An Architecture of Decision Support System Model Based on Knowledge Management

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Abstract

Knowledge management is the new phrase of modern enterprise management theory and it challenges the traditional information management, which can no longer fulfill the needs of knowledge management. This paper analyzes the position and functionality of decision support system based on the knowledge management, puts forward a logical architecture: Decision Support System Model Based on Knowledge Management, and gives an analysis and evaluation of its key technologies.

Keywords: Knowledge Management, Decision Support System, Ontology, Data Warehouse

1. Introduction

Decision Support Systems (DSS) are a class of information computerized system that supports decision-making activities. DSS are interactive computer-based systems and subsystems intended to help decision makers use communications technologies, data, documents, knowledge and/or models to complete decision process tasks. A basic decision support system usually consists of four components: the language system, presentation system, knowledge System for knowledge representation, and problem processing system that uses these representations in recognizing/solving problems. And there are six types of knowledge: the descriptive (informed) knowledge, procedural (skilled) knowledge, reasoning (expert) knowledge, linguistic knowledge that comprehension of incoming enables messages. presentation knowledge that enables the production of outgoing messages, and assimilative knowledge controlling what enters the knowledge store and what its impact is, the structure of the store, and its efficiency [7].

In [6], the authors proposed a prototypical architecture of knowledge-based decision support system for insurance tasks based on three kinds of knowledge representation formalisms: logical-based, deduction rules, and constraint satisfaction.

Wang [8] proposed an Ontology-Domain-System (ODS) approach based on an ontology model which characterizes the overall knowledge relevant to the domain using a combination of UML (Unified Modeling Language) and the OCL (Object Constraint Language) to specify the ontology model, a domain model and a system model, a domain model which describes the information relevant to system building for the domain, and a system model which instantiates the domain model for a specific system.

In [9], the authors proposed a meta-class based approach to behavior integration, which can be described through the OMG Meta Object Facility (MOF) since it has been integrated into UML and fits the nature of the object lifecycle view that they identified as their preferred angle for high level behavior descriptions.

2. Relationship between Knowledge Management and Decision Support System

2.1 Knowledge Management

With the changes in social economic model, people have come to the deeper and more direct perception of knowledge which plays a decisive role in the MRO (Maintenance, Repair, and Operations) products and have increased the value of labor. Knowledge management has been placed in an important position of organization management in the 21st century and advocated realizing the knowledge sharing and innovation in order to increase organizations' ability to deal with the contingency by applying the collective wisdom and thus to enhance the competitive advantages. Information, knowledge and wisdom are distinctive concepts. Information can be regarded as the encoding of the experiences and historical knowledge which is static. Knowledge is regarded as the totality of explicit and implicit knowledge for recognizing the world. It is a product and also a process. And wisdom is regarded as a dynamic process of knowledge innovation by applying the knowledge to the knowledge, which is also stressed on in the field of knowledge management. Not only the knowledge but the wisdom is mandatory to knowledge management. In the aspect of microcosmic, the essence of knowledge management in an enterprise is to manage the knowledge chain so as to increase constantly the value of knowledge in the course of knowledge exercising. In order to manage the knowledge effectively and efficiently, an enterprise must set up a proper knowledge management system.

2.2 Challenges of Knowledge Management over Traditional Information Management

Although both information and knowledge management are the outcome of the development of modern information technology, the latter is in a new stage of modern management, gradually taking the place of the former - keeping what is useful or beneficial and discarding what is not in the traditional information management. Information management focuses on the development of technology and information, stresses the importance of explicit instead of implicit knowledge, and emphasizes on the outcome instead of the process of production and the physical and linear factors instead of the occasional and non-linear factors. Knowledge management overcomes the defects of information management and focuses on the collaboratively learning ability and creativity. Therefore, many companies set up a position of CKO (Chief Knowledge Officer) in addition to CIO (Chief Information Officer). CKO undertakes two kinds of work: (1) to propose the architecture of knowledge, including the classification of knowledge (explicit and implicit knowledge), the design of a operating environment based on the knowledge and a managing procedure related to the knowledge-intensive business in order to prevent the drain on the knowledge; (2) to organize and implement the knowledge management, including the provision of technical support and communication environment.

