Applying Agent Technology to Facilitate Knowledge Sharing Among Bioinformatics Communities of Practice

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Abstract

Agent technology is a software programs or tool that could be developed and used to facilitate and support the community of practice (CoP) especially the bioinformatics communities who are involved in managing bioinformatics activities such as collective and organized, and shared knowledge in term of best practice and lesson learnt in order to perform their worked for better solutions and competativeness. This paper describes on the theoretical concept and approach of agent technology framework that could be developed in implementing bioinfomatics knowledge management system (BKMS) in order to facilitate knowledge sharing among bioinformatics communities as well as to demonstrates it into the system wise; on how the agent technology could be utilized in the BKMS as a system model for serving the communities that is developed by using groupware such as Lotus Notes software. The achievement in conducting this framework of the BKMS is an added value for the any organization that need to implement the BKMS as a system, which could be helped the CoPs to work together in achieving their aims and mission statements. The emphasis also will be given to the BKMS activities that may concern for agent technology to help the CoPs especially in working collaboratively including critical success factor (CSF) in order to ensure that BKMS initiatives would be delivered competitive advantage for the CoP as well as thier organization.

Keywords:

Agent Technology, Knowledge Management System, Bioinformatics, Communities of Practise and Lotus Notes.

1. Introduction

Agent technology is a software programs or tool that could be developed and used to facilitate and support the community of practice (CoP) especially the bioinformatics communities who are involved in bioinformatics activities such as collective and organized, and shared knowledge in term of best practice or lesson learnt in order to perform their worked for better solutions to overcome the problems or challenges arise without their interference during utilizing knowledge of bioinformatics environment. In bioinformatics communities that typically involved the biologists and researchers, and any others person who are work together in managing the bioinformatics knowledge for a particular purpose and then tended to be maximize the usage of the system as a special mechanism for them to work collaboratively (Morrow and Wilkins, 2004). Therefore, this paper describes on the theoretical concept and approach of agent technology framework that could be developed in implementing bioinfomatics knowledge management system (BKMS) in order to facilitate knowledge sharing among bioinformatics communities as well as to demonstrates it into the system wise; on how the agent technology could be utilized in the BKMS as a system model for serving the communities that is developed by using groupware such as Lotus Notes software. The achievement in conducting this framework of the BKMS is an added value for the any organization that need to implement the BKMS as a system, which could be helped the CoPs to work together in achieving their aims and mission statements. The emphasis also will be given to the BKMS activities that may concern for application of agent technology to help the CoPs especially in working collaboratively including critical success factor (CSF) in order to ensure that BKMS initiatives would be delivered competitive advantage for the CoP as well as thier organization.

2. The Agent Technology Functionality in Bioinformatics Environment

What is agent? Webster's dictionary defines an agent as “One who acts for, or in the place of, another, by authority from him; one intrusted with the business of another; a substitute; a deputy ...". This definition is largely not applicable to software agents, except possibly for agents for personal assistance. A more acceptable definition is by Russell and Norvig, (2002), ``An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through effectors." Similarly, Franklin and Graesser (1997) defined an autonomous agent as, ``a system situated within and a part of an environment that senses that environment and acts on it, over time, in pursuit of its own agenda and so as to effect what it senses in the future", in their interesting article on taxonomy of agents.

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In the information technology (IT), agent could be describes as a computer program that possess properties, and importantly, perform communication for the purpose of co-operation and negotiation, learning to improve performance over time, as well as autonomy, implying that agents can act pro-actively over an environment rather than passively waiting commands. In this case, the role of agent in knowledge management (KM) especially in collaborative context could be viewed in terms of a service agent and a personal assistant. The agent technology will allow and facilitate the bioinformatics communities as team member to work together by using its capabilities like informer for certain message or notification. Service agents are used to be implemented in certain features, like handling documents, managing white pages or yellow pages, do web searches, etc. Personal assistants have the responsibility of coupling human users to the knowledge management system (KMS). They also mediate communication among people, and this is of prime importance. Agent technology operation in KM is shown in Figure 2. In this case, an agent will act as a communicator for the user that is based on the direction given and produces the result when it is required to do so. Agent also could be categories in terms of its roles in knowledge searching, knowledge monitoring, and others (Hendriks, and Vriens, 1999).

