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DEVELOPMENT OF KNOWLEDGE MANAGEMENT SYSTEMS ON THE BASIS OF UNIFIED ONTOLOGICAL KNOWLEDGE BASE

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Creation of knowledge management system on the basis of a united model of knowledge organisation described in the form of the system of ontologies supplement each other is suggested. The base organization ontology and a set of ontologies of knowledge fields are included in the system. The construction variant of such model of knowledge is described and structure of knowledge control system on its basis is suggested.

Knowledge management systems

Knowledge is the important resource of modern organizations, and efficiency of their activity depends to a considerable degree on management of working process with all kinds of knowledge, i. e. on knowledge management [1, 2]. Knowledge management is carried out using both organizational and technological means. The technological component of knowledge management is knowledge management system (KMS) – the information communication system, combining and integrating processing of both explicit and hidden knowledge of organization. KMS supports the workers' network in their activity in creation, acquisition, saving, estimation, structurization, visualization, distribution, search and application of knowledge.

In the given paper the KMS is suggested to be created on the basis of ontology-semantic approach using unified ontological knowledge base and description all the elements of organization knowledge in it.

Organization knowledge

The term knowledge is widely used, but often rather indistinctly, in the environment of organization managers and experts of information management. There is large amount of definitions for this term, having different origin and in different context. One of the most widely used definition of knowledge, from the managers' point of view is the following one: «Knowledge is a combination of data and information, to which opinions, skills and experts experience are added, that as a result gives valued asset, which may be used at making decisions. Knowledge may be explicit (formalized) and/or hidden (nonformalized), individual and/or collective» [2]. So organization knowledge (or content of organizational memory), is set in people heads, in different physical entities, for example, in such as printed materials, audio and video materials, multimedia instruments, and also in various objects of information system, for example, programs, electronic documents, multimedia files, data base. All these elements are the objects of knowledge (OK), i. e. specific pieces of information, which are interrelated to each other and help in solving of organization tasks at their proper application.

All these objects are interconnected in complex way in knowledge system (KS), which effective use creates competitive advantages of organization. Therefore, knowledge management should influence working processes with these complex interrelations and systems, and improve their using.

All knowledge is also may be divided into declarative and procedural. Declarative (statistic) knowledge is well described by the complex system of concepts and relations between them (semantic systems, frames, ontologies). Procedural knowledge describes the order of works execution and has closer connection with organization activity, but their formal description is difficult. However, the procedural knowledge may be indexed rather well with using declarative knowledge that allows creating the uniform system of both declarative and procedural knowledge description.

To determine the structure of interconnection between the elements of organization knowledge it is necessary to choose (abstract) the concepts from the content of knowledge elements (documents, workers' experience) and to structure (organize) them in formal way, by specifying interconnection between these concepts. At present, one of the most developed methods of knowledge description in the form of set of concepts and interconnection between them are ***ontologies*** [4, 5].

Ontology may be defined as a sign system $O=\{C,R,P,H,F,G,L,A\}$, where C is the set of ontology concepts, and for each concept $c\in C$ there is, at least, one statement in ontology; R denotes binary character of relations between ontology concepts, fixing pairs of application domain/ range of values, i. e. the pairs (D,R) with D, $R\in C$; P is a set of concepts properties; H fixes the taxonomic character of relations (links), at which ontology concepts are connected by nonreflexive, acyclic, transitive relations $H\subset C\times C$. Expression $H(C_1, C_2)$ denotes that concept C_1 is a subconcept (derived concept) C_2; F and G are the functions of references so, that F: $F^{L^C}\rightarrow 2^C$ and G: $F^{L^R}\rightarrow 2^R$, that is F and G connect the sets of lexical units$\{L_j\}\subset L^C$ with the set of concepts and relations, which they correspondingly refer to in the given ontology, in this case one lexical unit may refer to some concepts or relations and one concept or relation may refer to some lexical units; A is a set of ontology axioms.

Use of ontologies for description of organization knowledge model allows using formal language for their description, for example, such as RDFS and OWL [6, 7]. And also it allows using strict discrete logic mechanism for carrying out the procedures of inference over the concepts and metadata of ontology [8]. Using ontology allows interpreting concepts (and terms corresponding to them) both by specialists of organization and by computer programs of management.

Thus, the suggested approach may be described in the following way. Knowledge of organization (KO) is a set of knowledge objects, which are connected with each other by the system of interrelated concepts $KO=\{KO_1,KO_2,...,KO_n\}$. Every object of knowledge includes a set of concepts, and it may be assigned its certain representation $KO_i\leftrightarrow OZ_i$, which describes the connection of the object of knowledge with the set of concepts, which it contains $OZ_i=\Phi_i\{C_0,C_1,...,C_m\}$, C_m are concepts, which are used for describing OZ_i. Here function Φ_i specifies interrelation with concepts of KO (it will be specified later). Concepts which are included into the structure of conceptions are dependent, they are described by the sets of properties and connected with each other by different relations $R=\{R_1,R_2,...,R_k\}$. Each concept defines a certain term (idea) from the field of knowledge of organization and it is specified in the form of properties set $C_i=\{p_{i1},p_{i2},...,p_{ic}\}$. The whole set of concepts, connected with the objects of organization knowledge is described in the form of one or several ontologies of the type $O=\{C,R,P,H,F,G,L,A\}$, which are represented in the formal language of ontologies description.

