ESTABLISHING A HEALTH COMMUNITY KNOWLEDGE MANAGEMENT SYSTEM

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ABSTRACT

A fundamental aspect of knowledge management is knowledge capture and expertise created by knowledge experts who make it available to a larger community of colleagues. Technology can support these goals, and knowledge repositories have emerged as a key tool for supporting knowledge sharing. However, Internet today suffers from lack of knowledge, although it contains a huge amount of information, almost on every subject.

The goal of the system we are going to present is to set up an intelligent collaborative work environment for the Management of Health Knowledge and Competence in the context of large health care systems. The first knowledge domain addressed by the system will be Cardiology. The IT platform proposed is designed in order to facilitate the transactions of knowledge and competence between health care experts and operators and to support the professionals in taking evidence-based decisions at the point of need. In an "Ambient Intelligence" vision, the proposed system will work on the development of meta-content services to improve information handling and knowledge management to support new forms of health organisations based upon learning environments and community memory.

KEYWORDS

Knowledge Management, health care, ontology, knowledge repository, intelligent agents

1. INTRODUCTION

The core of the system will be a portal web site that will comprise many services concerning transactions of knowledge. Among the technical objectives of the proposed system is to exploit the use of state-of-the-art technologies thus reducing and minimizing potential development risks. Transactions will be implemented using JAVA and the technology of Intelligent Agents. The knowledge repository (KR) of the platform will be implemented as an Ontology that for the use cases experimented in the system will contain information about the discipline of Cardiology. A Document Repository will contain scientific documentation. The system will support the establishment of a dynamic network of expertise. Every scientific term in the Ontology and every published document in the portal web site, will contain the name of the source (expert) and the names of the Experts in the Validation Board, for IPR and validation purposes. Consequently, the end user will be informed about the source of knowledge in order to establish a direct relationship with the expert that provided him with the specific information. So, the two (or more) experts will be able to establish a direct network of expertise by exchanging information on specific aspects of their discipline. Furthermore, a User Interface will be designed and implemented for a Validation / Authorization and Maintenance Board of Experts. This Advisory Board of experts will be responsible for authorising the User who adds knowledge in the KR. Additionally, they will be responsible for the Validation of the Knowledge, so that they will be able to maintain the KR. The Validation of Knowledge and the Maintenance of the KR are two vital tasks, because the information in the KR is highly critical for the society.

2. GENERAL OVERVIEW

The concept of an "knowledge organization" to offer "knowledge services" to medical professionals is very innovative.

Here it is worth to be mentioned that a big difference exists between the concept of "**information**" and the concept of "**knowledge**". The latter includes the concepts of experience and competence, ready to be transformed into action. This distinction is very important, to define and grasp the innovation on the technical solution of the proposed system, in contrast to information based services provided by the most dedicated search engines or searches into databases (both of medical staff). The added value of the services that the system is going to offer is very high since they are knowledge and not information oriented.

Another service of great importance, is that the proposed system will allow better utilisation of health professionals according to their level of expertise, which is going to be verified by using the system. Extracting and representing knowledge from data sources and human beings, is an emerging research area, with a lot of difficulties and obstacles to be overcome.

The platform proposed deals with both of them and its success is going mainly to be associated with success for establishing such mechanisms, for knowledge acquisition, representation, authentication, validation and distributions. All the above aspects, generate the need for research in the above areas.

Today the trend for research and hence of providing innovative solutions in the area of Knowledge Management (KM), is the use of ontologies (that are explicit specifications of conceptualisations providing a useful means to facilitate access and reuse of knowledge), in relation with user profiling and system intelligence. While ontologies will be responsible for Knowledge Representation, intelligence will be served by using technologies of intelligent agents, so to be able to dynamically maintain continuous needs of changing knowledge within the domain of the proposed system. Technologies like RDF and tools like OIL will be exploited to represent and maintain the ontology(-ies) of the system.

Based on these, the proposed technical solution will have to deal with the management of the knowledge, offering mechanisms for the explicit control and management of knowledge within an organization aimed at achieving the organisation's objectives.

The platform proposed will have to address and support, together with its technical solution, many aspects that from a human being routine operation might seem simple, but when they are viewed under a "corporate" or "organisational" viewpoint, reveal tremendous obstacles. Some indicative issues that have to be resolved in the frames of the current system are multidimensionality of knowledge, multilingualism, use of different practices, different usage equipment and technologies, different mentalities and ways of work between the participating health professionals, highly distributed knowledge and information.