2.3 Position of Modern Decision Support System in Knowledge Management

The barriers on implementing knowledge management system are two-folds: the organizational mechanism and technological maturity. The former is related to the right of the organization, the relationship of contracts, the functionality of management and etc. The latter mainly exists in the domain of organization. Due to the informational constant. time-independent and region-independent exchange and storage of the information participated by a group and the complex and non-structured intrinsic of knowledge management computer and knowledge management experts have developed a variety of technology and methods. Meanwhile, the complexity of technology has also caused a rise in cost, which affects the really prosperous development of knowledge management. Therefore, the essence of the barrier on the technology of knowledge management is: how to cope with the complicated semi-structured or non-structured problems arisen in the course of knowledge management system.

DSS (Decision Support System) provides the services to the management decision-makers who deal with semi-structured or non-structured problems. The fundamental aim of DSS is to improve the quality of decision through the unification of individually mental resources and the computer's processing capability. The application of DSS fuses the excellent management ideas in order to provide an efficient methodology for enterprises to analyze and resolve their business problems. The enterprise must firstly unify their management thinking, promote the management awareness, and draw clearly up the management goals accomplished through DSS. And only then they can conduct the business practices of DSS implementation. Modern enterprise knowledge management can benefit much from DSS [1] as follows:

(1) Fast calculating: DSS allows the decision makers to carry out mass calculations at the highest speed and lowest cost (the human resource cost of the high level management is usually high) and make timely decisions which is critical in many business practices such as stock exchange, marketing strategy and etc.

(2) Conquering the human limit in the access and processing of information: Human's mind is restricted by the ability of handling and storing information. Human being could not be able to memorize all the information without a mistake at time.

(3) Cognition limit: The ability to resolve the problems by an individual is restricted when a variety of knowledge and information are needed. In this case, group cognition will be helpful. However, the problems of coordination and communication within the group occur. And DSS can not only help people find and process mass stored information but reduce the problems of coordination and communication occurred among the group members.

(4) Cutting down the expense: It's costly to gather the decision makers of a group, especially the experts. By contrast, the computerized system support can cut the group size and allow the group members to communicate across the different places (saving the traveling expenses). In addition, it can increase the productivity and lower the cost of the supporting staff (e.g. financial and law analysts), whose support is mandatory for making decisions.

(5) Information support: Through DSS, the management can attain the correct, timely, and latest information to make decisions. Data can be stored in different databases within and outsides of the organization and may include the sounds and pictures, which must be transmitted quickly and fast from far away. The computer system can query, access, and transmit the needed information fast and economically.

(6) Quality support: DSS can improve the quality of decision. For instance, it can evaluate more alternatives, make quickly risk analysis and collect experts' opinions fast at the lowest cost (these experts can be in different places). Much of expertise can even be derived through the computer system. With the system, decision-makers can carry out the complex simulation, check every possible situation and evaluate fast and economically different effects. And all of these will result the better decisions.

(7) Knowledge discovery and sharing [2]: By building the enterprise data warehouse and performing the data mining and statistical analysis based on the data warehouse, the concealed knowledge about the enterprise can be found and the access, update, improvement, use and feedback of knowledge can also be exercised through the excellent knowledge management system designed based on DSS. DSS can realize efficiently, securely, uniformly, and collaboratively the management and maintenance of knowledge through the reasonable definition of business process, organization structure, and employee relationship.

2.4 Decision Support System Model Based on Knowledge Management

The data and information of DSS is the main source of knowledge and the unique effect of knowledge management in knowledge innovation, dissemination and sharing will promote and complement soundly the functionality of management decision of DSS. The authors propose a new architecture: Decision Support System Model [3] based on Knowledge Management as shown in Figure 1, which integrates the decision support system with knowledge management system.



