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The Design of Knowledge Management Architecture

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PART 2

Letter of Transmittal

In this report we will discuss how to design a Knowledge Management Architecture for the report one[1]. Where report one was on the topic of *Knowledge Management System (KMS) Concept in the case study of the Human Resources of the commonwealth government agency*.

This report was prepared from various information gathered form the World Wide Web, books, lectures and from my past knowledge.

This report is divided into several sections. Each of these sections is organized as follows:

- An introduction and a background section.
- An analysis that provides an in-depth look at of what possible KMSs would be appropriate to the agency.
- A design Architecture of the KMSs in a way to insure that these proposed systems would meet the goals which they should serve.
- The last section is a conclusion of what the report has presented.

This report is written to be comprehensive, examining all of the areas that are important to address the problem domain that was outlined in report 1.The analysis and the focus on the problems is intended to be a stepping-stone to assist the commonwealth government agency senior manager. Which is done by giving him a guide on how to implement KMSs and apply KM architecture to achieve the required objectives and improve the agency's' performance.

Abstract

A lot of businesses are overwhelmed by the information explosion in the last several years, and are looking for new methods and systems to extract maximum outcome from information. This report will try to develop and design an architect of possible knowledge management systems in order to resolve the problems encountered in report1 case study. Through the application of various knowledge management systems in the commonwealth agency, these systems should improve the agency's efficiency and effectiveness by handling these valuable intangible assets.

1. Introduction

Interest in Knowledge Management (KM) has grown rapidly among managers, researchers, and consultants in the past decade. The idea that knowledge can be purposefully managed has considerable appeal to firms as a way to improve learning, performance, and adaptability while reducing risk in rapidly changing environments. Although KM deals extensively with people-centred issues of learning, sharing and integrating knowledge, many KM projects are built on a foundation of information technology forming KMSs. These Knowledge Management Systems (KMSs) will be discussed in details in the first part of this report.

Knowledge management is not one single discipline. Rather, it an integration of numerous endeavors and fields of study. In which, there are many different Knowledge Management Systems (KMSs) that could help in information collecting, storing and processing in order to produce knowledge out of them.

In the first part of this report, the main emphasis will be on KMSs. These systems will be introduced in a way to attempt to find answers to some questions that was raised in report 1, by trying to find out what went wrong with the staff recruit process. Also this report will suggest some possible solutions through the employment and deployment of KMSs. While the second part will combine all of the KMSs that were suggested in the first part of the report and try to develop an overall architecture out of them. By that, if any malfunction or problem occurs to any of the suggested KMSs after they have been implemented in the agency, we can simply return to our designed architecture and remove or add any system. Then see how the removal or addition of that system could affect other systems in this architecture.

The next section will briefly give a background on what is actually Knowledge Management and what is System. Then in section 3 we will discuss the various types of Knowledge Management Systems applicable to our case study, and how we can improve the agency's decision and outcome through the use of these systems.

2. Background

In order to fully understand what a Knowledge Management System is, we need to know what does Knowledge Management (KM) and Systems means.

Systems

Systems can be defined as sets of interacting components that operate together to accomplish a purpose (Alter p 585).

Knowledge management

There is not one singularly accepted definition of knowledge management. The following are some definitions described by various resources as:

- 'getting the right knowledge to the right people at the right time to serve the right objectives' (*Stephens, 2001, pp. 26-30 at p. 26*);
- 'a process for optimising the effective application of intellectual capital to achieve organisational objectives' (*Edwards, 2002, pp. 51-61)*;
- 'the systematic process of finding, selecting, organising, distilling and presenting information in a way that improves an employee's comprehension in a specific area of interest' (*IKM, 2003*); and
- 'creating, using sharing and learning from knowledge in order to improve an organisation's capacity to act' (*Moodie, 2002*).

These definitions all encapsulate a view of knowledge that is directed to improving efficiency, performance and achieving organisational objectives. A key feature of knowledge management is the sharing of knowledge as opposed to simply the dissemination of information.

