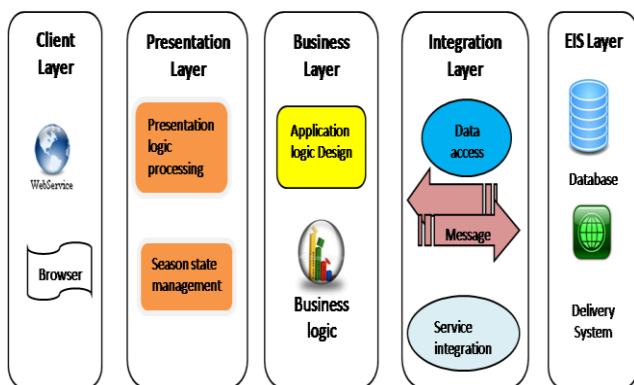

Figure 1.   Basic Layer for Web-based Application

Based on Figure 1, the Presentation layer consists of oriented functionality responsible for managing information between user and system. The layer contains all the components that allow interaction with the end-user. The Business layer implements the core functionality of the system. Finally, the Integration layer provides access to data from databases based on queries by the user to allow sharing and collaboration of knowledge using the system. Other layers are the N-tier design layers, namely the Client layer and the EIS layer. This basic layer is actually derived from the OSI layer that consists of seven layers, namely the application, presentation, session, transport, network, data link and physical layers.

B. Knowledge Dissemination

Knowledge dissemination is one of the processes in the knowledge management cycle which are identify, plan, acquire and develop, distribute, encourage usage, control or maintain and dispose. Based on this cycle, Dalkir [4] distinguished them into three stages: knowledge capture and

creation, knowledge sharing and dissemination, and knowledge acquisition and application. Knowledge dissemination is made up of two key elements: make the knowledge accessible and make the knowledge usable. Yang [5] identified that knowledge dissemination is a way the knowledge is shared within or outside an organization to encourage innovation on the part of the knowledge receiver. The process of knowledge dissemination involves the acquisition and creation of knowledge, comprising, in part or in whole, the organization's knowledge assets as well as sharing and collaborating [1] [6].

TABLE I.   TYPES OF KNOWLEDGE DISSEMINATION

Types	Descriptions
Knowledge Sharing	- Information is given by one organization and retrieved by another. - Implies the giving and receiving of information framed within a context by the knowledge of the source. - Involves direct commitment from both sender and receiver. - Connect individuals who seek knowledge to the knowledge that is most relevant. - Uses different techniques such as training and education
Knowledge Collaboration	- Occurs when two or more people or organization work together to reached their objective in achieving the goals or vision - Needs supporting from organization members to ensures successful implementation of knowledge collaboration - Exploits knowledge about tasks, applications, interface, and users in ways that help users accomplish tasks effectively - Uses various collaborative services such as bulletin board and email.

Knowledge disseminates in an organization through four general routes: socialization, externalization, combination and internalization. The two main types of knowledge that an organization has are tacit knowledge and explicit knowledge. Data is turned into information and information is formed into knowledge [7]. Knowledge is of potential value to a business manager [8]. In an organization, the dissemination process becomes challenging when there is a limitation on the sharing of organizational knowledge. Furthermore, the ability to integrate and apply the specialized knowledge of an organization is fundamental to create and sustain its competitive advantage. The main types of knowledge dissemination are knowledge sharing and knowledge collaboration as shown in Table I.

Knowledge Sharing: Knowledge sharing is a process to determine the commitment of sender and receiver. Some researchers indicate difficulties in certain stages of the knowledge sharing process. First, knowledge is embedded in a certain cognitive and behavioral context. Without understanding the context, one cannot inquire into the reasoning and the assumptions behind a particular piece of

knowledge. Second, knowledge is asymmetrically distributed in an organization. Third, knowledge sharing is voluntary [9] and efficient knowledge sharing depends on the willingness of individuals to identify the knowledge they possess and to share knowledge when required [10]. If the potential knowledge transmitter is not aware that someone in the organization would be interested in the knowledge she or he possesses, she or he will not actively share this knowledge. As human behavior is inherently opportunistic, adverse selection and moral hazards may influence the individual's motivation to share knowledge in a negative manner.

