ATLANTIS PRESS

Advances in Economics, Business and Management Research, volume 119

1st International Conference on Emerging Trends and Challenges in the Management Theory and Practice (ETCMTP 2019)

Knowledge Mapping as a Task of Personnel Training of Digital Economy Companies

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***Abstract*— Currently, the main value is knowledge. A competent approach to knowledge management is one of the key factors of companies' growth and development. Success is achieved by organizations that effectively create, transmit and use knowledge. However, these processes are quite complex. Companies need effective tools for their effective implementation. In the present article, the author's approach to knowledge mapping as a task of personnel training of digital economy companies is proposed. Knowledge is mapped based on the creation of ontologies in this approach. This approach was tested by creating a knowledge map for the process of investing in start-ups. In particular, new ontology classes were proposed and new class properties were defined. The decision-making process on investing in start-ups was used as an example of knowledge structuring.**

Keywords: digital economy, knowledge, knowledge mapping, personnel training, start-up

I. Introduction

Modern trends in the development of the world economy lead to the formation of a new concept of economic development. The new, post-industrial stage of social development increasingly focuses on information, high technology, innovation, personal knowledge and skills. This concept was called "knowledge economy" ("digital economy"). Today, a competent approach to knowledge management is one of the key factors of companies' growth and development. This is especially important for the formation of young and innovative companies.

Today, the volume of information that employees work with, is huge. And it will increase. That's why, many problems are arising.

First of all, information can be duplicated, and several employees spend valuable time gathering the same information. Secondly, information may become outdated and an employee may make a wrong decision based on outdated information. Thirdly, the significant volume of information lead to the fact that employees do not understand each other when they talk about one of the same subject in different words. Fourthly, the useful information is lost, when the person is out from the company. Thus, the useful experience of the one person does not become the experience of all employees.

Today, professions from STEM group are becoming very popular. Knowledge management in these professions is especially important, and errors are especially critical and expensive. Thus, V. Rogova in her work notes the following: "In human resources structure the STEM (Science, Technology, Engineering and Mathematics) specialties employees is becoming important, because they are most necessary for the development of digital economy" [1].

In the corporate sector, the importance of working with information and knowledge management is indicated by the following fact. Russian manufacturing companies on the average use only 43 % of structured management practices, compared to 62 % in the United States, according to a World Bank (WB) study "Management capacity and Russian companies' efficiency". One of the most significant practices (which is the worst case in Russia) is the monitoring of business activity based on big data [2].

That's why, knowledge management has not yet become a highly effective tool for Russian business. Not every company has the means and resources to implement knowledge management systems. Such implementations can be afforded mainly by large businesses, which need to store and to structure existing knowledge, as well as to ensure the transfer of knowledge between departments. A possible solution of this problem is personnel training, which can be provided using knowledge mapping.

II. Literature Review

Obviously, one of the key knowledge carriers in companies is their personnel. That's why, the effective approaches to human capital management are so important.

As E. Cahyaningsih et al. say "human capital in organization is famous as the precious asset for organization. Organizational intellectual capital reflected in the individual knowledge, skill, experiences, abilities and

self-motivation. Hence, organizational value also can be measured by their human capital. It also considers that human capital represents every organizational member's idea, knowledge, innovation and how they make the decision making in working activities. Furthermore, HC can be consisting of technical knowledge, experiences, and knowledge management which embedded in their organizational culture and it can improve the organizational initiatives" [3].

Special attention should be paid to the ideas of these authors about human capital management. "Human capital management (HCM) is set of activities to manage organizational human capital. These processes conducted to improve the organizational competitive value through employees' abilities into higher level of individual performance. Human capital management process includes planning, recruitment and selection, placement, development and training, retention, employee satisfaction, engagement, reward and collaboration activities to manage individual and organizational competency. Hence, assume that HCM activities consist of employee development, motivate and management which embedded in the organizational activities. Furthermore, HCM represent organizational talent management, learning and development which requires organizational and individual abilities, commitment, changes, leadership, engagement and performances" [3].

At present time, actual scientific and practical tasks are personnel training, its certification, creation of transparent and fair system of motivation, assessment of daily activity of employees.

Current research indicates that such tasks can be successfully decided within the knowledge management system in the organization.

From the point of view of the theory and practice, the question of knowledge management system creation is also important. Universally known that the company knowledge management system consists of [4]:

- the knowledge flow support (process point of view);
- the knowledge repositories;
- the knowledge cartography (mapping and navigation);
- the communities of knowledge workers.