When using ontology the possibility of describing the objects of knowledge in the form of metadata set $OZ_i=\Phi_i\{C_{i0},C_{i1},...,C_{im}\}=M_i(M_k,M_c)$ appears. Metadata are the data, describing the context (*context* – in Latin *connection*) and content (in English *content* – content) of the objects. Context metadata describe the connection of an object with other objects of knowledge of the system and content metadata describe the contents of an object (i. e. knowledge including into the object). Using metadata, especially content (semantic) ones allow solving efficiently such tasks of operations with knowledge as search, categorization and recommendation of knowledge. Context metadata $M_c=\{p_1,p_2,...,p_n\}$ represent the set p_i of values of properties of a concept, corresponding to the object of knowledge (document, report, specialist, subdivision) and these values p_i are either literals l_i (constants of different type), or references r_i to the other copies of metadata. The second element of metadata description $M_c=\{s_1,s_2,...,s_m\}$ is content metadata, which represent the set of statements of the form $s_i=(c,r,o,v)$, where c is the subject of statement (concept or copy are context metadata of a certain concept), o is the object (copy is content metadata of a certain concept), and r is the relation between subject and object, and v is a weighting coefficient, which estimates the importance of the given statement for object of knowledge description.

Ontology with the descriptions of all objects of knowledge in the form of metadata set is ***the ontological base of organization knowledge.***

The model of ontological base of organization knowledge

The creation of united ontology for detailed description of organization knowledge model is rather a laborious task. It is a matter of a long project with the involvement of experts group, whose knowledge should include all areas of activity of the studied company.

The solution of this problem may be a cancellation of deep system decomposition and inclusion into ontology only the most significant concepts from the studied knowledge domains, or separation of one of organization activity area and creation of detailed, but narrow specialized ontology for this area. Probably, both these approaches have their disadvantages. The first approach gives too rough and abstract model, and the second one does not allow using the model for interconnection between all the subdivisions of the company.

To solve this problem it is suggested to create the hierarchy of organization knowledge fields and to give a possibility of creation ontologies of different subdomains separately, which may have different thoroughness depending on demands for their detailed simulation. In this case, the ontology of organization knowledge is described in the following way $O=\{O_o,\{O_s\}\}$, where O_o is the organization ontology, and $\{O_s\}$ is the hierarchical set of organization knowledge subdomains.

Organization ontology describes the main concepts of organization (organization structure, employees, external agents, processes etc.) and also objects, being the sources of knowledge (Fig. 1).

Organization ontology also contains the concepts and relations necessary for forming hierarchy of

knowledge fields and further use of this hierarchy by supplements of management. This hierarchy represents knowledge domains connected with commercial, scientific or other company activity, that is those fields knowledge of which is of some interest for the company.

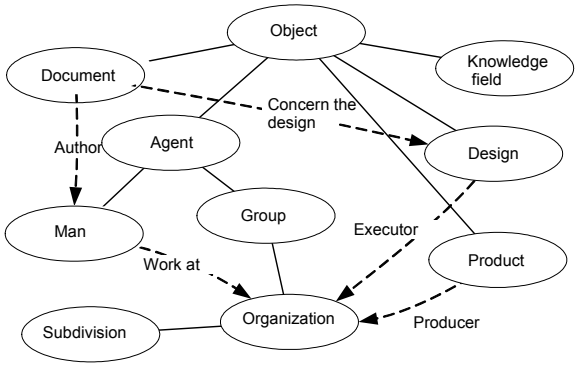

Fig . 1. *The example of organization ontology*

Ontologies of knowledge fields are connected with the hierarchy of knowledge fields from organization ontology. Structure of ontologies of knowledge fields is not fixed and can not be changed in using knowledge models in management. Ontologies of knowledge fields provide a certain level of knowledge model flexibility and possibility of its step-by-step increase.

Restriction of model scales by the limits of a concrete subdomain results in model simplification, allows involving experts of narrow specialization and carries out step-by-step module development of ontology and organization knowledge base. Thus, it is possible to decrease significantly the laboriousness of management development. Matching these relatively small ontologies may be provided either by development of upper level ontology or using the methods of ontologies, separate knowledge subdomains integration into one ontology [7]. The structure of ontological base of organization knowledge is showed in Fig. 2.

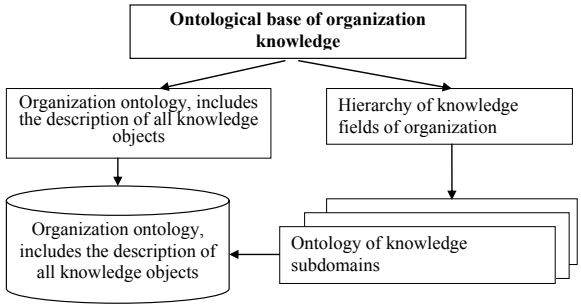

Fig. 2. *Structure of organization knowledge model*

Structure of knowledge management system

The structure of management, based on the unified ontological base of organization knowledge, is presented in Fig. 3. It is realized on the basis of relation database (RDBMS) in the form of table set and stored procedures for using them, and also in the form of API components, which represent the set of methods for its application.