Furthermore, it is well known that nowadays, each organization, hospital, clinic, physician, etc. may use different standards for storing and processing medical data, making them useless even in the data level. This implies a crucial problem when activities like the proposed system have to be established. For the right operation of the system's platform and the satisfaction of the mentioned functional specifications, the technical side of the platform, along with the medical one, will form a meta-protocol and meta-standards to overcome such obstacles and generate a common "knowledge warehouse" from where knowledge is going to be retrieved later on. These two "modules" will act as a meta-level of the already existed and used protocols and standards, able to describe effectively and unify the old ones, making them useful in terms of knowledge distribution. Thus, the desired collaboration and exchange of information between different platforms/techniques, using several working habits, individualities, and philosophies will be possible.

The proposed platform overall, will aim at offering an innovative protocol for the health sector, so that to be feasible the generation of common structures and schemata for knowledge, of various medical directions (pathology, cardiology, paediatric, etc).

The system will be able to be applied in a variety of platforms, and in an abstract way will make the logical as well as the real connections between the common Internet user (i.e., the potential system user, professional expert), the WEB site(s) that offer a variety of content and type of knowledge "instances", and finally, will lead to the exploitation of such schemata, taking under consideration ethical and security aspects, to promote leverage of knowledge, expertise and competence among the members of the Network of Excellence. The most therefore innovative part is then the complete system, when it is conceived as an overall. Under this concept, it will offer the chance to various types and levels of users (health care experts), to have access to knowledge and participate in a continuous learning process, by relating knowledge of individuals, to common, organisational-wise acquired and possessed one.

3. ARCHITECTURE

In order to facilitate the system's functionality, we propose a flexible, open and modular architecture that can easily be extended to accommodate future needs and domains of knowledge. The suggested infrastructure falls in separate and discrete components, which are dedicated on a certain piece of functionality. The benefits of such architecture are summarized in the following issues:

improved scalability, reliability regarding both software and hardware faults, reusability and maintainability.

The main challenges of the our infrastructure are outlined below:

- To create and maintain a well structured representation of Knowledge in a specific domain of Medicine Science.
- To handle the huge amount of documents in order to extract scientific terms and turn them into knowledge.
- To deliver efficient knowledge management on top of the information sources.
- To promote personalized delivery of the most appropriate piece of knowledge (with respect to the user querying profiles) in a form and format that matches the standards of users' interests, medical status, communication and operating device/terminal features.
- To deliver information with respect to the user's linguistic characteristics (support of multilingualism).
- To deliver collaboration services; special emphasis must be placed on wireless devices exploiting the GPRS or UMTS capabilities.
- To provide secure delivery of information to the experts, depending on the type of knowledge.
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Taking into account the above-mentioned points of action, we propose the following system architecture as shown in Figure 1.

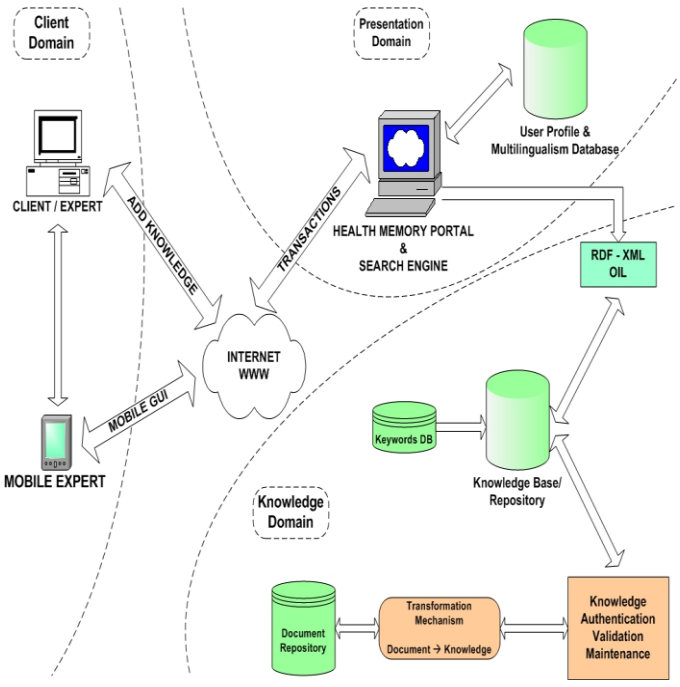

Fig. 1. The Platform Architecture

As depicted above, the platform can be divided into three main domains:

- the Client Domain;
- the Presentation Domain;
- the Knowledge Domain.