The sender and receiver contexts are highly important in knowledge sharing, particularly in method and design [11]. In the sender's context, the challenge is the use of various competing paradigms. This requires a precise quantitative approach that focuses on specific domains and variables that suit the contextual information and factors. In the receiver's context, knowledge needs to be converted and adapted based on their needs, and knowledge needs to be requested from information resources. This process may involve knowledge creation [10]. Adapting and altering processes for knowledge creation will represent new knowledge and not necessarily 'tinkered old knowledge' in a new context [12]. Knowledge sharing must consider its condensed content and specification of location, whether centralized or decentralized [13]. It can be employed in such techniques as chats, learning routes, peer assistance, social network analysis and storytelling. Current tools for knowledge sharing are blogs, Flickr, Google applications, LinkedIn, Skype and Wikis.

1) Knowledge Collaboration: Knowledge collaboration involves geographically dispersed teams together supporting communication, coordination and cooperation where place no longer matters. Knowledge collaboration brings for virtual meetings across great distances hence saving time and cost, greatly decreasing travel requirements, enabling faster and better decision-making and achieving improved communications flow. The process of knowledge collaboration occurs in place and time dimensions. The time dimension allows interaction between participants at the same time and at different times. The place dimension makes the distinction of whether the interaction happens at the same place or at different places. These dimensions provide four communication scenarios: synchronous, co-located; asynchronous, co-located; synchronous, remote and asynchronous, remote [11]. Knowledge collaboration also considers managing shared resources, provider and receiver activities, managing constraints and relationships, decision making and communication.

Two major approaches need to be used in knowledge collaboration, which are the knowledge repository approach and the community-based approach. These approaches should be applied together to support the process of knowledge collaboration. Using these approaches, tacit and explicit knowledge rely on the engagement between provider and receiver. These approaches focus on understanding and supporting knowledge transfer and collaboration through natural and formal human communications via web systems such as chats, audio and video conferencing, email, document and file sharing, and bulletin boards. Collaborative services are used to assist the process of knowledge collaboration. These include bulletin boards, email, discussions, online paging, charts and white boards, audio and video conferencing and screen sharing. Conversations using either the bulletin board or e-mail provide an alternative communication medium over the Internet. Audio and video conferencing enhance human communication by supporting graphical and multimedia presentation. In addition, collaborative services also offer a web-based meeting tool that can manage, monitor and facilitate meetings among participants.

III. A Study on Existing Web-based Applications in Hospitals

The study focused on knowledge dissemination from hospitals via their web-based applications. It refers to the sharing and collaboration of knowledge from the hospital community, such as the doctors, support staff and pharmacists. The receivers are patients and the public at large. In this study, a list of web-based application features was developed for a hospital's web-based application to facilitate knowledge dissemination. There are five items constructed, which are information sharing within the hospital environment, disseminating knowledge among hospitals, providing services, mentoring and facilitating communication, and communication support.

The study procedures of the study are as follows:

1) Select hospitals for evaluation
Nine state hospitals around Malaysia were selected. They are located in the Federal Territory of Kuala Lumpur, Sabah, Selangor, Johor, Terengganu, Penang, Negeri Sembilan and Pahang.

2) Visit the hospitals' official websites
The information in Tables II and III was used as a guideline to identify the functions and tools of knowledge dissemination.

3) Identify the specific functions and tools at each website
Next, an evaluation is performed by filling in the template as shown in Table IV. Each website is browsed to identify the existence of each tool using the template.

It is found that the concept of knowledge dissemination was not completely applied at these websites, thus the information shared was insufficient and incomplete. How information is delivered is very important for it to be useful and friendly. In addition, making it interactive would encourage patients and the public to engage with the hospital.

In this case, a hospital's website should enable potential patients to view available doctors, give information to the general public on the hospital's services on offer and allow people to make appointments. The required features of knowledge dissemination for a hospital's web-based application are shown in Table II. The features are divided into various components, such as information shared, tasks presentation, document and file transfers and notification.