Using ontological knowledge base allows creating the set of subsystems, carrying out semantic processing of information and knowledge. Particularly, subsystem of knowledge search allows carrying out context and content search requests to knowledge base, processing metadata of knowledge objects and selecting those of them, which solve a query of a user. The facilities of subsystem of knowledge search are used by the other functional subsystems of KCS portal, which provide users with various services, for example, such as navigation at metadata of knowledge objects and document storage.

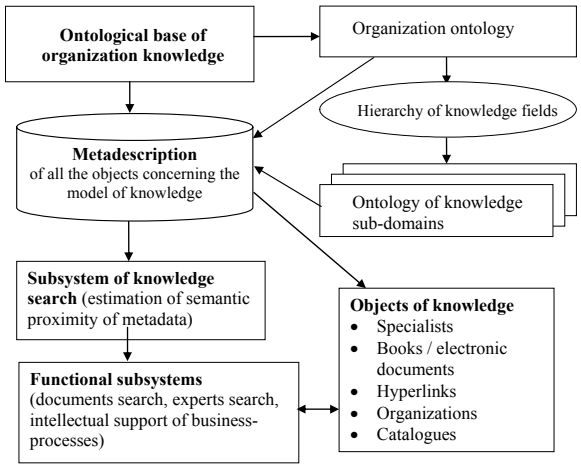

Fig. 3. *Knowledge management system structure on the basis of unified model of organization knowledge*

Carrying out content requests to the subsystem of knowledge search is connected with estimation of semantic similarity of M_c knowledge objects descriptions. To carry out inference the methods of descriptive logic are used. The determination of knowledge objects semantic metadata similarity comes to the search of spacing between the sets of weighted ontology concepts tree. The calculation methods of such estimations are described in [5, 10]. Using ontology concepts and estimation of semantic similarity allows creating unified intellectual space of organization, where all the objects, containing knowledge, are allocated.

Conclusion

Ontology-semantic approach was used at carrying out the project of knowledge management system creation at «EleSy» company (Tomsk), which develops automaton equipment: the description of general organization ontology and separate knowledge domain «Controlled electrical drive», being a part of ontology «Automation» is created. General ontology of organization contains main concepts, corresponding to organization knowledge objects and key concepts, connected with them (Document, Specialist, Organization, Project, Process, Product etc.). The developed model includes 24 knowledge fields, divided into groups: «Devices and automation equipments»; «Systems and complexes of technology process automated control systems»; «Theory, methods and software for facilities and automation systems creation». Ontology «Automation», which describes 578 concepts and 15 relations, is developed in detail. The quantity of concepts in section «Controlled electrical drive knowledge» is 375, that forms about 65 % of the total quantity of ontology concepts.

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CREATION AND APPLICATION OF KNOWLEDGE BASE OF SPECIALISTS' COMPETENCE PROFILES IN AN ORGANIZATION

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An approach to specialists' model construction and its usage in the knowledge management system with application of ontological organisation model is proposed. The problems on knowledge management that can be solved on the basis of the model proposed are considered.

Introduction

At present, any successfully working organization has in its staff a part of employees, who possess both considerable theoretical knowledge and wide practical experience in the fields of their activity. Participating in one or another business-process of an organization they are also involved into the process of accumulation, search and exchange of knowledge, a considerable part of which is the implicit knowledge. These very employees of a company represent the most valuable asset of the company, which should be efficiently managed [1, 2]. In the given paper it is proposed to improve the management of hidden organization knowledge by means of developing and using specialists' models, experts, first of all, within the bounds of knowledge control system (KCS) and processes of their construction by carrying out qualifed audit. The specialists' models and their simulation are the key elements in hidden knowledge management, but they may also be used in the other fields, for example, in human resource management of searching for specialists with required experience.

Experts of an organization

In a successful organization there is a considerable part of employees possessing theoretical knowledge and practical experience. All of them are refered to the category of skilled specialists; possess a certain formal status in the hierarchy of business management, take part in forming company development strategy, analysis of problem situations, reasoning and decision making.

It is natural that being participants of corresponding business-processes they are involved into the processes of knowledge search and accumulation, exchange, new ideas generation and so on. However, their involvement into knowledge processes is not determined so much by specialist formal status as by the fact to what extent the organization and its staff appreciate scope of knowledge and experience of this specialist, his amplitude, depth of theoretical knowledge and thought standards. Such specialists are more often than others got involved in the analysis of problem situations, strategies development and alternatives estimation, generalization and popularization of best practices, and namely such specialists are accepted to refer to the category of ***experts***.

Expert may be determined as [3] *a skilled specialist, who has a large scope of knowledge, useful for organization, can create efficiently new knowledge in the process of scientific and/or practical experience and uses this knowledge in his practical activity. He is widely appreciated as a reliable source of knowledge and skill, whose ratings are accepted by the organization or their colleagues as competent and important.*