WEB-BASED DECISION SUPPORT SYSTEMS AS KNOWLEDGE REPOSITORIES FOR KNOWLEDGE MANAGEMENT SYSTEMS

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ABSTRACT

Problem solving and learning processes conducted on the basis of contemporary Web-based DSS provide for development and enhancement of knowledge management systems. Knowledge objects form the foundation of the conceptual approach to the knowledge management based on the contemporary Internet technologies and knowledge accumulated in DSS.

Keywords: knowledge management systems, decision support systems.

1 INTRODUCTION

Knowledge management (KM) has become an important theme as managers realize that much of their firm's value depends on ability to create and manage knowledge. To transform information into knowledge a firm must use additional resources to discover patterns, rules, and context where the knowledge works [1-3].

Knowledge that is not shared and applied to the practical problems does not add business value. Today people can share their knowledge in three primary ways. Organizational information systems (IS) that store, manage, and deliver documents are called content management systems (CMS). With the arrival of modern communications technology, people can share their knowledge via collaborating knowledge management systems (KMS). In addition to content management and collaboration, the knowledge can be shared via expert systems. Comprehensive discussion of important dimensions of knowledge, the knowledge management value chain, and types of KMS can be found in [2, 3].

Web 2.0 companies use the Web as a platform to create collaborative, community-based sites (e.g., social networking sites, blogs, wikis, etc.). The Web has now become an application, development, delivery, and execution platform [4].

Software as a Service (SaaS) - application software that runs on a Web server rather than being installed on the client computer – has gained popularity, particularly with businesses. Collaborating on projects with co-workers across the world is easier, since information is stored on a Web server instead of on a single desktop.

Rich Internet Applications (RIAs) are Web applications that offer the responsiveness, "rich" features and functionality approaching that of desktop applications. RIAs are the result of today's more advanced technologies (such as Ajax) that allow greater responsiveness and advanced GUIs.

Web services have emerged and, in the process, have inspired the creation of many Web 2.0 businesses. Web services allow you to incorporate functionality from existing applications and Web sites into your own applications quickly and easily.

Web 2.0 companies use "data mining" to extract as much meaning as they can from XHTML-encoded pages. XHTML-encoded content does not explicitly convey meaning, but XML-encoded content does. So if we can encode in XML (and derivative technologies) much or all of the content on the Web, we'll take a great leap forward towards realizing the Semantic Web.

Many people consider the Semantic Web to be the next generation in Web development, one that helps to realize the full potential of the Web – the "Web of meaning". Though Web 2.0 applications are finding meaning in the content, the Semantic Web (heavily depended on XML and XML-based technologies) will attempt to make those meaning clear to computers as well as humans [5].

These trends in the Web Science – the new science of decentralized information systems – provide for new opportunities in the KM.

In this paper we consider contemporary Decision Support Systems (DSS) as knowledge repositories that can be expanded to KMS using the Web 2.0 software development technologies and tools. This paper is based on a series of previous authors' publications [6-11].

2 KNOWLEDGE MANAGEMENT AND DECISION SUPPORT SYSTEMS

The AI representation principle states that once a problem is described using an appropriate representation, the problem is almost solved. Well-known knowledge representation techniques include rule-based systems, semantic nets and frame systems [12].

KM refers to the set of business processes developed in an organization to create, store, transfer and apply knowledge. KM increases the ability of the organization to learn from its environment and to incorporate knowledge into business processes. There are three major categories of KMS: enterprise-wide KMS, knowledge work systems (KWS), and intelligent techniques [2, 3].

Enterprise-wide KMS are general purpose, integrated, firm-wide efforts to collect, store, disseminate, and use digital content and knowledge. Such systems provide databases and tools for organizing and storing structured and unstructured documents and other knowledge objects, directories and tools for locating employees with experience in a particular area, and increasingly, Web-based tools for collaboration and communication.

KWS (such as computer-aided design, visualization, and virtual reality systems) are specialized systems built for engineers, scientists, and other knowledge workers charged with discovering and creating new knowledge for a company.

Diverse group of intelligent techniques (such as data mining, neural networks, expert systems, case-based reasoning, fuzzy logic, genetic algorithms, and intelligent agents) have different objectives, from a focus on discovering knowledge (data mining and neural networks), to distilling knowledge in the form of rules for a computer program (expert systems and fuzzy logic), to discovering optimal solutions for problems (genetic algorithms).