PART 1

3. Applicable Knowledge Management Systems

After examining what went wrong in report1, now we will try to eliminate such problems through a number of KMSs. The KMSs that are mentioned in this section are classified into two major kinds, which are Hard and Soft Knowledge Management Systems.

The *Hard Knowledge* builds on the rich history of Information Management to explore how explicit ('hard') knowledge can generate competitive advantage. These hard KMSs implies to the definition of explicit knowledge as the knowledge that has been articulated, more often than not, captured in the form of text, tables, diagrams, products specification and so on (*Nichols, 2000).*From the knowledge-based management systems that generate recommendations (e.g. decision support systems) to knowledge repositories that capture best practices, a variety of KMS are discussed in this context. These KMSs should have the ability to effectively manage explicit knowledge to achieve the agency's goals. The *Soft Knowledge* examines the role of collaboration within communities and teams as a core mechanism by which tacit knowledge, which cannot be articulated (*Nichols, 2000)*, generates the agency's value. Different kinds of technology are important in such settings, and managerial issues are also distinctly different from hard knowledge management systems. This area of KM is still evolving rapidly, we will try to focus some light on how we can benefit from this area of soft knowledge management through application of communities of practice (CoP) and virtual communities (VCs) and others that will be discussed.

I. Hard Knowledge Management Systems

3.1 Information Retrieval Systems

Insufficient information provided to the senior manager of the commonwealth government agency was one of the reasons for him to not know exactly what other managers in the agency needed of new staff to be recruited. Here comes the need for an effective system that can provide its clients with information on demand.

The suggested Information retrieval System (IRS) can collect, represent, store, organize, and provide information when ever requested to. This will certainly facilitate working with documents and organise the employee's work. In the rest of this section we will discuss a typical IRS, by first providing how a typical system works and a model of that system.

The problem of information retrieval can be simply stated as we have vast amounts of information to which accurate and speedy access is becoming ever more difficult (W*arner, 1996*). One effect of this is that relevant information gets ignored since it is never uncovered, which in turn leads to much duplication of work and effort. With the advent of computers, a great deal of thought has been given to using them to provide rapid and intelligent retrieval systems.

In principle, information storage and retrieval would be simply applied to the agency. The following is an example similar in concept to IR, in which, we can apply it by analogy to IR systems. Warner gives an example of IR as a store of documents and a person (user of the store) formulates a question (request or query) to which the answer is a set of documents satisfying the information need expressed by his question. He can obtain the set by reading all the documents in the store, retaining the relevant documents and discarding all the others. In a sense, this constitutes 'perfect' retrieval. This solution is obviously impracticable. A user either does not have the time or does not wish to spend the time reading the entire document collection, apart from the fact that it may be physically impossible for him to do so.

The purpose of an automatic retrieval strategy is to retrieve all the *relevant* documents at the same time retrieving as few of the *non-relevant* as possible. When the characterisation of a document is worked out, it should be such that when the document it represents is relevant to a query, it will enable the document to be retrieved in response to that query. Human indexers have traditionally characterised documents in this way when assigning index terms to documents. The indexer attempts to anticipate the kind of index terms a user would employ to retrieve each document whose content he is about to describe. Implicitly he is constructing queries for which the document is relevant. When the indexing is done automatically it is assumed that by pushing the text of a document or query through the same automatic analysis, the output will be a representation of the content, and if the document is relevant to the query, a computational procedure will show this (*Rijsbergen, 1999)*.

3.1.1 *A typical Information Retrieval System*

A typical IR system is shown bellow. The diagram shows three components: input, processor and output. Starting with the input side of things. The main problem here is to obtain a representation of each document and query suitable for a computer to use. Most computer-based retrieval systems store only a representation of the document (or query) which means that the text of a document is lost once it has been processed for the purpose of generating its representation. A *document representative* could, for example, be a list of extracted words considered to be significant (*Rijsbergen, 1999*).

