BioHerbWebs: A Mobile Knowledge Portal for Bioinformatics Community of Practice with a Collaborative Environment

Rusli Abdullah, Mohd Hasan Selamat, Azmi Jaafar, Suhaimi Napis, Wan Noor Rafida Wan Maya Othman & Wan Roslina Wan Ishak

Faculty Computer Science and InformationTechnology Universiti Putra Malaysia 43400 UPM Serdang

Summary
BioHerbWebs is a mobile Knowledge Management System (mKMS) or mobile knowledge portal is a system that supports, creates, captures, stores and disseminates expertise and knowledge in a collaborative environment. The idea of mKMS is to ensure that the right knowledge is delivered to the right person just in the right time using the mobile devices. However, locally, we have never heard about mKMS since it is stll a new area that are still evolving. In this paper, we propose the system development and implementation that might be useful to support community of practice (CoP) in bioinformatics domain which hoping that this research can be served as a guidance for future reference in developing mKMS in any other related field.

Key words:
mKM system, Bioinformatics, CoP, mobile devices, Collaborative Environment

1. Introduction

Knowledge is something that came from information processed by using data. It includes experiences, values, insights, and contextual information and helps to evaluate and incorporate new experiences and information. Knowledge originates and is applied by knowledge workers. It would be more useful if it could be shared and used among the community as people use their knowledge in making decisions. During the last several years, many organizations realized they own a vast amount of knowledge and that this knowledge needs to be managed (Satyadas, Harigopal & Cassaigne, 2001). Some of the reasons why knowledge needs to be managed are information overload, technology advancement, increased professional specialization, competition, workforce mobility and turnover and capitalizing on organizational knowledge. Because of the power and importance of knowledge to work collaboratively, there is a need for organizing the knowledge and it is called KM.

KM is a concept where it could be used for creating knowledge repositories, improves knowledge access and sharing as well as to communicate through collaboration, enhancing the knowledge environment and managing knowledge as an asset for an organization. The term KM is one such management approach, and is portrayed in the popular business literature as an innovation with the potential to affect the whole of an organization's business, especially its processes and information systems (Cole, 1998). It also refers to a range of practices used by organizations to identify, create, represent and distribute knowledge for reuse, awareness, and learning across the organizations. KM programs are typically tied to organizational objectives and are intended to lead to the achievement of specific outcomes, such as shared intelligence, improved performance, competitive advantage, or higher levels of innovation.

KMS refers to a system for managing knowledge in organizations, supporting creation, capture, storage and dissemination of information. It can comprise a part of a KM initiative. The idea of a KMS is to enable employees to have ready access to the organization's based documented of facts, sources of information, and solutions. Some of the advantages claimed for KM systems are sharing of valuable organizational information, organization can avoid re-inventing the wheel, reducing redundant work, may reduce training time for new employees and retention of Intellectual Property after the employee leaves if such knowledge can be codified (Maier, 2007).

mKM system can be defined as "a management process in the course of which mobile communication techniques in conjunction with mobile devices are employed for the creation, validation, presentation, distribution or application of knowledge" (Derballa & Pousttchi, 2004). Through mKM, we can increase the access to knowledge, regardless of temporal and spatial constraints. Thus, mKM extends KMS by the anywhere, anywhere information access metaphor by making KM functionalities available on mobile devices. Bioinformatics are the analysis of biological information using computers and statistical techniques; the science of developing and utilizing computer databases and algorithms to accelerate and enhance biological research. In this project, we only focus on herbs plantation data since it is a part of agriculture field that are now a very demanding field in Malaysia.

Manuscript received May 5, 2008
Manuscript revised May 20, 2008

In this paper, we describe the proposed system development and implementation of mobile BioHerbWebs portal that might be useful to support community of practice (CoP) in bioinformatics domain focusing in herb plantation. The remaining sections are structured as follows: Section 2 reviews the prior work related to the research. Section 3 describes the research design used to conduct the research. Section 4 reports the case study of Mobile BioHerbWebs Portal. Section 5 discusses on the result and discussion and section 6 concludes the study and presents the future directions.