It is said that effective KM is 80% managerial and organizational, and 20% technology. One of the first challenges that firms face when building knowledge repositories of any kind is the problem of identifying the correct categories to use when classifying documents. Firms are increasingly using a combination of internally developed taxonomies and search engine techniques.

Organizations acquire knowledge in a number of ways, depending on the type of knowledge they seek. Once the corresponding documents, patters, and expert rules are discovered they must be stored so they can be retrieved and used. Knowledge storage generally involves databases, document management systems, expert systems, etc. To provide a return on investment, knowledge should become a systematic part of the organizational problem solving process. Ultimately, new knowledge should be built into a firm's business processes and key application systems.

KMS and related knowledge repositories should facilitate the problem solving process (Figure 1). During the process of solving problems managers engage into decision making, the act of selecting from alternative problem solutions.

The different levels in an organization (strategic, management, and operational) have different decision-making requirements. Decisions can be structured, semi-structured or unstructured. The structured decisions are clustered at the operational level of the organization, and unstructured decisions at the strategic level.

Management information systems (MIS) provide information on firm performance to help managers monitor and control the business, often in the form of fixed regularly scheduled reports based on data summarized from the firm's transaction processing systems (TPS). MIS support structured decisions and some semi-structured decisions.

DSS combine data, sophisticated analytical models and tools, and user-friendly software into a single powerful system that can support semi-structured and unstructured decision making [3, 13, 14].

The main components of the DSS are the DSS database, the user interface, and the DSS software system (Figure 2). The DSS database is a collection of current data from a number of applications and groups. Alternatively, the DSS database may be a data warehouse that integrates the enterprise data sources and maintains historical data.

The DSS user interface permits easy interactions between users of the system and the DSS software tools. Many DSS today have Web interfaces to take advantages of graphics displays, interactivity, and ease of use.

The DSS software system contains the software tools that are used for data analysis. It may contain various OLAP tools, data mining tools, or a collection of mathematical and analytical models that easily can be made accessible to the DSS users.

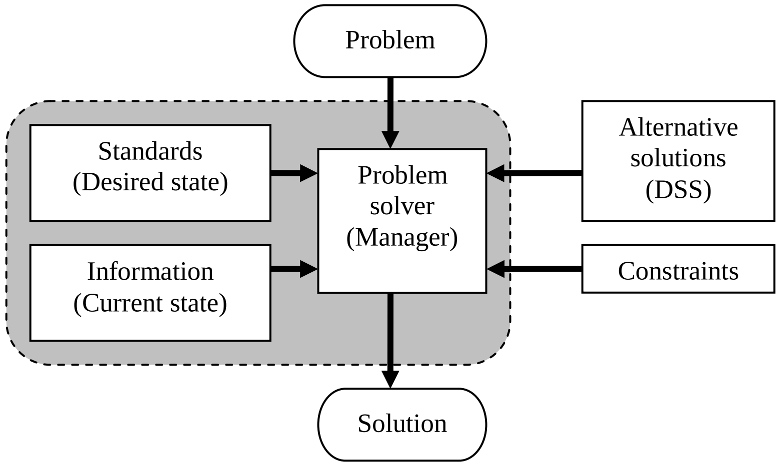

Figure 1: Elements of the problem solving process.

The dialog manager is also in charge for the information visualization. Finally, access to the Internet, networks, and other computer-based systems permits the DSS to tie into other powerful systems, including the TPS or function-specific subsystems.

There are many kinds of DSS. The first generic type of DSS is a Data-Driven DSS. These systems include file drawer and management reporting systems, data warehousing and analysis systems, Executive Information Systems and Spatial DSS. Data-Driven DSS emphasize access to and manipulation of large databases of structured data and especially a time-series of internal company data and sometimes external data. Relational databases accessed by query and retrieval tools provide an elementary level of functionality. Data warehouse systems that allow the manipulation of data by computerized tools tailored to a specific task and setting or by more general tools and operations provided additional functionality. Data-Driven DSS with Online Analytical Processing (OLAP) provide the highest level of functionality and decision support that is linked to analysis of large collections of historical data.