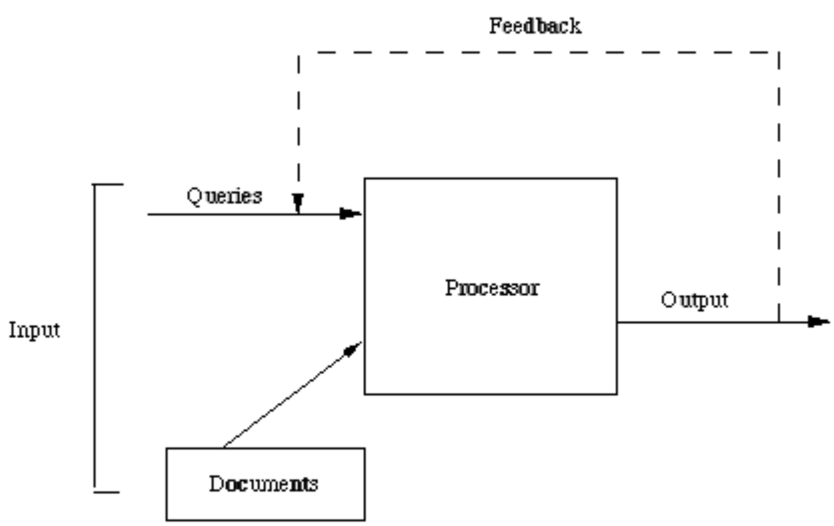

Figure 1: A typical IR system (*Rijsbergen, 1999*)

When the retrieval system is on-line, it is possible for the user to change his request during one search session in the light of sample retrieval, thereby; it is hoped, improving the subsequent retrieval run. The processor, which is the part of the retrieval system concerned with the retrieval process. The process may involve structuring the information in some appropriate way, such as classifying it.

3.1.2 *How to evaluate a specific IRS*

To figure out whether a specific IRS is performing effectively, acceptable or poorly, there is a certain criteria in which we can measure what will reflect the ability of the system to satisfy the agency's needs, which are (*Paijmans, 1997)*:

a) The *coverage* of the collection, that is, the extent to which the system includes relevant matter.
b) The *time lag*, that is, the average interval between the time the search request is made and the time an answer is given.
c) The form of *presentation* of the output.
d) The *effort* involved on the part of the user in obtaining answers to his search requests.
e) The *recall* of the system, that is, the proportion of relevant material actually retrieved in answer to a search request.
f) The *precision* of the system, that is, the proportion of retrieved material that is actually relevant.

3.2 Online analytical processing (OLAP)

Information analysis is one of the important steps in order to extract knowledge out. Such a system is recommended to our case study since we have seen in report 1 that the senior manager of the commonwealth government agency outsourced the process of recruiting 130 new staff to an external company without conduction any kind of information analysis. For example, to know if this process could be in-sourced, i.e. performed by the agencies HRM department in order to save costs, etc....

OLAP is interactive querying of data, most likely from a database; usually using a software package specifically developed to support information query. The software will usually have a range of pre-defined queries, allow queries to be developed and stored (either by query tool experts or business users), and provide for ad-hoc queries (*Carickhoff, 1997*)

It is important to distinguish the capabilities of a Data Warehouse from those of an OLAP (On-Line Analytical Processing) system. In contrast to a Data Warehouse, which is usually based on relational technology, OLAP uses a multidimensional view of aggregate data to provide quick access to strategic information for further analysis (*Forsman, 1997*).

3.2.1 *How can OLAP support Information Analysis in the Agency?*

OLAP enables analysts, managers, and executives to gain insight into data through fast, consistent, interactive access to a wide variety of possible views of information. OLAP transforms raw data so that it reflects the real dimensionality of the enterprise as understood by the user.

While OLAP systems have the ability to answer "who?" and "what?" questions, it is their ability to answer "what if?" and "why?" that sets them apart from Data Warehouses. OLAP enables decision-making about future actions (*Forsman, 1997*).