2. Literature Review

2.1 KMS and its Functionality

Knowledge taxonomy for KMS consists of knowledge acquisition, storage, dissemination and application. Here are the definitions for each process:

a. Knowledge Acquisition
According to a model by Arthur Andersen and APQC (1996), to acquire knowledge in a mobile environment and to make sure that the knowledge could be acquired from the right people, time and place, these steps are suggested:

- Identify knowledge: Determine sources and type of knowledge
- Collect knowledge: Gather and transform knowledge according to the specifications
- Adapt knowledge: Categorize the knowledge
- Organize knowledge: Prepare and map knowledge into the specific requirements
- Store knowledge: Keep and index the knowledge dynamically

b. Knowledge Storage
Knowledge storage is the process where the knowledge is kept in repositories. These can be in form of documents that are organized and categorized to enable future browsing or speedy access of knowledge.

c. Knowledge Dissemination
KMS can disseminate knowledge in mobile environment in many ways, depending on whether the communication method is synchronous, asynchronous, or combination of both.

d. Knowledge Application
In the process of knowledge application, knowledge generated by KMS in mobile environment will be used by CoPs (Communities of Practices) for problem solving, decision making and learning.

One example of KMS implementation experience has been done in Bina Nusantara University (BINUS) Indonesia, which is using Lotus Notes software as the knowledge platform. The technology architecture for the KMS has three layers which are related to the interface layer (browser), logical/intelligence layer (Agents, Filters, Data mining, Work flow) and communication/transport layer (Messaging/Groupware (Lotus Notes) and Intranet/WWW). The knowledge repositories can be directly accessed using browser through communication and transport layer. The system can be accessed via LAN and Internet through the central campus connection. The functionality of KMS is well known and the system needs to be developed in the organization. In order to develop the architecture of the BioHerbWebs portal, we use four layers of architecture that consists of infrastructure layer, technology layer, protocol layer and repository layer (Abdullah *et. al.*, 2004). Each layer will have at least one client to communicate to the system in the server and access the knowledge repositories via LAN or WAN whether in the mode synchronous or asynchronous of collaboration among the communities of the practice.

2.2 Mobile KMS (mKMS)

Researches on mKM are still evolving nowadays. We can see quite a few implementations of mKM developed in news journalism domain, repair technicians, and construction sites. However none has been developed for bioinformatics domain. In this section, we will review state-of-the-art mKM systems and bioinformatics domain that involve KMS or mobile environment. One example of mKM system is NewsMate, which provides mobile and distributed news journalists with easy access to timely information via a PDA (Personal Digital Assistant) with network access using mobile phone. NewsMate supports services such as to-do list that is matched with internal archives, provides information on people with similar tasks then match the task between predefined external sources and they also have SMS (Short Message Service) facility to alert people with overlapping activities (Fagrell, Forsberg, Johannesson, Ljungberg, 2001).

Another example is by Grimm et al. (2005). They propose a reference mKM system which they derived from existing systems and from user requirement within the KM project Mummy. However, this model is simple enough as they don't have their specific focus area. They do say that the key concept of mKM system is the context-aware

information processing. This means that the system must have certain knowledge about the user in order to assist them through mobile devices. Mummy project on the other hand is mKM system developed on facility management at construction sites, mobile health care support and video based e-learning. Mummy research focuses on capturing context to enhance intra and inter-individual knowledge transfer processes, such as remembering, reconstruction and communication. It provides support for retrieval and presentation of relevant information in photographic and textual format.

Hou and Yang (2006) combines mKM mechanism with PDA (Personal Digital Assistant), information (user notes, address book and schedule) to know user's interests and availability so that they can provide customized services in the complicated electronic commerce environment. They use profile mining to determine the category of PDA user, volume of knowledge user can obtain and the characteristics of other users that highly interact with PDA user.

2.3 KMS in Bioinformatic

In bioinformatics domain, KMS provides a place for the member of CoP to acquire knowledge from the knowledge community of bioinformatics. Further, large volume of knowledge can be stored in KMS for the purposes of knowledge sharing and application among the members in collaborative environment regardless the time and location constraint (Abdullah *et. al.*, 2007). There are few existing KMS in bioinformatics domain such as Kleisli query system, e2e and Blast. Kleisli query system is a system designed for the broad-scale integration problems that have powerful extensible query optimizer and efficient query execution engine. e2e consists of many exploration tools semantically working together across disciplines and across heterogeneous sources. Blast is an acronym for Basic Local Alignment Search Tool. It is a web based search tool developed and maintained by National Center for Biotechnology Information (NCBI). In 2002, Riikonen, Boberg, Salakoski and Vihinen have developed a BioWAP (bioinformatics wireless application protocol) services with a new way of accessing biological databases and bioinformatics applications that running on the Internet through mobile devices. Although the connections are through mobile devices, there are no KM implementations in BioWAP.