Also is very important to understand the difference between an industrial society and a knowledge society. It concludes in following: *industrial society* supposes traditional production of necessary material and *knowledge society* implies technological production of knowledge and smart knowledge services [4].

In order to manage knowledge effectively it should be referred to data and information, which is particularly important for many scholars [5, 6, 7, 8, 9, 10]. As A. Chournazidis notices: "Data is the primary source of knowledge. They are symbols, observation tools (numbers, pictures, text) that require interpretation (coding). Through interpretation, these symbols acquire the value of information. The interpretation factor is particularly important for a learning company, since it provides meaning to the information" [11]. Also this author reports that "there are two types of knowledge: the "implicit" or "declarative" knowledge, which concerns the "knowing that" of the members of the company, namely their personal cognitive construction, and the "explicit" or "procedural" knowledge, which concerns the "knowing how", namely knowledge in the form of files, which helps to the solution of the problems of the company and to information processing" [11].

As has been noted earlier, in a knowledge society, it becomes particularly important for companies to store and provide quick and easy access to knowledge. For this purpose, such tool as knowledge maps is used. The main purpose of knowledge maps is to specify the path, where knowledge is located in the company. Knowledge maps are used for the following purposes.

At first, it becomes easier to search information and knowledge sources. Secondly, it becomes possible to organize effective interaction of consumers of knowledge with their holders (for example, experts in a certain profile area) and representative sources. Thirdly, knowledge maps ensure transparency and availability of resources. And, finally, they create a complete picture of the resource base of the company.

Knowledge maps allow to see all the resources of the organization in their relationship, even if they are scattered, created by different departments and developed in different formats. The objects of knowledge maps are:

- documentation,
- sites,
- resources (e.g. directories, knowledge bases),
- events,
- communities,
- experts (names and contacts).

There are four general types of knowledge maps [12]:

1) Process-oriented. They show knowledge and knowledge sources, that support the main business processes of the company. It can be organizational processes, research, production, sales, etc.

2) Conceptual. They assume various methods of hierarchical classification of content in the form of concepts and semantic relations between them. Also, these knowledge maps are often called taxonomies or ontologies. A corporate thesaurus is a special case of simple ontology. It shows a system of concepts and relations of the company's business area or its subdomain. Ontology can, in particular, relate similar projects carried out by two different departments of the company. It makes this knowledge more explicit and related.

3) Competency maps demonstrate the skills of a specialist, his career and professional profile. Corporate "yellow pages" are compiled on the basis of this type of information. It facilitates the search for experts in the company, especially with a geographically distributed structure.

4) Social media maps show knowledge networks and communication models in the enterprise among different communities of practitioners, partners of the company and other social units. One of the type of maps applications is the analysis of methods to share knowledge in the process of collaboration.

Knowledge maps are developed for different purposes:

- personnel training,
- resources project consolidation,
- improve communications of employees,
- resources and information capabilities visualization, etc.

One of the key problems of the Russian economy in general and Russian business in particular is a significant quantity of specialists who have a formally confirmed level of education (formally confirmed skills – for employees of companies). At the same time, both the country's economy as a whole and individual companies have a significant shortage of professionals who demonstrate high performance.

Personnel training in an organization supposes a corporate knowledge model of the company.

III. The Development of Approach to Knowledge Mapping for Personnel Training

The corporate knowledge model includes the following elements [13]:

- competency clusters – sets of closely related corporate competencies;
- taxonomies of corporate competencies;
- specialist competency profiles dedicated to specific user roles to perform a range of practical knowledge management tasks;
- indicators of behavior.

Sets of corporate competencies are the basis for the development of professional competence models.

Based on the approach, described in the work of V. Bova, the model of specialist competence is represented as the following: $MSC = \{O, K\}$, where O - general characteristics of the specialist; K - indicators of competence of the specialist in the relevant subject areas of organization knowledge.

The general characteristic of the specialist includes declarative data about the user.

The competence of the specialist $K = \{Kf, Ks\}$ includes competencies indicators for the employee (qualifications, skills, experience) in the fields of knowledge Kf and their semantic description Ks based on ontology of knowledge areas; $Kf = \{(F1, k1), \ldots, (Fn, kn)\}$ where (Fi, ki) – knowledge area (i) and competence level of a specialist in this field of knowledge; Ks – a description of the specialist in the form of a set of semantic metadata.

Ontology (knowledge mapping) is used in the process of training company employees in the following ways. At the first stage, the most critical areas of knowledge for the business are identified. These areas may include knowledge of:

- the specifics and conditions of company market;
- key technological processes of production and services of the company;
- methods of personnel training;
- etc.