The first domain of the platform is the **Client Domain**. The Client Domain comprises two different "options". Firstly, the end user will be able to interact with the platform by using his/her Web Browser from his/her desktop computer. This option represents the so called *desktop user*, who is in his/her office or his/her house and wants to retrieve or/and add some "pieces" of knowledge to the portal.

The second option includes the *mobile user*. In this option, the expert is "mobile" (e.g. he/she travels around Europe) and uses a Personal Digital Assistant (PDA) while he/she is travelling or being out of the office. In this case, health care expert should be able to interact with the platform even on moving. The system recognizes him/her automatically, as well as his/her used device. Thus, the platform provides him/her with a different User Interface in order to be adopted on the capabilities and characteristics of the used mobile device like. This special user interface will provide the user with the ability to fully interact with the system. Consequently, the client – expert will have the opportunity to use the services at any time from anywhere. The desired ubiquity is therefore achieved by the mobile option of the project's platform.

Secondly, the platform will contain a **Presentation Domain**, which will consist of the Portal and an "intelligent" Search Engine. The final portal will offer several services and a *two-function search engine*.

As soon as the user enters the portal he/she will be asked to provide his/her username and password in order to personalize the portal according to user's personal information and interests. The main page of the portal will present to the user some general information and news according to his/her personal profile. Furthermore, the expert will have the opportunity to transact with the knowledge base in order to retrieve and/or add knowledge in it.

Additionally, as mentioned previously, the portal will provide a two – function search engine. This search engine will assist the user to find the knowledge he/she seeks in two different ways. The first way is the most common one. The user will enter some keywords to a text area in order to retrieve the knowledge he/she is looking for. The second option and the more intelligent one will be the navigation in the Domain Ontology by answering questions asked by the portal. The user will be asked several questions by the portal and he/she will navigate among the knowledge terms in the Domain Ontology just by providing the corresponding answers.

Finally, the third domain of the platform will be the **Knowledge Domain**. Knowledge Domain will comprise the backbone of the platform. The Knowledge Domain

will consist of some discrete modules, which will provide knowledge to the user-expert by cooperating with each other. The main module of the Knowledge Domain will be the *Domain Ontology*, which in our case will be an ontology based on Cardiology terms. Moreover, a Document Repository will be developed and used. This Repository will be a database containing validated documents. These documents will be entered in an intelligent software engine in order to extract some keywords so as to maintain the Domain Ontology. And lastly, a Keywords Database will contain the keywords entered in the Domain Ontology.

Technical Issues

The technical work related to our system is divided in seven major sectors mentioned below:

- Web-based platform
- Mobile platform
- Profiling - Personalization
- Knowledge Management
- Ontologies
- Security

The above technical terms will be examined and analyzed further in the following pages of the current section of the document in order to provide the reader with a first approach of the work to be done.

Web-based platform

The backbone is a Web-based platform and more specifically a Web Portal. This portal will cooperate with every component in the platform in order to implement the requested tasks by its end users.

Firstly, the portal will communicate with a database, which contains the personal user profiles. This database will act as a profile provider to the portal, so that it will be able to personalize the information provided to the user according to his/her rights and interests.

Additionally, the used portal will contain a *news server*. The news server will be responsible for the transmittance of the latest news on the user's areas of interest. The portal will be responsible for the personalization of the news that going to be provided to every specific user. Consequently, every expert will have the ability of being informed about the latest developments in the areas of knowledge of his interest.

Thirdly, the portal will include a *chat server*. The chat server will be responsible for the establishment of the network of expertise among users. The user who retrieved a piece of knowledge may want to directly communicate with the provider of the specific piece of knowledge. The chat server of the portal will provide this ability to every user-expert.

Moreover, a *collaboration server* will also be used to the final system. The collaboration server will be responsible for keeping some log files containing information about the interaction of every expert with the platform. Furthermore, the collaboration server will have the capability to organize the experts according to their interests into several groups.