3. Research Methodology

In order to get done for this research, we need to get inputs that can help us throughout the process. We get our inputs by employing the following approach; documentation study of previous research and also a questionnaire survey in the Community of Practices (CoPs). We have discussed about previous studies in literature review section. For the second method, the designing of the questionnaire involves on what are the most relevant element questions that is supposed to be included in mKM system.

These elements questions are important to ensure mKM system worked according to its specifications and also we want to know user's requirements and preferences. Pre-questionnaire has been answered by variety of respondents that involves in research on biological data and herbs plantations and this questionnaire consists of two sections. First section is about mobile issues aiming to know how potential user usually works collaboratively with colleague and to know their opinions regarding mobile usage. For this section, we conclude that respondents usually work collaboratively to share info, news and schedule by using email and meeting as a medium.

However, mobile plays an important role too as it is an informal medium to share knowledge and SMS is the most popular function in mobile devices. Respondents agrees to cooperate if exist a system that uses SMS or MMS (Multimedia Messaging System) to send and receive latest information regarding their interest or work. Types of files that usually they want to share are document files, text files, pdf files and image files. Second section asks about respondents' expectations on mKM system and its functionalities. At first, we ask if they know about mKM and their opinion on mKM. For those who know about mKM, they all agree that mKM is either important or very important nowadays. According to their answers, in terms of knowledge sharing, storing and searching, mKM do plays an important or very important role. When being ask about their expectations on mKM, most of respondents agrees that mKM should bring more benefits to the community such as easy access to knowledge anytime, anywhere, shortens learning process, helps in decision making, helps respondents for opinion regarding specific issues, develops their ability to solve problems and many more.

4. Case Study: Mobile BioHerbWebs Portal

4.1 System Configuration

We proposed a new model of the BioHerbWebs in such a way need an interaction of users from different location with different background to collaborate together in mKM system so that the knowledge process – knowledge acquiring and dissemination may reach right person at the right time. Figure 1 shows the proposed model of CoP in

BioHerbWebs Portal. In this case, members in the CoP who involved in this project may have their own roles and responsibilities as describes below.

- Users: Users are the people who want to acquire information about herbs for the purpose of updating his/her knowledge or sharing his/her knowledge with others in the system.
- Biologists: Biologist are the people who do the experiment and have the raw data of herbs plantation knowledge that may helps us to identify the varieties of herbs plantation that exists in Malaysia today.
- Researchers: The researchers may involve people from the bioinformatics area, computer science area or both. The researcher's role is basically same as the role of biologist and computer scientists which may also used this system in their works of areas.
- Farmers: The farmers are the people who work directly in the planting which may use the system to pass, deliver or contribute any knowledge for the knowledge deposit purpose.

System analysis/programmer: The computer scientist are the people who have been or currently involved in KMS development which may helps us to validate and develop a KMS architecture and framework to ensure our system may perform successfully.