Figure1. Decision Support System Model Based on Knowledge Management

The bottom level is the fundamental supporting environment for the information infrastructure of an enterprise, including the acquirement of Intranet information about the process of different aspects of MRO (Maintenance, Repair, and Operations) products and operation management system within the enterprise, Internet information outside the enterprise, and the data and information derived from ERP, CRM, and etc. adopted by the enterprise. The interaction of the three systems realizes the thought of Intranet. And through the design and implementation of excellent Internet information acquisition tool, the usefully external information can be employed effectively to serve the internal management within the enterprise and thus help the enterprise seize the better opportunities and challenges of the market. The middle level is the multi-dimensional data warehouse of the enterprise. The enterprise's information resources existing in the information support environment on the bottom level are multifarious, disorderly, and vast. The enterprise needs to discover the valuable models and knowledge and organize further,

tightly, and scientifically so as to support beneficially the implementation of knowledge management. The top level is the decision support system based on knowledge management to support better the work flow of the business process of enterprise on each level, including as follows:

(1) The process of the mining of data warehouse and the fusion of individual knowledge between the employees and data warehouse is applied to fulfill the entire process of data warehouse, including the knowledge discovery and knowledge extract based on the constant needs of employee and the constant fusion of individual knowledge of employee and the data warehouse.

(2) The process of knowledge transferring and sharing among the employees provides the possibility of knowledge sharing and intersection among the different set of knowledge discovery and, in the meanwhile, the opportunity of communication and interaction of the non-structured individual knowledge that could not be presented in the data warehouse of enterprise, thus innovative knowledge might be brought out.

(3) The process of individual knowledge support and information feedback are regarded as the employee' operating procedures under the instruction of individual knowledge platform and the process of information feedback of operating outcome. The full utilization of the process can gather information feedback in real time and provide a mandatory foundation for the flawlessness and the control in a closed knowledge management system.

(4) To support the decision process of high-level management through the establishment of decision-making model and the employment of advanced system theory and radically determine and lead the evolving process of enterprise's development.

From the analysis above, we can see the course of the vertical knowledge extract within an enterprise, the dispersion and fusion between the employee's knowledge and knowledge management system, the interaction, intersection, and growth among the employee's knowledge in their working environment and the knowledge updating process of the employees in the loop of enterprise information management. This is an implementation of the logical model of knowledge management system.

3. Key Issues of Implementing Decision Support System Model Based on Knowledge Management

3.1 Knowledge Description

3.1.1 Knowledge description based on ontology [4]

There are three kinds of technologies employed for knowledge sharing: KQML (Knowledge Query Manipulation Language), KIF (Knowledge Interchange Format), and shared Ontology.

KQML is defined for exchanging information and knowledge and for an application program to interact with intelligent systems in order to share knowledge in support of cooperative problem solving. It also focuses on an extensible set of performatives to define the permissible operations that agents may attempt on each other's knowledge and goal stores and provides a basic architecture for knowledge sharing through communication facilitators which coordinate the interactions of other agents. And the performatives comprise a substrate on which to develop higher-level models of inter-agent interaction through the contract nets and negotiation.

KIF is a computer-oriented language for the interchange of knowledge among disparate programs and provides for the representation of knowledge & non-monotonic reasoning rules and the definition of objects, functions, and relations. It is logically comprehensive in the first-order logic and has declarative semantics understood without appeal to an interpreter for manipulating those expressions.

Ontology is a specification of a conceptualization, a description of the concepts and relationships for agents, and used to define the common vocabulary so as to support the sharing and reuse of formally represented knowledge for a shared domain of discourse, including definitions of classes, relations, functions, and other objects.

In philosophy, ontology means the origin of a thing. In computer science and the related fields, it refers to the basic method of applying the theory of ontology, i.e., the theory and method of abstracting a set of concepts and the relationship among those concepts from the entities in the real world through the conceptual analysis and model building. The theory of ontology has been the key research topic in the field of artificial intelligence since 1990s. The ontology model provides the common representation for knowledge sharing in a problem domain and the knowledge can be exchanged and understood in a heterogeneous environment of computer system.