TABLE II.   FEATURES OF KNOWLEDGE DISSEMINATION

Features	Description
Information Shared	Views hospital services such as bulletin board
Tasks Presentation	List of medical prescription and White board
Document and File Transfer	Allow medical material to shared such as upload and download
Content Management	Hospital can update content of information such as services, patient history and treatment
Facilitate Communication	Through email, chat
Scheduling Management	Handling patient appointment
Negotiation	Support real time interaction
Notification	Email for respond to hospital practices , patient and community
Meeting	Discussion among hospital practices and
Training facilities	Medical and health awareness

Table III shows the two components of knowledge dissemination, which are knowledge sharing and knowledge collaboration, with their respective features and tools. For each type of feature, related tools are used. For knowledge sharing, blogs and bulletin boards are used. For knowledge collaboration, chats as well as audio and video conferencing are used to facilitate communication between provider and receiver. The tools are capable of supporting the features in knowledge sharing or knowledge collaboration. For example, document and file sharing is used to support the features of document and file transfers as well as content management in knowledge sharing. It may also support meeting features in knowledge collaboration.

TABLE III. FUNCTIONS AND TOOLS OF KNOWLEDGE DISSEMINATION

Types	Features	Tools
Knowledge Sharing	Information Shared	blogs, bulletin board
	Document and File Transfer	document and file sharing, web calendar
	Content Management	document and file sharing
	Training facilities	virtual events, tutorial,

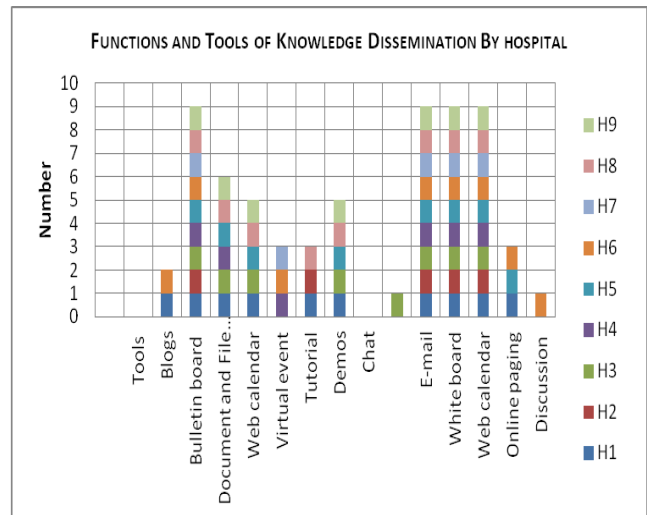|		demos
Knowledge Collaboration	Facilitate Communication	chat, audio and video conferencing, bulletin boards, e-mail, white board
	Scheduling Management	web calendar
	Notification	online paging, email
	Negotiation	video conferencing
	Meeting	Video conferencing, document and file sharing, discussion

Figure 2.   Functions and Tools of Knowledge Dissemination

Figure 2 shows the study results. It is found that most of the hospitals in the study provide a bulletin board, e-mail, a white board and a web calendar for the purposes of knowledge sharing and collaboration in their web application system. However, a chat tool is not offered by any hospital website. Some hospitals, such as H3 and H6, provide audio and video conferencing, as well as discussion. H1 and H7 share their current services through a blog and online paging. Among the purposes of online paging are for appointments and bookings.

Most of the hospitals in the study do not provide public education through their websites but provide Continuing Medical Education (CME) and Really Simple Syndication (RSS) programs for their staff. The results indicate that H2, H6 and H9 focus on providing CME, whilst H3, H5 and H7 offer RSS services. In addition, there are integration services among hospitals, called the MOH-Cube, which is implemented using webmail services.

IV.   PPOPOSED ARCHITECHTURE FOR KNOWLEDGE DISSEMINATION IN A HOSPITAL'S WEB-BASED APPLICATION

The proposed architecture for knowledge dissemination in a hospital's web-based system is shown in Figure 3.