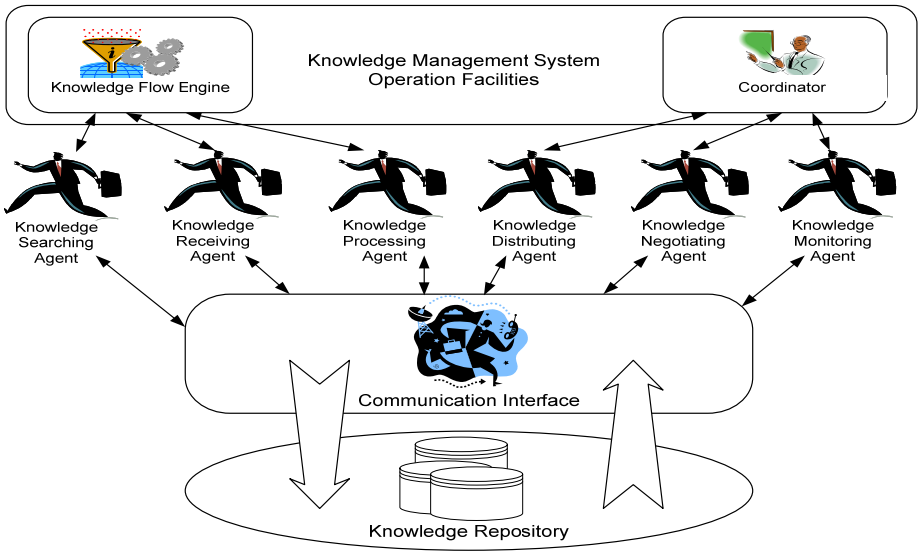


Figure 1: The Operational of Agent Technology in Managing Knowledge (Hendriks, and Vriens, 1999)

3. Methodology

The research has been conducted which starting from by reviewing the literatures with regards to agent technologies capabilities and its related issues in order to facilitate and support knowledge sharing of bioinformatics communities for a particular environment and followed by the fomulating of a system model on how the agent is working on a particular task in such environment, and then a prelimenary system testing is carrying out in order to ensure the system model in a selected domain especially in related to the Bionformatics Knowledge Management System (BKMS) is developed and implemented as a case study. In this context, the application of agent technology in the system model has been demonstrated into the actual system implemention by using groupware software namely Lotus Notes which is currently running on client and server based environment. So that the system can be used in order to facilitate and support bioinformatics communities to share their knowledge and work together collaboratively for their any purposes at any where, any platform and any time.

4. A Case Study

As groupware software, Lotus Notes (Lotus, 2002) provides various types of services for a CoP. The most important service offers by this product is in term of knowledge repository. This service will serve the CoP to share their knowledge and any things that are stored in knowledge repositories. Another common service of agent technology, which is allows people to get information or

notification regarding on the latest knowledge deposition in the knowledge repositories at any time and any place. In Lotus Notes, agent technology could be programmed and performed manually or automatically by the user based on a selected of choice. These selections, normally is based on the document created in a database and the setting up of the time scheduling by the user. The conceptual diagram of KMS with agent technology is shown in Figure 2 below. By using this software, the knowledge was organized by creating a central database and it could be entered using forms and it could also be browse by using the viewers' facilities in Lous Notes by itself or a Web based environment. In order to make the community more aware and alert about a new knowledge was created in the database by enhancing and embedding agent technology, which could be used based on scripting or formulas given by the users.

Agent Specification Algorithms

There are two agents was identified and developed to ensure KM system could be served for the CoP. These agents are namely: profiling and notification agent. The role of these agents is described in the agent specification algorithms as below.

- **Profiling Agent** – Is used to trigger and record all the knowledge about its dissemination to the CoP in term of the status and accessing of knowledge. The algorithm specification for profiling agent is shown at Figure 3(a).

- **Notification agent** – Is used to trigger and notify CoP about the incoming of new knowledge that was created and could be accessed by them who interested with. The system will keep on alerted CoP about it for three times, If the knowledge created couldn't be accessed in this times, otherwise, the agent will assume this knowledge is no longer interested and agent will be ignored it for sending back with the same knowledge type to them on the future. The algorithm specification for notification agent is shown at Figure 3(b).