In order to implement the above mentioned services and modules several technologies can be used. The main technology will be JAVA and Intelligent Agents. Intelligent Agents will be responsible for the transactions between the expert and the platform according to his/her personal profile. JAVA will be used in order to implement the required web pages as JAVA Server Pages. Furthermore, a database will be designed and developed to keep the necessary information concerning the users' profiles.

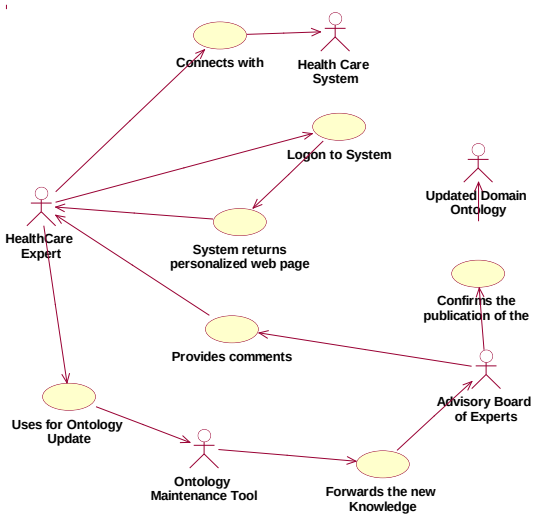

Fig. 2. Use case scenario for web-based platform

Mobile platform

An alternative solution of using the proposed system is through a mobile device. Any well-known mobile device (PDA, palmtop, etc) will be used for this purpose. The user will be able to look for valuable knowledge at any time using his/her PDA. Of course, there are several issues that have to be examined and solved here. For example, the content presented in this device will not be the same as the one presented (for the same query) on a normal PC connected to the Internet.

The graphical user interface will be separately designed and implemented in order to fit to the terminal's capabilities. The system will automatically recognize the terminal capabilities in order to configure the graphical user interface. In the case of a PDA, the graphical user interface will be dedicated to this specific kind of device. This means that a configuration manager will be implemented to handle the whole transaction between the

system and the mobile device before sending the appropriate user interface.

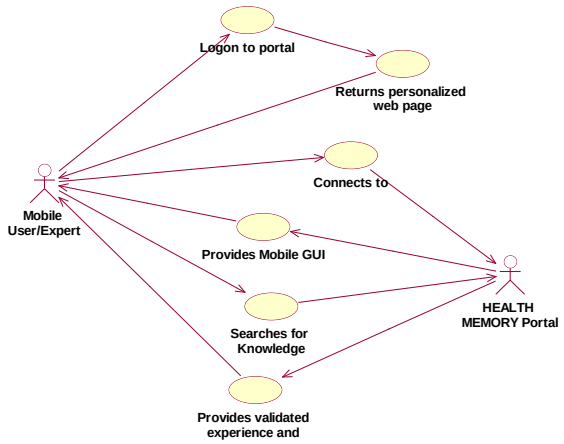

Fig. 3. Use case scenario for mobile platform

Profiling - Personalization

The needed Personalization and Profiling algorithms and techniques will be designed and used to achieve the required personalization of the final system. A software module will be implemented in order to collect and group the user characteristics according to their nature, status, etc. The right repositories will be used to update the stored data upon modification. Thus, the system will easily form patterns of profiles and build a hierarchical structure composed of profiles and sub-profiles.

Moreover, a presentation module will be responsible for the presentation of the requested information to the end user. It will identify the user's access device and, based on the user profile it will present user-adaptable interface utilizing metadata information. This component is only focused on the Web-based application and not the mobile one.

Finally, the last module of personalization and user profiling will be the Advisory Module. The Advisory Module will be implemented as a graphical user interface used for authorization and validation of new pieces of knowledge. The Advisory Module will be presented only to experts that their profile indicates that they are capable of getting such a position (members of the Validation Advisory Board of Experts – VABE). The user profiling and personalization mechanisms will also be implemented using JAVA Technologies, and more specifically Intelligent Agents. Intelligent Agents will be useful in the case of the retrieval and usage of the profile of a specific user.

Knowledge Management

Knowledge management is the explicit control and management of knowledge within an organization aimed at achieving the organization's objectives.