OLAP and Data Warehouses are complementary. A Data Warehouse stores and manages data. OLAP transforms Data Warehouse data into strategic information. OLAP ranges from basic navigation and browsing (often known as "slice and dice"), to calculations, to more serious analyses such as time series and complex modeling. As decision-makers exercise more advanced OLAP capabilities, they move from data access to information to knowledge (*Forsman, 1997*).

3.2.2 *Why should Managers use OLAP*

The most Important applications of OLAP is the ability to provide managers with the information they need to make effective decisions about an organization's strategic directions (to in/outsource in our case). The key indicator of a successful OLAP application is its ability to provide information as needed, i.e., its ability to provide just-in-time information for effective decision-making. This requires more than a base level of detailed data.

Just-in-time information is computed data that usually reflects complex relationships and is often calculated on the fly. Analyzing and modeling complex relationships are practical only if response times are consistently short. In addition, because the nature of data relationships may not be known in advance, the data model must be flexible. A truly flexible data model ensures that OLAP systems can respond to changing business requirements as needed for effective decision making (Pends & Creeth, 2003).

Although OLAP applications are found in widely divergent functional areas, they all require the following key features:

- Multidimensional views of data
- Calculation-intensive capabilities
- Time intelligence

3.2.6 *How can the Agency Benefits from OLAP*

Successful OLAP applications increase the productivity of business managers, developers, and whole organisations. The inherent flexibility of OLAP systems means business users of OLAP applications can become more self-sufficient. Managers are no longer dependent on IT to make schema changes, to create joins, or worse. Perhaps more importantly, OLAP enables managers to model problems that would be impossible using less flexible systems with lengthy and inconsistent response times. More control and timely access to strategic information equal more effective decision-making.

OLAP reduces the applications backlog still further by making business users self-sufficient enough to build their own models. However, unlike standalone departmental applications running on PC networks, OLAP applications are dependent on Data Warehouses and transaction processing systems to refresh their source level data. As a result, IT gains more self-sufficient users without relinquishing control over the integrity of the data (*Forsman, 1997*).

Lastly, by adopting OLAP system will not only reduce IS and IT costs for the agency but also can help employees (managers and staff) work more independently, saving time and costly resources.

3.3 Electronic Document Management Systems (EDMS)

The widespread use of computers in today's offices has dramatically increased both the volume of paper produced and the need for electronic document management. Many documents must be retained in storage for several years due to contractual or legal reasons. Older information may need regular access. The storage and retention of documents costs millions every year in office space, and searching for these documents in file cabinets consumes many valuable hours (*SAIC Company, 2003*).

In nowadays, we cannot image a successful business organization without systems that automates its paper and document work, and this implies to our case. As information increases in the agency, the demand of an effective system that could manage all of this soft information increases too.

This system could work perfectly with other suggested KMSs in this report. In which it could provide support to other basic KM systems in the agency by organistion and classifying different documents related to different departments in the agency. By that, it will serve as a repository for which any employee or staff requesting any document could find it easily saving time and effort.

3.3.1 *Features of EDMSs*

There are some basic features that should exist in a good designed EDMS. These features would assist staff will they work with such systems, which are:

• Electronic tables of contents
• Hyper-linking of related documents and text
• Secure check in check out and updates
• Version, revision, routing, and approval history log and tracking
• Automated engineering change requests, change orders, and change notifications
• Comments field to permanently capture user notes
• Online help system
• Project folders to manage all related documents
• Multi-library searching and archiving
• API calls to Interface with 3rd Party Products
• Established Tree structure (*SAIC Company, 2003*).

3.3.2 *Converting paper-based documents to paperless EDMSs*

These systems offer different solutions for data storage and electronic document management problems, including classified documents. Through improving access, saving printing costs, and improving configuration control by turning paper, film and legacy documents into compact, searchable digital data libraries accessible through Web interfaces.

Paper-based documents and microfilm products could be converted to digital media. Typical data includes customer databases, sales and accounting spreadsheets, training presentations, drawings, proposals, and corporate reports.