Ontology can be classified into two categories: domain ontology and information ontology. The former is employed to express the definition of information services for a business domain and the mandatory description of the business process. The latter is employed to express the model of service content and user's interest (or constraint). In an interactive transaction, the process of transaction and the data involved in the transaction can be expressed by means of domain ontology and information ontology, respectively.

3.1.2 Ontology and decision support

The purposes of using ontology system are usually to provide the capability of knowledge employment in the database, promote the ability of knowledge sharing in the complicated system and database, and assist us in understanding and employing the terminology of a specific domain more efficiently and reaching the agreements in domain knowledge. Generally speaking, the ontology system is usually constructed by the soundly knowledge engineers who have the understanding of a specific domain and employ the concept of artificial intelligence to describe the goal, property, and internal interaction within the system. And the concepts are also used to define an entire domain by employing the PL (Predicate Logic), FOL (First Order Logic), and domain axiom. And the domain axiom is applied to the reference engine and become the source of knowledge reasoning and foundation of decision support.

3.2 Building Flawless Database and Data Warehouse

Knowledge management is to solve two main problems: the communication and the decision. The latter means to make quick response to the constantly changing market by utilizing all the information based on the flawless data, data warehouse, and decision support system which are grasped by the enterprise.

3.2.1 To ensure the data quality

Data are extracted and transformed before loading into the data warehouse. To affirm the data possessed by the company is mandatory in order to compile a data dictionary for the company which is similar to compiling the capital assets of a company. A fine company needs a catalogue of all its information data. It's a critical step of knowledge management to have the information be regarded as the important assets and have them be controlled strictly.

3.2.2 To affirm the scope and the form of data needed to deal with decision support

The main reason that most projects of data warehouse fail is the vague definition of demand in addition to the poor support from the high level management. An explicit demand analysis is the key to a successful data warehouse and used to evaluate the success of a project. During the phase of demand analysis the enterprise management is also urged to take active participation in and reconsider how to solve the business problems through the use of data.

3.2.3 To select proper technology platform to realize the prototype of the data warehouse [5]

Make sure that the investment on the technology platform is not too high and the integration of the system is able to cover each stage of the data warehouse construction. The project of the data warehouse is an engineering process relied closely on the confidence of the management. If the initial investment is too high and the desired results defer due to the fast change of enterprise's demand in one hand and it will lower the implementation confidence of enterprise management on the other hand. If the methodology of fast development is adopted, the users can be informed of the functions of the system and indicate timely the defects of the system. This interactive process is also helpful to promote the participating extent of and gets more support from the user and thus increases the successful rate of the project.

3.2.4 To coordinate and collaborate work with the aid of the information department of enterprise and experienced consultants

There exists experienced information technology employees in many enterprises but the benefits which can be gained with the aid of professional consultants are usually ignored. In fact, the effect of the professional consultants in a successful data warehouse project cannot be neglected. To the information technology employees, data warehouse is a brand new application type and the advantages of it is that the information technology employees within the enterprise can understand better the internal data structure despite of the disadvantage of their lack of experiences in implementing the data warehouse which is the expertise of the consultants. The collaboration of the two kinds of experts can promote the success of the project and avoid a detour in the project implementing at the same time.

3.2.5 After the prototype of the system is finished, it comes to the operating stage of conducting a business practice

Through the feedback of users the functionality of system can be improved constantly. In the meanwhile through the analysis of the operating performance of the system, the bottleneck of it can be found so as to enhance a highly efficient and beneficial data warehouse system which can, then, undertake really the core function of enterprise decision support.

4. Conclusion

Knowledge management is the new phrase of modern enterprise management theory and it challenges the traditional information management theories of which can no longer fulfill the needs of knowledge management in enterprises. This paper analyzes the position and functionality of decision support system based on knowledge management, puts forward a logical model of decision support system based on knowledge management, gives an analysis and evaluation of its key technologies to enhance a highly efficient and beneficial data warehouse system, and undertakes the core function of enterprise decision support.

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