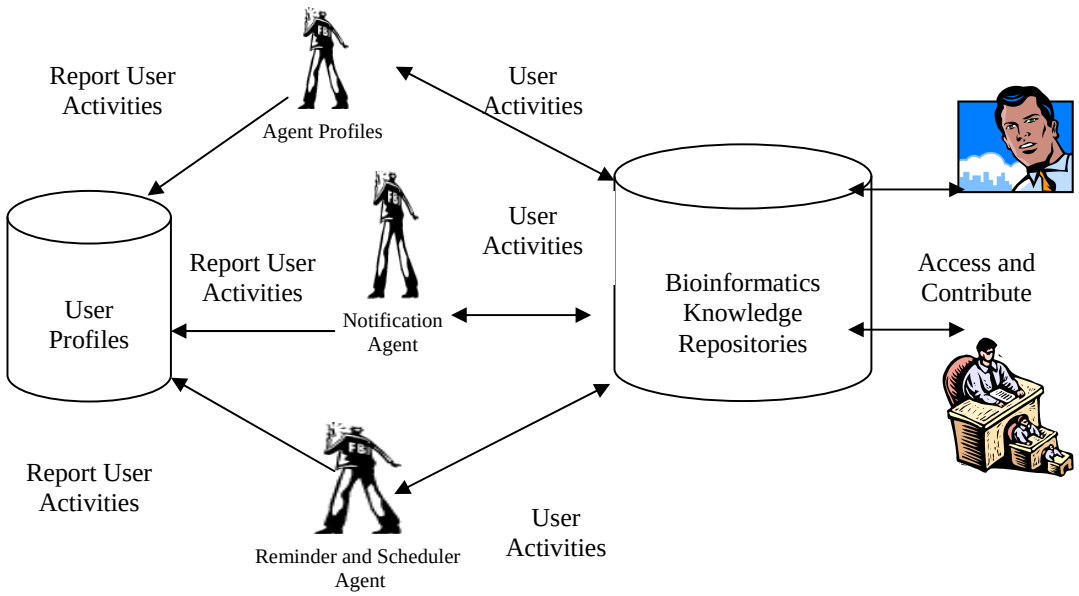


Figure 2: Agent Technological Services to Support Bioinformatics Community of Practice

Line #	Steps
1	*FOR ACTION all knowledge is access by CoP*
2	*Stamp user id, time*
3	*Store type of knowledge*
4	*IF new user id THEN*
5	*Create status = 1*
6	*ELSE*
7	*Update status by increased 1*
8	*ENDIF*
9	*Calculate the duration of access*
10	*Store all particulars in Log-File*
	NEXT ACTION

Figure 3(a): Profiling Agent

Line #	Steps
1	*FOR ACTION all knowledge is created by CoP*
2	*IF save is OK THEN*
3	*Get e-mail address at CoP file*
4	*FOR ACTION all members of CoP*
5	*IF new user or status access NOT > 3 times*
6	*THEN*
7	*Send e-mail by attachment of messages*
8	*ELSE*
9	*Do nothing*
10	*ENDIF*
11	*NEXT ACTION*
12	*ELSE*
13	*Do nothing*
14	*ENDIF*
15	*NEXT ACTION*

Figure 3(b): Notification Agent

The KM Prototyping of System Development Process

A KM system prototype for bioinformatics environment with agent technology is developed to serve CoP for supporting their activities that being done in a certain period of time. The system development process is based on the rapid application development (RAD) because the developers and users could be developed and testing the system immediately until they are satisfied with the system. In this case, members in the CoP who are involved the project, may have their own respective roles such as biologists and researchers, as well as administrators. The system connectivity of a team member in client and server environment of CoP is shown as in Figure 4 below.