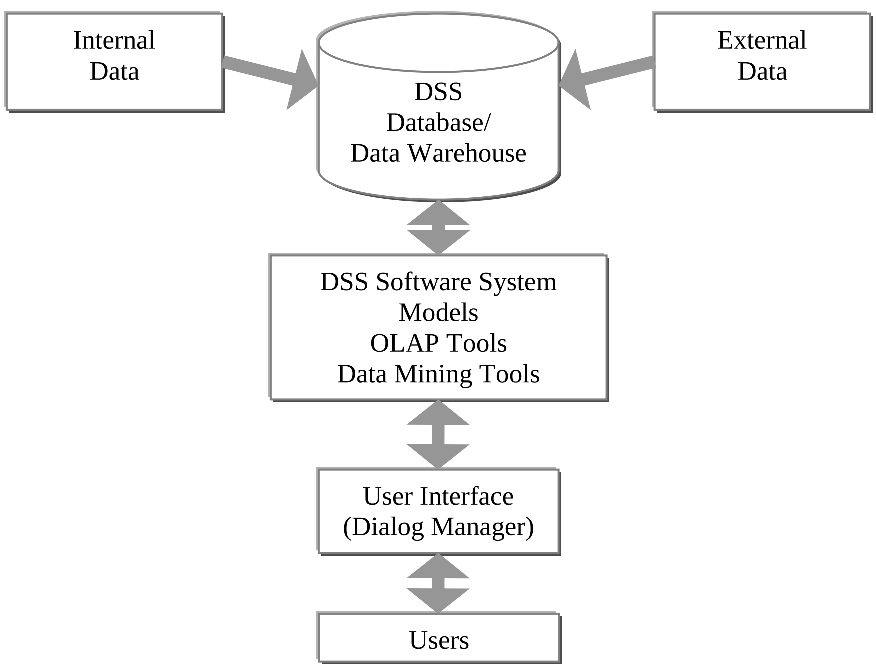

Figure 2: Main components of the DSS.

A second category, Model-Driven DSS, includes systems that use accounting and financial models, representational models, and optimization models, and optimization models. Model-Driven DSS emphasize access to and manipulation of a model. Simple statistical and analytical tools provide an elementary level of functionality. Some OLAP systems that allow complex analysis of data may be classified as hybrid DSS providing modeling, data retrieval, and data summarization functionality. Model-Driven DSS use data and parameters provided by decision-makers to aid them in analyzing a situation, but they are not usually data intensive. Very large databases are usually not needed for Model-driven DSS.

Knowledge-Driven DSS or Expert Systems can suggest or recommend actions to managers. These DSS are human-computer systems with specialized problem-solving expertise. The expertise consists of knowledge about a particular domain, understanding of problems within that domain, and skills at solving some of these problems (AI algorithms and solutions can be used). A related concept is data mining. It refers to a class of analytical applications that search for hidden patterns in a database. Data mining is the process of sifting through large amounts of data to produce data content relationships. Tools used for building Knowledge-Driven DSS are sometimes called Intelligent Decision Support methods.

Document-Driven DSS are evolving to help mangers retrieve and manage unstructured documents and Web pages. A Document-Driven DSS integrates a variety of storage and processing technologies to provide complete document retrieval and analysis. WWW provides access to large document databases including databases of hypertext documents, images, sounds and video. Examples of documents that would be accessed by Document-Driven DSS are policies and procedures, product specifications, catalogs, and corporate historical documents, including minutes of meetings, corporate records, and important correspondence. Search engines are powerful decision-aiding tools associated with Document-Driven DSS.

Group DSS (GDSS) came first, but now a broader category of Communications-Driven DSS or groupware can be identified. These DSS includes communication, collaboration and related decision support technologies. These are hybrid DSS that emphasize both the use of communications and decision models to facilitate the solution of problems by decision-makers working together as a group. Groupware supports electronic communication, scheduling, document sharing, and other group productivity and decision support enhancing activities.

A DSS model that incorporates Group Decision Support, OLAP, and AI is shown on Figure 3.