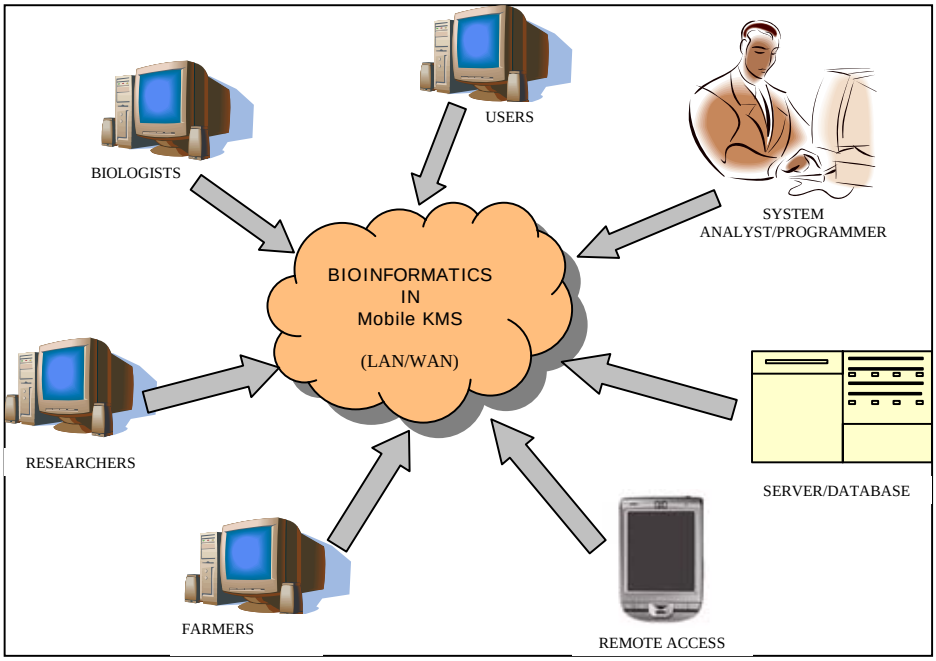


Fig. 1: BioHerbWebs Portal collaboration model

4.2 System Development of BioHerbWebs Knowledge Portal

We designed model and architecture BioHerbWebs based on the literature review of previous work and pre KM implementation survey as discussed in research methodology section. Then, we develop BioHerbWebs Knowledge Portal prototype based on the model and architecture. The high level architecture of our BioHerbWebs is shown in Figure 2. CoP can interact with the system either from personal computer or from mobile device. The description of system components as follows.

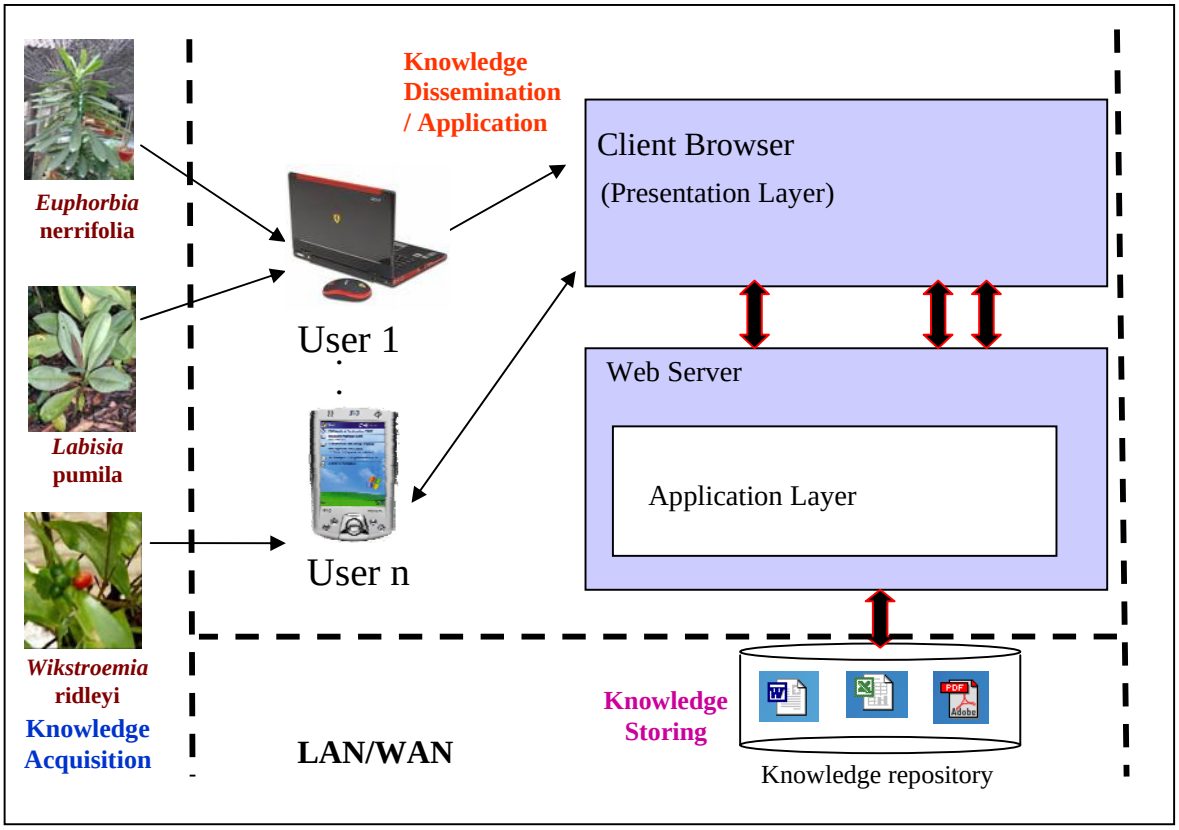


Fig. 2: BioHerbWebs Portal architecture

a. Network Access

The user should have mobile devices with GPRS (General Packet Radio Service) to get access to system or computer with an internet connection. To send SMS to user, system requires a GSM (Global System for Mobile Communication) modem as a port to connect to the user. User may access to the BioHerbWebs using client browser and Web browser (WWW) either through LAN or WAN connection.