The form for which the digital output of the paper-based Document could take different formats, such as:

- Adobe Portable Document Format (PDF) for Web documents
- Formatting for on-screen display, including tables, spreadsheets, etc…
- Digital format for storage or CD distribution
- Publishing documents on the Internet
- Providing for Internet download or via CD-ROM

Electronic document storage and access can take many forms depending on the type which suits the agency best. An example of what a EDMSs could use fro storage :

- Servers
- Jukebox CD handler data solutions
- High speed redundant RAID storage systems

3.3.3 *Benefits of EDMSs*

EDMSs provide some benefits which could improve performance through the automation of work, such as:

- Quick, user-authenticated access to applications via the desktop
- Log and retain all users and views for each document
- Scalable and easily deployed to grow with changing system requirements
- Library management function provides administration with a single point of control for added security
- Cost-effective Internet and desktop document delivery

3.4 Artificial Intelligence (AI) & Expert Systems

These two fields of science have developed good applications in various fields and especially in the business arena. They are becoming gradually an important component in organisation's KMSs. For our case, the use of such systems could certainly improve flexibility and accuracy of work and enhance decision making for the agency's senior manager as well as to other managers, as these systems could become an integral component of any KMS in future.

Artificial Intelligence

Artificial Intelligence is a branch of Science which deals with helping machines find solutions to complex problems in a more human-like fashion. This generally involves borrowing characteristics from human intelligence, and applying them as algorithms in a computer friendly way. A more or less flexible or efficient approach can be taken depending on the requirements established, which influences how artificial the intelligent behavior appears (*Champandard, 2002*).

There are a couple of AI systems available nowadays which could exploit in our case study. In this report we will discuss one of them which suit more the situation in report1.

3.4.1 Data Mining Systems

Many data mining and search technologies have been developed to find information from various kinds of databases, including open databases like the Internet. However, no concrete management technology exists to manage the information found and make the best use of it in groups in an organization.

It is becoming a critical issue for advanced organizations to make the best use of information gathered from their database and from the Internet. Information is used to predict future trends and to make very important decision; for that they are called Decision and Support Systems (DSS). To use information, it must be organized first. Well organized information is regarded as company knowledge (*Kuwata & Yatsu, 1996*).

For example, if we want to survey *'agent technology'* on the Internet, we need to retrieve information from the Internet. Search services and index services can be used for this purpose. To make use of the information gathered, we need to organize it as knowledge. In the case of *'agent technology'*, we need to classify the technology and check the state of each class to write survey reports. The readers of the reports understand only when the information is organized (*Kuwata & Yatsu, 1996*).

Figure 2 bellow illustrates a model of the information life cycle described by Yoshitaka Kuwata and Masashi Yatsu in their paper on Managing Knowledge using a Semantic-Network. In which, there are three stages in the cycle; Finding, Organizing, and Sharing stages. In the first stage, information is found by humans. Next, it is organized and stored as knowledge to be referred. Then the knowledge is shared by members until it becomes obsolete . Organizing information at the 2nd stage turns it into knowledge. This is essential to make the best use of the information (*Kuwata & Yatsu, 1996*).

We can in analogy apply that to the Karl Popper theory in the interaction between the Three Worlds (*Popper, 1976*). The humans perceive the information, then they conceive it, and finally they state it in the form of writing (see figure 3 bellow).

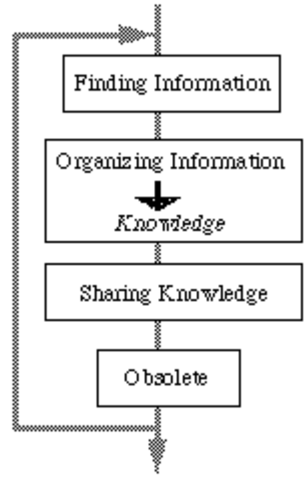

Figure 2: Information Life Cycle
(*Kuwata & Yatsu, 1996*).