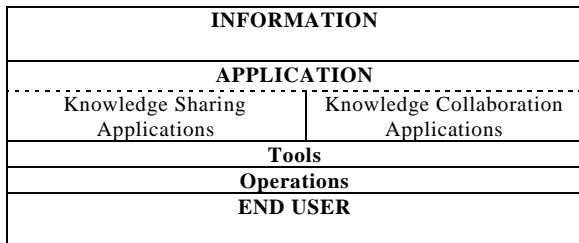| INFORMATION	
APPLICATION	
Knowledge Sharing Applications	Knowledge Collaboration Applications
Tools	
Operations	
END USER	

Figure 3.   Knowledge Dissemination Architecture for Hospital Web-based Application

The proposed architecture is divided into 3 main layers, which are:

A.   Information Layer

The information layer consists of the various models such as the product model and the hospital knowledge model.

B.   Application Layer

The application layer consists of two elements: the knowledge sharing application and the knowledge collaboration application. These elements are supported by various tools and operations.

C.   End-user Layer

The end-user layer forms the front end of the system. It includes the web browser used by the end-user, such as Internet Explorer or Netscape, for the purpose of knowledge sharing and knowledge collaboration.

V.   CONCLUSION

In summary, knowledge sharing and knowledge collaboration are very important and can be incorporated within a web-based application. Its implementation should be considered by any organization, including hospitals, that involves the community. The rapid emergence of new technologies, in particular those related to the tools and features for knowledge sharing and knowledge collaboration, requires hospitals to be more alert to the technological changes that can improve their community services and competence of their staff. In future work, we plan to implement the proposed architecture in the selected hospitals to validate the idea. It is hoped that the implementation results would provide some pointers on ways to perfect the architecture.

REFERENCES

[1] R. Bose, "Knowledge management-enabled health care management systems: Capabilities, infrastructure, and decision-support," Expert Systems with Applications, no. 24, pp. 59-71, 2003.

[2] RT. Fielding and RN. Taylor, "Principled design of the modern Web architecture," ACM Transactions on Internet Technology (TOIT), Vol. 2, Issue 2, pp.115 – 150, 2002.

[3] J. Long, Storage Networking Protocol Fundementals. Cisco Press, Indiana Polis. 2006.

[4] K. Dalkir, Knowledge management in theory and practice. The MIT Press. 2011.

[5] J. Yang, "Knowledge integration and innovation: Securing new product advantage in high technology industry," The Journal of High Technology Management Research, vol. 1, no. 16, pp. 121-135, 2005.

[6] A. Savaneviciene and K. Duoba, "Knowledge Creation and Dissemination in Virtual Organizations," Frontiers of e-Business Research, pp.734-743, 2004.

[7] Tzyh-Lih Hsia, Li-Min Lin, "A Framework for Designing Nursing Knowledge Management Systems," Interdisciplinary Journal of Information, Knowledge, and Management, no. 1, pp. 13-22, 2006.

[8] W. R. King, P.V. Marks Jr. and S. McCoy, "The Most Important Issues in Knowledge Management," Communication of the ACM vol. 9, no. 45, pp. 93-97, 2002.

[9] B. E. Dixon, J. J. McGowen, G. D. Craven, "Knowledge sharing using codification and collaboration technologies to improve health care: lessons from the public sector," Knowledge Management Research and Practice, no. 7, pp.249-259, 2009.

[10] I. Nonaka H. Takeuchi The knowledge creating company. Oxford: Oxford University Press, 1995.

[11] G. Bafoutsou, and G. Mentzas, "Review and functional classification of collaborative systems," International Journal of Information Management 22 (2002), pp.281-305, 2002.

[12] S. Fernie, S. D. Green, S. J. Weller and R. Newcombe, "Knowledge sharing: context, confusion and controversy". International Journal of Project Management 21 (3) pp.177–187, 2003.

[13] H. Kasper, M. Dausinger, H. Kett and T. Renner, Marktstudie Social Media Monitoring Tools, Frauenhofer Verlag, 2010.