b. Mark-up Language

The internal structure is encoded in XHTML (Extensible Hypertext Markup Language), markup language that has the same depth of expression as HTML (Hypertext Markup Language), but also conforms to XML (Extended Markup Language). Because they need to be well-formed, XHTML makes it possible to for the system content to be displayed in mobile devices without any changes or WAP (Wireless Application Protocol) implementations.

c. Operating System and Development Platform

The server is implemented in Java on Microsoft Windows 2003 platform. We use Java since it is an open source language that is platform independent, means that we can run Java anywhere. Java is also designed to be secured and with Java codes, we create a program that allows us to send SMS to users.

d. Mobile Devices

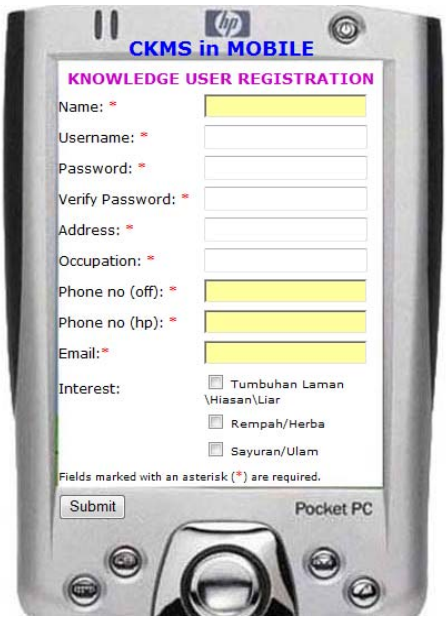
A mobile device is a pocket-sized computing device to access, acquire and disseminate knowledge of BioHerbWebs portal. Examples of devices are personal digital assistant (PDA) and smartphones.

5. Result and Discussions

In this section, we will discuss proposed techniques for two of the methods in mobile KMS that are knowledge acquisition and dissemination since only these two methods will requires mobile devices involvements. A key benefit of BioHerbWebs portal is that it allows the CoP to interact and communicate between users on PC with user on mobile device. When members of CoP posting any new knowledge to the portal using PC, it can be instantly accessed on mobile device and members with mobile device can exchange knowledge with other members using PCs or notebook. This mKM environment is a good start for CoP of bioinformatics to get flexibility of knowledge sharing at anytime, anyplace and anywhere. We show a part of physical design of BioHerbWebs system because this system is still on development. The description of two main system functionalities is as follows.

a. Knowledge Acquisition

User can browse the system through mobile devices or computers but if they want to submit new knowledge, they need to register. During registration, user will have to fill in their personal particulars such as name, email address, phone numbers and pick up their interest regarding herbs plantation, e.g.: spices or vegetables. They can pick more than one interest. After registration, system will then store the data into user database. Based on their interest, user will be put into certain category. For example, if the interests of the user are spices and vegetables, they will be put in the spices user category and vegetables user category.



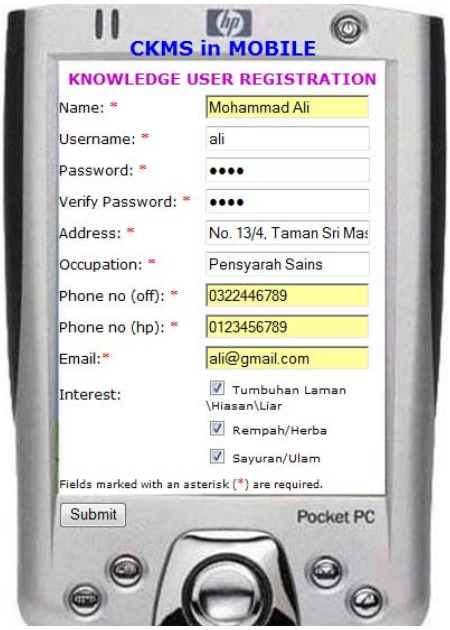


Fig. 3 User Registration Menu

To submit new knowledge, user must go to the knowledge acquisition menu. In here, user must enter the required field, pick the category that most suited the knowledge and may attach related file. After submission, the knowledge will be kept in a temporary database before system administrator will check whether the knowledge is valid or not. After validated, the knowledge will now be stored in permanent database.