This implies exactly to the KMSs case. The KMS perceives a stored or collected information then it conceives it by applying certain statements written in a specific logical language. Then it displays after it has processed the conceived information, for the employee to come an extract and comprehend this output as knowledge.

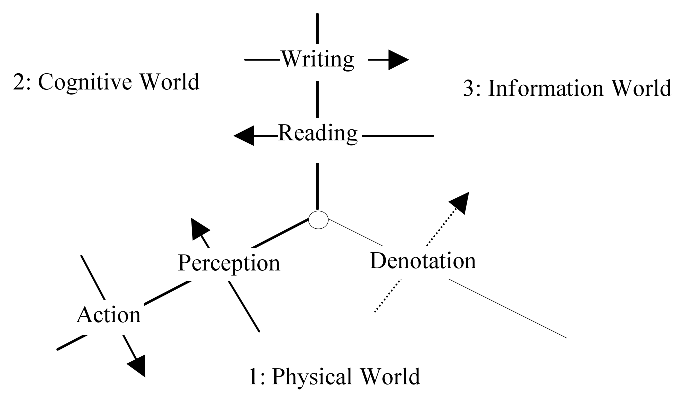

Figure 3: Interaction between the Three Worlds (*McDonald, 2001*)

3.4.2 Expert Systems

A similar KMS application similar to AI systems is Expert Systems which could also be used to facilitate knowledge management and improve decision making.

An expert system is a computing system which, when provided with a certain amount of basic information and a general set of rules instructing it how to reason and draw conclusions, can then mimic the thought processes of a human expert in a specialised field (*The Macquarie Dictionary,1998, p. 743*).

A rule-base system is one kind of expert system. Rule-base systems involve the modelling of complex or intricate rules accompanied by an engine that is able to automate the process of investigating those rules by interacting with applicants to extract relevant personal details. Rule-base systems that model legislation have two functions:

- they interrogate the user, identifying the next relevant legislative issue (closing off irrelevant paths as they go); and
- they infer conclusions, applying the structural logic of the legislation on the basis of information collected from the user (*Charles, 2002*).

Expert systems are often called knowledge-based systems, in which they try to mimic the reasoning an expert would use in order to reach conclusions in a specific area of expertise. Additionally, Expert systems improve the use of knowledge because they represent knowledge in an explicit form, using if-then rules, so that it can be applied automatically. These Rule-base systems are one element of a knowledge management framework in that they provide a means for agencies to codify and promulgate a consistent interpretation of complex rules.

3.4.2.1 *Expert Rule-Based Systems*

Expert rule-base systems have the potential to make decision-making more accurate, consistent and efficient. If we apply such a system to the problems that occurred in report 1, this will relieve the senior manager using the system on making- up his mind on the outsourcing process. Another use is in the recruitment process, as this system could help in new staff selection according to a specific criterion to be considered. After the relevant data is entered, the rule-base can identify the assistance that may be available. Rule-base system as well insures that the same interpretation of the rules will be applied in each case[20].

The use of rule-base systems fosters consistent decision-making and can also decrease the time and costs associated with making administrative decisions.

II. Soft Knowledge Management Systems

After we have discussed some suggested types of Hard Knowledge Management Systems. Next we will introduce three Soft Knowledge Management Systems that will help to resolve the problems of poor communication and interchange of information encountered in the report 1 case study.

3.5 Communities of practice (CoP)

On of the main reasons behind the chaos that occurred in the commonwealth government agency during staff recruitment were the poor communication skills which resulted in misunderstanding between the senior manager and the rest of the agency's department managers. To overcome and prevent to some extent such problems from occurring again, the commonwealth agency could apply one of the different soft knowledge management system which supports Communities of Practice (CoP).

CoPs at the simplest level, may be defined as small group of people who have worked together over a period of time. Not teams, not a task force, probably not even an authorized or identified group. People in CoPs can perform the same job (tech reps) or collaborate on a shared task (software developers) or work together on a product. They are peers in the execution of real work. What holds them together is a common sense of purpose and a real need to know what each other knows. There are many communities of practice within a single company, and most people belong to more than one of them (*Justesen, 2002*).