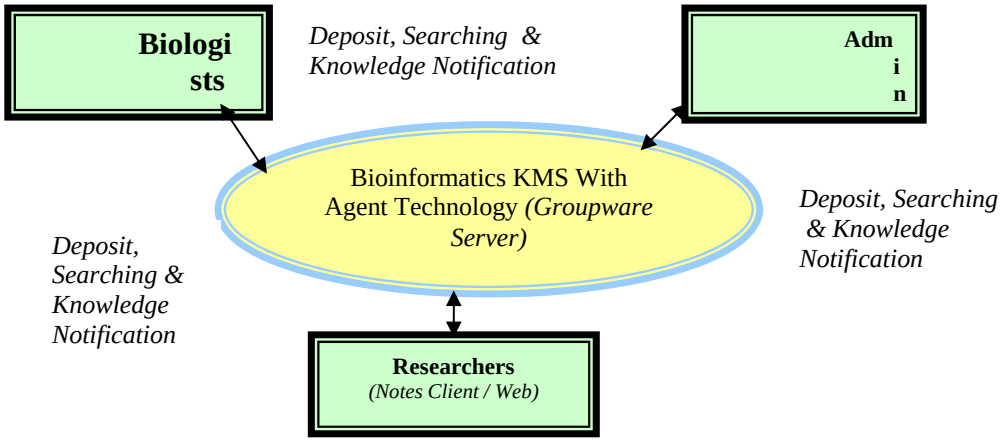


Figure 4: The KMS of CoP connectivity in Bioinformatics environment

These services provided for the community include normal communication and also notification system that is based on the condition of previous profile. In additional of communication aspect, the facilities of Intranet agent that have been programmed is used through e-mail system that running automatically when new knowledge has been created in the knowledge repositories. The system and the responsibilities of each member in supporting Intranet agent technology for CoP, as well as the system interfaces are described as follows:

a) Biologists

Normally, biologists will start creating the knowledge that being proposed for a certain project in the organization. When he or she has finished depositing knowledge into the knowledge repositories, the system will trigger the event and pass it to any member specified through e-mail system. This notification will be done based on previous record in order to make sure alerts could be done to those who are interested in the particular knowledge in order to make a decision. Otherwise, this knowledge will be un-meaningful for the other member. This illustrated the factor of knowledge notification agent as described in the Figure 2 as above.

b) Researchers and Administrators

When the researchers or supervisors also want to make a decision, they should open their mailboxes and look on the subject matter. If they are willing to know about the detail of the knowledge created, they are asked to enter the username and password for security purposes. At the same time another agent will work by updating the status of accessing document as users who are interested with the subject matter. This illustrated the factor of knowledge monitoring agent as described in the Figure 2 as above.

The Integrated Development Environment (IDE) Tools of Lotus Notes

By using the groupware of Lotus Notes, the best agent technology capability that could be developed is used Lotus Script programming that comes along with this package. The examples of the IDE and scripting development of interface are shown in Figure 5, 6, 7 and Figure 8 below.

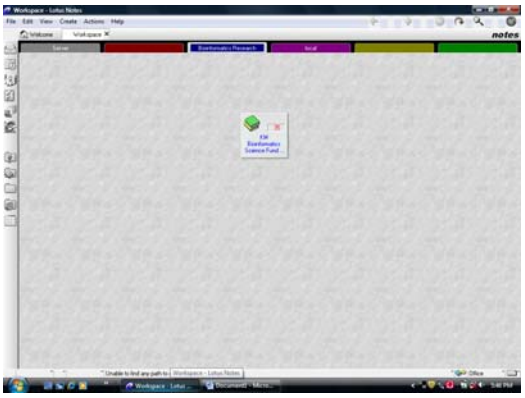


Figure 5: The IDE Interface in Lotus Notes.