Fig. 4 Knowledge Acquisition Menu

b. Knowledge Dissemination

After the new knowledge stored in database, the category chosen during knowledge acquisition will determine which user group that the system will invoke. For example, if the new knowledge is under the category Spices, the spices user category must be notified of this new knowledge. Based on their personal details kept earlier, user in the spices user category will receive an alert in the form of SMS through their mobile devices stating that there is a new knowledge in Spices category.

6. Conclusion and Future Works

In this paper, we introduce mKM system and bioinformatics in supportinf community of practise (CoP) to work collaboratively. Then we are also explored the state-of-the-art mKM system in bioinformatics domain as a case study of how the knowledge sharing can be implemented over mobile computing. Based on previous studies and analysis that we've made on pre-questionnaire, and then, we are proposing a new technique for mKM system particularly in bioinformatics domain focusing on herbs plantation. We present the logical design and a part of physical design of the system.

Since the system is still in development, our future plan is to conduct post-questionnaire once the system is completed. The objective of the questionnaire is to evaluate the effectiveness of the KM framework in the system implementation in term of usability, performance and accessibility of the system. User acceptance test with user will be conducted prior to system delivery to the system owner. Usability of the system is tested based on four main functionalities: knowledge acquisition, knowledge storing, knowledge dissemination and knowledge application. Accessibility and user friendly of the system also taking into consideration to maximize the systems capabilities to ensure users can fulfilled the requirements while accessing to the system. Futhermore, since the agriculture field is being improved rapidly nowadays, it is expected more mKM system in other bioinformatics area will be developed and hoping this paper will serve as a guidance for future research.

References

[1] Anbulagan, K., (2001), "An Experience in Knowledge Management System Implementation at Indonesian Leading IT School", Eight International Sysmposium on the Management of Industrial and Corporate Knowledge (ISMICK'01), 22-23-24 October 2001, France.

[2] Arthur Andersen and APQC (American Productivity and Quality Center), (1996), "The Knowledge Management Assessment Tool: External Benchmarking Version", Arthur Anderson/APAQ.

[3] Cole, R.E. (1998), "Knowledge and the firm", California Management Review, Vol 40 No. 3, Special Issue.

[4] Derballa V., Pousttchi, K., (2004), "Extending Knowledge Management to Mobile Workplaces", Sixth International Conference on Electronic Commerce, Delft University of Technology, The Netherlands.

[5] Fagrell, H., Forsberg, K., Johannesson, E., Ljungberg, F., (2001), "NewsMate: Providing Mobile and Distributed News Journalists with Timely Information", in Beyond Knowledge Management: Managing Expertise, M.Ackerman et al.

[6] Grimm, M., Tazari, M. R., Balfanz, D., (2005), "A Reference Model for Mobile Knowledge Management", Proceedings of I-KNOW'05, Graz, Austria.

[7] Hou, J.L., Yang, S.T., (2006), "A mobile knowledge carrier with personalized knowledge provision", Computers and Industrial Engineering 51, 44-57.

[8] Maier, R (2007): Knowledge Management Systems: Information And Communication Technologies for Knowledge Management. 3rd edition, Berlin: Springer.

[9] Riikonen, P., Boberg, J., Salakoski, T., Vihinen, M., (2002), "Mobile Access to Biological Databases on the Internet", IEEE Transactions on Biomedical Engineering, Vol. 49, No. 12

[10] Abdullah, R., Sahibudin, S., Alias, R.A., Selamat, M.H. (2004). "Collaborative Knowledge Management Portal for Learning Organization", International Conference on Knowledge Management (ICKM2004), Meritus Mandarin Singapore, 13-15 December 2004.

[11] Abdullah, R., Selamat, M.H., Jaafar, A., Atan, R., Ibrahim, H., Hamidon, S.H., Wan Mayu, W.N., (2007), "Mobile Access to Bio-Plant Databases in a Collaborative

Environment", The 2nd National Intelligent Systems And Information Technology Symposium (ISITS'07), Oct 30-31, 2007, ITMA -UPM, Malaysia.

[12] Satyadas A., Harigopal, U., Cassaigne, N. P., (2001), "Knowledge Management Tutorial: An Editorial Overview", IEEE Transactions on Systems, Man, and Cybernetics-Part C: Applications and Review, vol. 31, no. 4, pp. 429-437.