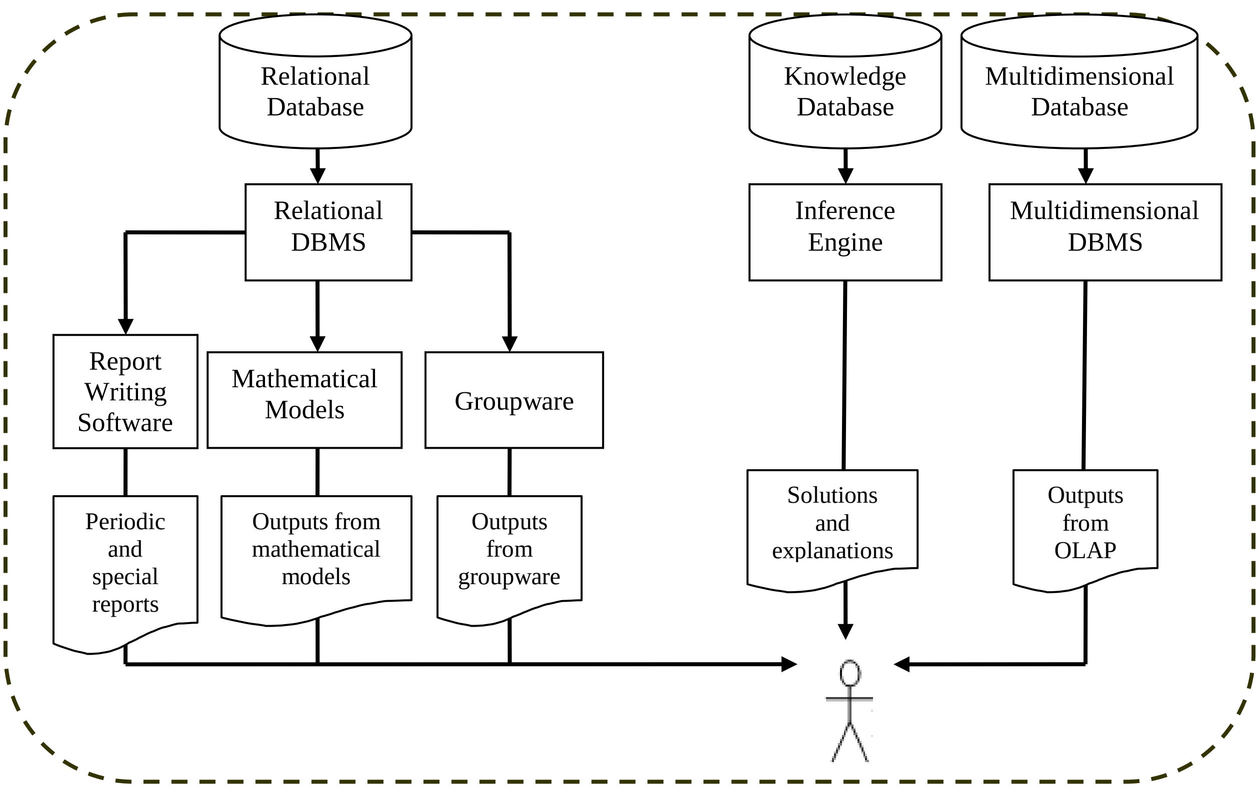

Figure 3: A DSS model that incorporates GDS, OLAP, and AI.

DSS facilitate the decision-making. Decision making is an integrated part of the overall problem solving process. KMS should facilitate the problem solving process. In the next section we are going to discuss how Web-enabled DSS can be integrated into contemporary KMS.

3 WEB-ENABLED DECISION SUPPORT SYSTEMS

All types of DSS can be deployed using Web technologies and can become Web-based DSS. Managers increasingly have Web access to data warehouses and analytical tools. To discuss the recent trends in this area the latest achievements in the three-layer design, Rich Internet Applications (RIA), and Web services should be taken into account.

Three-layer design is an effective approach to development robust and easy maintainable systems. The corresponding architecture is appropriate for systems that need to support multiple user interfaces. Contemporary Web applications are three-layer applications.

The most common set of layers includes the following:

- Data layer that manages stored data, usually in one or more databases.
- Business logic (domain) layer that implements the rules and procedures of the business processing.
- View layer that accepts input and formats and displays processing results.

RIA have two key attributes – performance and rich GUI. RIA performance comes from Ajax (Asynchronous JavaScript and XML), which uses client-side scripting to make Web applications more responsive by separating client-side user interaction and server communication, and running them in parallel. Various ways to develop Ajax applications are discussed in [5].

Web services promote software portability and reusability in applications that operate over the Internet. Web service is a transition to service-oriented, component-based, distributed applications. Web services are applications implemented as Web-based components with well-defined interfaces, which offer certain functionality to clients via the Internet. Once deployed, Web services can be discovered, used/reused by consumers (clients, other services or applications) as building blocks via open industry-standard protocols. Web service architecture is built on open standards and vendor-neutral specifications. Services can be implemented in any programming language, deployed and then executed on any operating system or software platform.