Knowledge management entails:

- Formulating a strategic policy for the development and application of knowledge;
- Executing the knowledge policy with the support of all parties within the organization; and
- Improving the organization where knowledge is not optimally used or is not adapted to changing circumstances.

More specifically, the following objectives can be set in terms of the processes within the context of knowledge management in our system:

- Ensure an effective and efficient *development of new knowledge* and improvement of existing knowledge with a view to the strategy of health organizations and the individual objectives of the health professionals.
- Ensure a specific *distribution of new knowledge* to other health departments and *transfer of knowledge* to new health professionals through knowledge transfer or relocation of knowledge bearers.
- Ensure an *effective securing of knowledge* which is also easily accessible to the whole health community.
- Ensure the *effective and efficient combination* of the best knowledge available within an organization or a network of organizations.

In terms of the dimensions of knowledge, the following objectives will be set in the frames of knowledge management techniques:

- Keep the *content* of knowledge bearers up to date and correct under changing circumstances; apply the best knowledge.
- Make the *location* of knowledge bearers optimal in the context of organization processes; apply knowledge at the best location.
- Improve the *form* of knowledge bearers in relation to the users and the expected use of it; apply knowledge in the best form.
- Adapt the *availability* of knowledge to the time that the knowledge is needed; apply knowledge when required.

In order to achieve knowledge management in the platform knowledge repositories will be implemented. Data warehouse and database technologies will be used. The main part of the repositories will be built on major already existed databases, which will take into account rule-based techniques. International standards will be taken into account during the whole process of implementation and integration.

Ontologies

Knowledge management nowadays faces several problems. First of all, the searching by using keyword matching has often low precision. Moreover, discrete keywords do not represent knowledge. Additionally, the results of a search cannot be arranged in a semantically

relevant way. And finally, the search results until now include only documents, which are not knowledge.

The answer to the above mentioned problems seems to be ONTOLOGIES. In Knowledge Management (KM), it is widely accepted that ONTOLOGIES are explicit specifications of conceptualisations providing useful means to facilitate access and reuse of knowledge. The ontologies used in the specific project will contain some knowledge terms. Therefore, ***the ontology will be dynamically maintained by a "Knowledge Advisory Board", in order to be updated according the current developments in the specific health area***. In the current project, an ontology will be created in order to include terms in the area of **Cardiology**. Of course, the open architecture design of the proposed system will facilitate the implementation and adoption of new ontologies from several areas of the health sector.

The advantages of ontologies are mentioned below:

- An ontology allows semantically data retrieval based on domain criteria
- Ontologies provide no limits to the depth of knowledge represented
- The search results are grouped by using their relevance to the whole query.
- The ontologies can be updated as new terminologies and relationships.

The ontology that will be implemented in the platform is depicted in the following diagram.

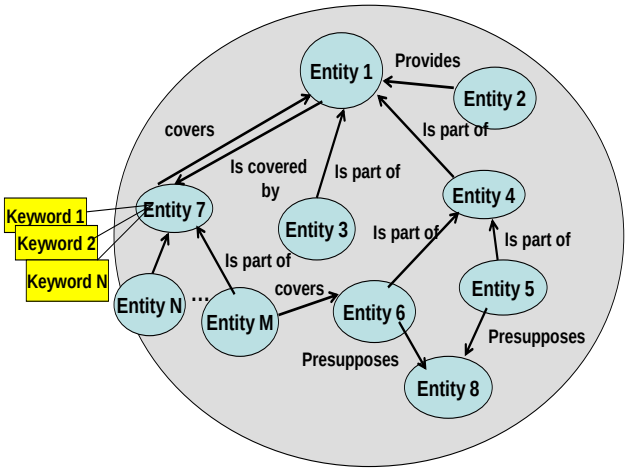

Fig. 4: *Domain Ontology Model*

4. CONCLUSION

The goal of the system is to set up an intelligent collaborative work environment for the Management of Health Knowledge and Competence in the context of large health care systems. The IT platform proposed is designed in order to facilitate the transactions of knowledge and competence between health care experts and operators and to support the professionals in taking evidence-based decisions at the point of need. In an "Ambient Intelligence" vision, the proposed system will work on the development of meta-content services to improve information handling and knowledge management to support new forms of health organizations based upon learning environments and community memory.

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