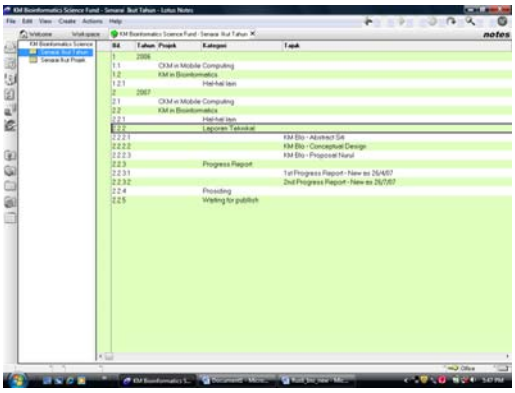


Figure 6: Building Bioinformatics Program

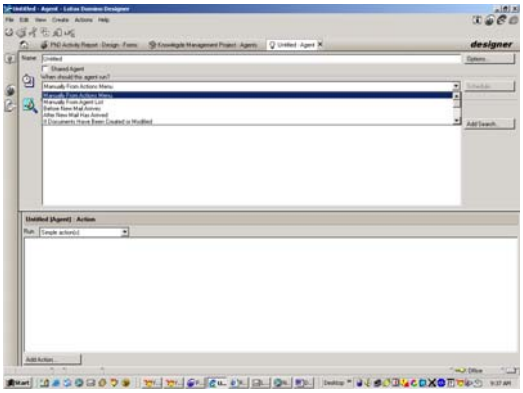


Figure 7: The IDE Interface in Lotus Notes.

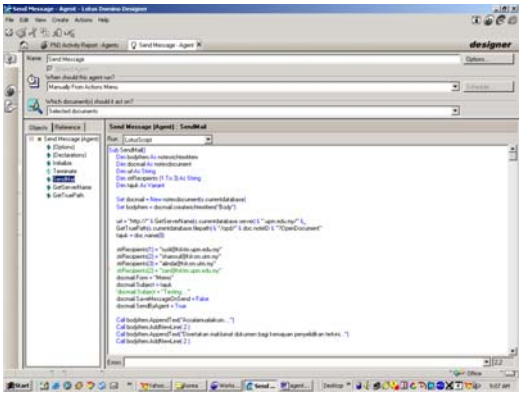


Figure 8: Building Agent on Scripting Program

The Workflow of KM with Agent System Implementation

In the system implementation process of agent technology, a member of the project teams would create a new knowledge by using the form component and save it into the system. This knowledge would be organized in the forms of record. After that, the agent will be activated and passed it to the community members as a knowledge alert for future decision-making by using e-mail as communication tools. See Figure 9.

When members of CoP are willing to use it for making decision, the system will prompt the username and password as a security check, and then another agent will trigger this event and update the log file for future event. This log file is useful in order to keep track the same category of message will pass to the members who are searching or interesting with. Otherwise, the system will not send it any more. See Figure 10. For the example of this interface is shown in Figure 11.

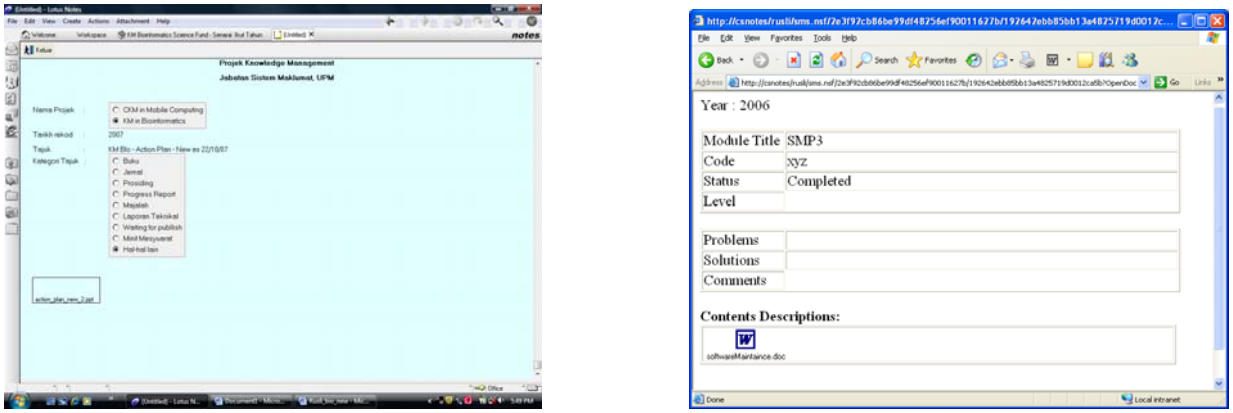
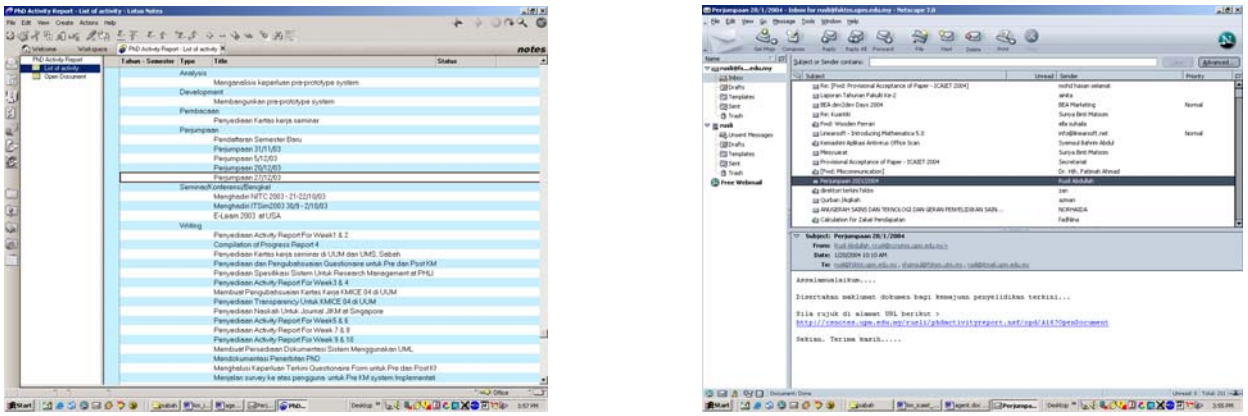