Managers tend to relinquish some control, allowing employees to self-organise into communities. The management defines the overall objectives, then allows the team on the ground to implement the solution based upon the better tactical information that they have to hand.

Both on-line and face-to-face networking communities are a great way of facilitating this kind of management. All of the key players including the management are placed in a collaborative framework. The management uses this to sell the big picture - the employees can then use it to respond to tactical information, share good ideas and push the process forwards. As the management are active community members they can monitor progress, give guidance and measure success.

A generic list of benefits:

- Flexible Management
- Knowledge Transfer
- Improved response times
- Decreasing the learning curve for new employees
- Reducing rework and preventing "reinvention of the wheel"
- Rapidly spawn ideas for new products and services
- Increased innovation
- Improved team work
- Improved staff retention (*Lesser& Storck, 2002*)

3.6 Virtual Communities (VC)

In essence, VC are groups of people who share similar goals and interests. In pursuit of these goals and interests, they employ common practices, work with the same tools and express themselves in a common language. Through such common activity, they come to hold similar beliefs and value systems (*efios, 2003*).

VCs are very similar in concept with CoP, yet we can distinguish between them as in VCs a group of people (staff members) with the same interest or expertise share problems and issues within a organisation exploiting Information technology without actually meeting each other face-to-face.

Virtual Communities could:

- Solve problems
- Learn about other's problems
- Stimulate involvement
- Create ideas
- Distribute knowledge across the business units
- Develop best practices[24]

Typical procedures for setting up virtual communities are:

- Create kick-off meetings (face to face) or sessions with the local members of the initial community.
- Find subject matter experts and facilitators, as well as focal points if you are working internationally and in different regions.
- Define a schedule of regular recurring face to face or telephone (conference call) meetings to complement the community.
- Make sure that all participants are aware of what information should be shared and what information should not be shared - make sure that the facilitators know how to feed and handle the information and threads discussed in the community. Educate people on the value of the 'virtual' aspect and give indications on responsiveness.
- Find a sponsor and define clearly what 'success' of the community is. Involve the sponsor regularly.
- Do not try to steer the community too much.
- Try to reward contributors / successful communities (*efios, 2003*).

Once the virtual community has been set up, there are some benefits that can come out of the community, which are:

- Web (and therefore perhaps near-ubiquitous) access
- Work across different time zones.
- Just-in-time questions and answers.
- Practitioners can get in touch with peers and share experience.

- Implicit knowledge becomes tacit.

PART 2

4. KMS Architecture

In the first part, we examined various types of KMSs introduced to produce solutions to problems encountered in report 1. This part will collect all recommended KMSs and combine them in an architecture that will serve as a guide. So if any systems goes wrong or you want to add or remove any of them, we need only to return to the designed guide (KMSs architecture) to see how that particular system may affect neighboring systems and the architecture as a whole.

For the design approach to be successful, there are important characteristics to be implemented, which are:

The knowledge management architecture must be:

- Available (if knowledge exists, it is available for retrieval)
- Accurate in retrieval (if available, knowledge is retrieved)
- Effective (knowledge retrieved is useful and correct)
- Accessible (knowledge is available during the time of need) (*Morey, 1998*).

The KMSs combinations are shown bellow in figure 4.