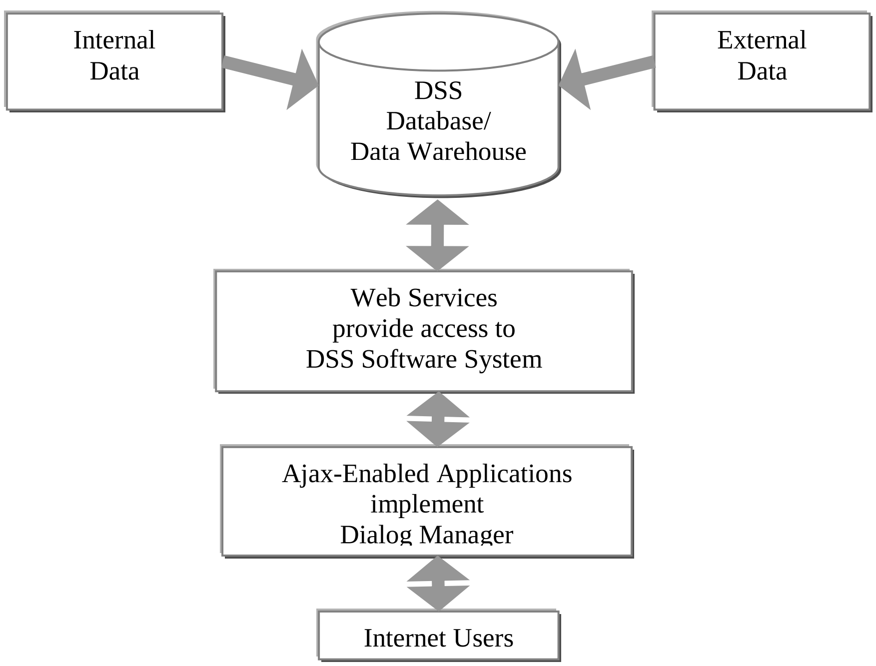

Figure 4: Web-enabled DSS.

The service-oriented architecture (SOA) provides the theoretical model for all Web services. The model behind Web services is a loosely coupled architecture, consisting of different software components working together. Consuming Web services is based on open standards managed by broad consortia (e.g., World

Wide Web Consortium, Organization for the Advancement of Structured Information Standards, Web Services Interoperability Organization).

What makes Web services different from ordinary Web sites is the type of interaction that they can provide. Most of the enthusiasm surrounding Web services is based on the promise of interoperability. Every software application in the world can potentially talk to every other software application. This communication can take place across the old boundaries of location, operating system, language, protocol, and so on.

Three-layer architecture maps well on the structure of main components of the DSS (see Figure 2). RIA provide for efficient implementation of the Dialog Manager GUI for DSS. Web services allow incorporating functionality from existing applications and due to this providing for access to the DSS Software System through the SOA. The components of the Web-enabled DSS are shown on Figure 4.

We can call a group of the following related components a knowledge object (Figure 5). Discussed techniques allow to create new Web services (based on the existing ones and contemporary DSS software systems), and Ajax-enabled application interacting with these Web services. So we can talk about creation and modification of the knowledge objects.

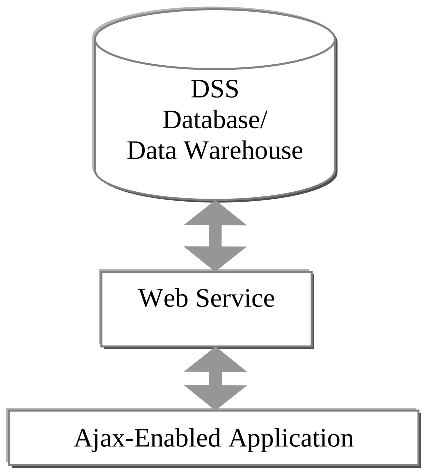

Figure 5: Structure of a knowledge object.

Web-enabled DSS provide for expandable collections of the knowledge objects that constitute the knowledge repository of the corresponding KMS. From this point of view the knowledge objects can be considered as a knowledge representation technique.

4 PROBLEM SOLVING AND LEARNING

AI distinguishes two general kinds of learning. The first kind is based on coupling new information to previously acquired knowledge. Typical examples include learning by analyzing differences, by managing multiple models, by explaining experience, and by correcting mistakes. The second kind is based on digging useful regularity out of data; a practice often refers as data mining. Typical examples include learning by recording cases, by building identification trees, by training neural nets, by training perceptrons, by training approximation nets, and by simulation evolution (e.g. genetic algorithms).