Figure 9: Interfaces of new knowledge generation (left) and agent notification by using normal e-mail (right)



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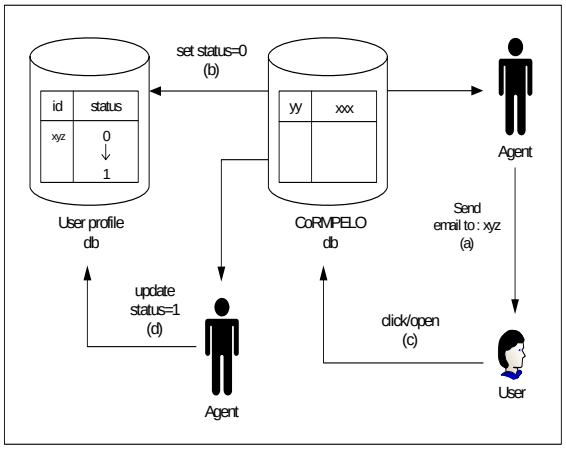

Figure 10: Agent Status Update Workflow

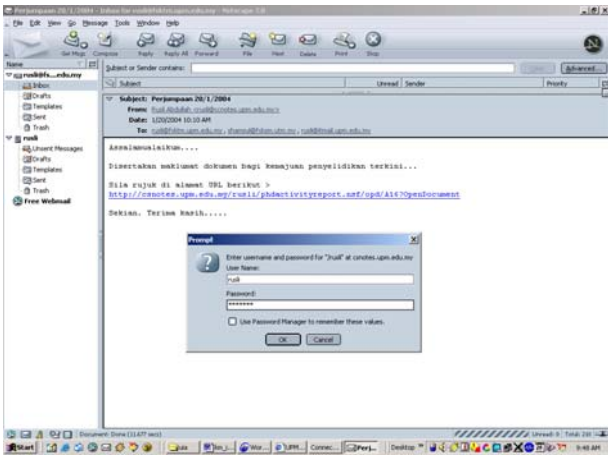

Figure 11: Interface of security Check

5. Result and Discussions

The proposed solution shows that the agent technology has contributed to the automation processes of knowledge acquisition, storing, dissemination and using it among the community and reduces human intervention for decision-making system. These processes could be done using autonomous agent developed, that will act on behalf of the members of the CoP and workable at any time as long as users using and deposits the knowledge throughout the system. In our case, autonomous agent has two types of events for supporting decision-making. The first type of event occurred when new knowledge was created, the agent is used for keeping up community informed about the new knowledge was created in the community. The second type of event occurred when user accessing new knowledge deposited, the agent is used to update the user profile in order to determine the future related knowledge with the currently accessed knowledge that would be notified to them or not. The flow of event for applying agent technology in term of horizontal layer for this case study is shown in Figure 12 below.