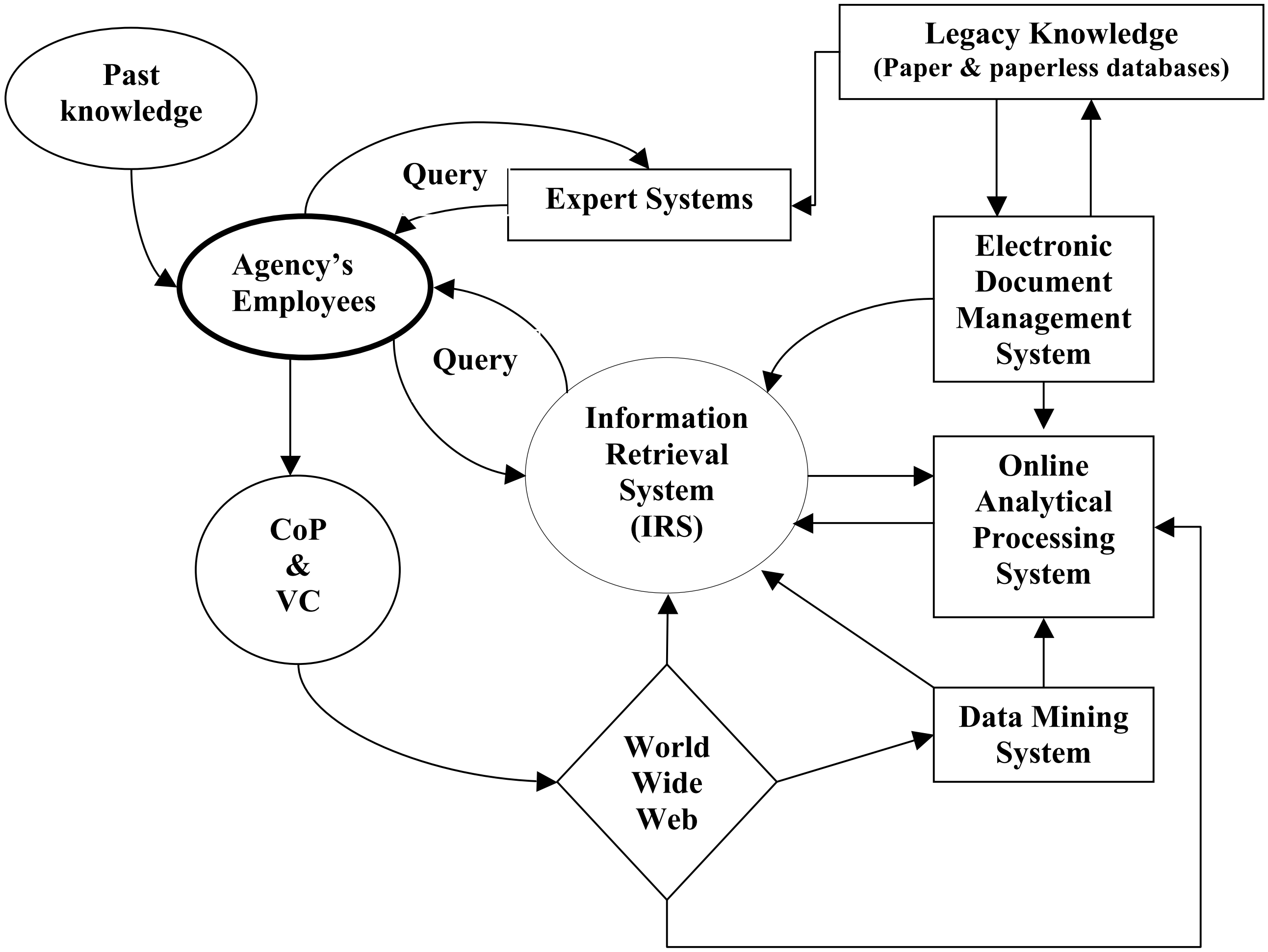

Figure 4 KMSs Design Architecture

5. Conclusion

KMSs attempt to mimic the concept proposed by Karl Popper[20] in attempting to transform the fed, stored or collected data from the physical world it resides in to its final destination which is called the information world (third world). From this, we notice that KMSs performs conception on behalf of humans (users). Popper calls the conception occurs the second or cognitive world. The second world will be responsible of processing the information then displaying it to the third (information) world as knowledge.

Next is the issue of combining these KMSs in an effective knowledge architecture which will enable any organisation to start on the path to becoming a learning organization. Effective knowledge propagates rapidly throughout the organisation. The impact of the loss of a knowledge worker is lessened. Employees begin to see that their ideas are important, and a virtuous cycle of innovation and empowerment results.

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