Expert systems primarily capture the tacit knowledge of individual experts, but organizations also have collective knowledge and expertise that they have built up over the years. This organizational knowledge can be captured and stored using case-based reasoning (CBR). In CBR description of the past experiences of human specialists, represented as cases, are stored in a database for the later retrieval when the user encounters a new case with similar parameters. The system searches for stored cases with problem characteristic similar to the new one, finds the closest fit, and applies the solution of the old case to the new case. Successful solutions are tagged to the new case and both are stored together with the other cases in the knowledge base. Unsuccessful solutions are also appended to the case database along with explanations as why the solutions did not work.

Problem-based learning (PBL) is (along with active learning and cooperative/collaborative learning) one of the most important developments in contemporary higher education. PBL is based on the assumption that human beings evolved as individuals who are motivated to solve problems, and that problem solvers will seek and learn whatever knowledge is needed for successful problem solving. PBL is a typical example of an application of the first type of learning in higher education [11].

Combining the main ideas of CBR and PBL the following problem solving and learning process can be depicted as it's shown on Figure 6.

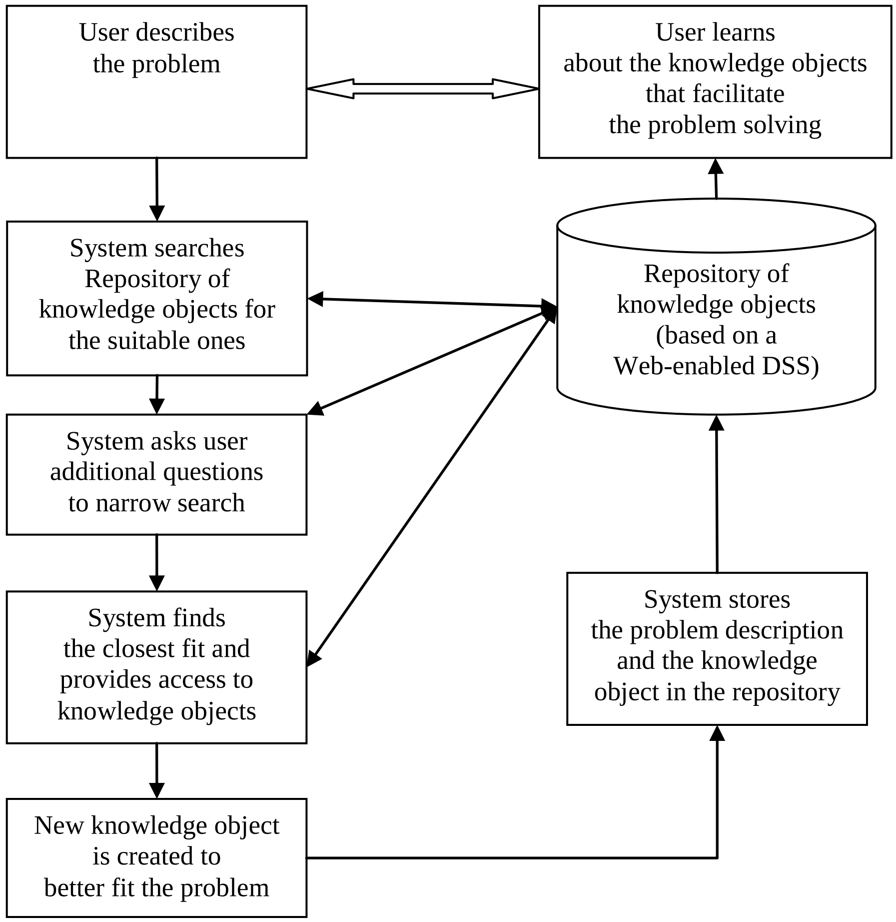

Figure 6: Problem solving and learning with knowledge objects.

5 CONCLUSIONS

Knowledge is a complex phenomenon, and there are many aspects to the process of managing knowledge. Knowledge-based core competencies of firms are key organizational assets. Knowing how to do things effectively and efficiently in ways that other organizations cannot duplicate is a primary source of profit and competitive advantage that cannot be purchased easily by competitors in the marketplace.

This paper discusses Web-enabled DSS, related knowledge repositories, and KMS that facilitate the problem solving and learning. The knowledge objects approach to the knowledge representation allows considering contemporary DSS as integrated parts of the corresponding KMS.

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