Beside that, we also found that in order to ensure the agent is utilized and helpful as well as is a successful in the organization; there are some critical success factors (CSF) that could be considered. Firstly is the role of members in the community that should be worked with the system more aggressive. These include the issues of their willingness to deposit the knowledge into the system for sharing knowledge among the community. Another issue is the infrastructure and technological requirement which involves people who are responsible to the system, and to ensure that it would be stabilize round the clock, because the agent will work automatically at any time over the computer network and based on scripting given to them in the client and server based environment.

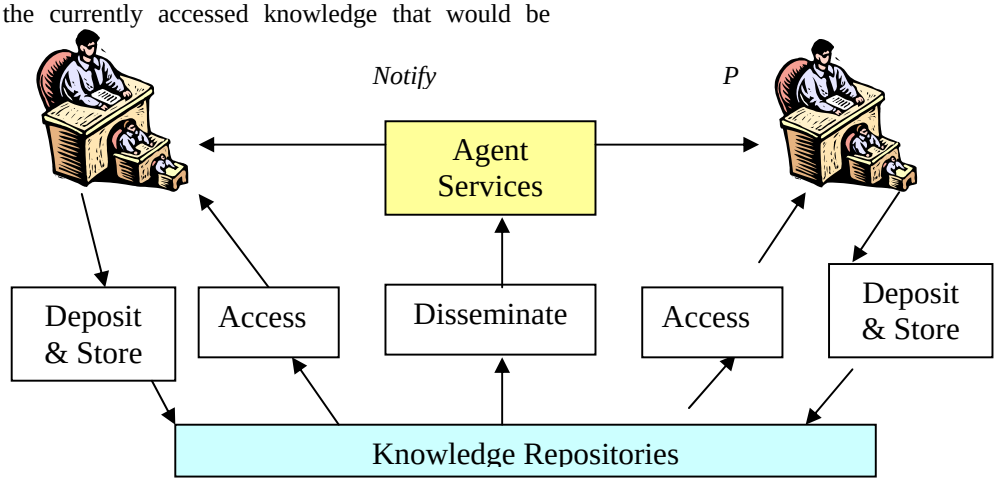

Figure 12: The workflow of agent services environment in organizing knowledge for CoP

The Critical Success Factors in Implementing Bioinformatics KM System.

Firstly, by encouraging the team member look for windows of opportunity to introduce the benefits of KM in bioinformatics – try to find where KM will be most valuable by talking to people or Cop that involved with strategic initiatives, internal consulting groups, or people in BKMS with whom we have developed personal relationships between team and users. Then answer the following questions. What are their objectives? What issues are being addressed? How can KM help the organization meet those objectives and deal with those issues? Secondly, the organization should actively to address the importance of knowledge sharing of Best Practices and The Building of Consistent Processes. By sharing of best practices, it will reduce costs and time as well as staffs will be searching for the previous knowledge in the portal as a sole point of reference. Therefore, all activities will be consistently activated. The third point is in terms of knowledge capturing for lessons learned where it is the oversight group of SMP that must be discussed based on lessons learned at regular meetings and provide a common space for sharing the results for quality and productivity.

6. Conclusions and Future Research

KM system is a good platform where people could share their knowledge between the communities of practice (CoP). In this case, agent technology is a tool that could be used in order to act on behalf of CoP in bioinformatics environment to do something repetitively and time based system especially in supportinging various types of bioinformatics activities such as knowledge gathering, storing, disseminating and its application in terms of best practise and lesson learnt for future purposes.

For this reason, it is justified because an agent has the capabilities in term of doing repetitive and time-based task that are alive in the system to serve the CoP. For future research, we recommend that the BKM system should be measured in term of the important critical success factors that affect agent technology and it's used as a technical tools. The research also should be carry out to incorporate significant differences between intelligent agent and other agents or multi agent system (MAS), that are related to them in order to an integrated utilization of organizational resources.

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