Further, the group of company's experts identifies the most significant sets of definitions (concepts), specific to this knowledge area. The selected concepts are detailed, and relationship between them are established at the next step. Then the developed ontology is tested in practice, and by its results, necessary adjustments and clarifications are made.

The developed ontology is presented for acquaintance to employees of profile divisions and further there is a training of personnel to work with it.

In works, devoted to information technologies, the definition of ontology formulated by T. Gruber is used. "Ontology is a formal explicit description of concepts in the subject area under consideration, the properties and attributes of each concept (slots), and the restrictions imposed on slots (facets)" [14].

In the works [15, 16] a formal ontology model describes in the form of "three sets" $O = \langle T, R, F \rangle$, where T – set of concepts (classes) of the subject area described by ontology O; R – set of relations between classes in a subject area; F – set of interpretation functions defined on classes and / or relations of ontology O [15, 16].

There are several approaches to the creation and study of ontologies. The first approach (formal) is based on a logic (predicates, descriptive, etc.). The second approach (linguistic) is based on the study of natural language and the construction of ontology on large text arrays. These approaches work closely together. There are 3 main principles of ontology classification:

- by degree of formality;
- by content;
- by purpose of creation.

In this paper, we will consider an approach to classifying ontologies by purpose of creation. Ontology construction involves the following procedures [17]:

- definition of goals and applications of the developed ontology;
- ontology development which uses the specialized knowledge representation language and related software;
- achieving a common understanding of the information structure;
- ensuring the knowledge use in the subject area.

This paper uses an iterative approach to ontology development. First of all, it is necessary to conduct a rough review of the ontology. Then the resulting ontology is checked and refined. The final step in development is to add some specific details.

Ontology creation takes place in the following sequence:

1) analytical work is carried out within a separate subject area. The dictionary of definitions in which there are various characteristics of the investigated object is described. After that, the links and logical chains between the conceptual categories, related to the subject area, are determined;
2) base definitions are emergined;
3) various layers of abstraction are described;
4) conceptual statements are differentiated according to the level of abstraction;
5) the relationship between conceptual solutions is defined and described;
6) the obtained result is analyzed.

For the correct construction of ontology, it is necessary to determine its configuration, to understand the breadth and adequacy of the subject area's description. You need to answer the following questions to do this:

- what is the scope of ontology?
- how and for what will ontology be used?
- what questions will be answered?
- who will analyze and support ontology?

IV. Case Study

Let's consider an example of knowledge mapping for personnel training using ontology as an investment in start-ups (venture business). This type of activity involves increased risk, weak formalization of knowledge, and an intuitive decision-making. This is why knowledge mapping is particularly important for this area.

Class "Start-up" describes a set of basic and integral concepts in the field of innovative projects. Specific components are instances of this class. For example, a business angel is an instance of the class "Investor type", which in turn belongs to the class "Investor basic information".

Developed ontology structures informal knowledge about the start-up projects. The purpose of ontology is to provide investors a tool to assist in decision making about investing in a particular project. The developed ontology is planned to be used as a "framework" for designing a decision support system, in the future. It will evaluate and make recommendations on the selection of the most promising investment projects. This ontology should be supported by experts. The "Start-ups" ontology contains factors and criteria that require special consideration in venture investment.

Protégé 5.0 editor was chosen to develop the ontology and OWL ontology description language was used [18].

Let's consider the hierarchical representation of classes in the ontology of start-up projects. There are three approaches to describing a class hierarchy.

1. The process of top-down development. It is defined general concepts firstly and the subject area is specified then. Such classes as "Start-up Company" and "Investors" are developed at the first stage. The next step is to specify the concepts of the class by creating its sub-classes: "Project team", "Basic information about the project", "Investor type", etc. Further detail allows you to further specify the object of research. For example, "Project team" is detailed on the founders, employees, etc.

2. The process of up-stream development. The specific leaf classes of the hierarchy are described firstly. They grouped to define more general concept classes then. For example, you start a build of ontology by defining "Employees" and "Founders" sub-classes. A common class "Project team" is created for these sub-classes after that. The class "Start-up" is created for sub-class "Project team", in its turn.

3. A process involving a combination of 1st and 2nd species. At the first stage, the most key concepts are identified. They are further generalized and limited. Viewing of ontology in this case begins with the definition of the highest level. The class "Start-up" details on the "Contact information" branch in our case. The class "Contact information" correlates with class "Basic information about the project" as the concept of the same (middle) level in its turn. Fig. 1 shows the possibility of dividing ontology classes into different levels of generalization.

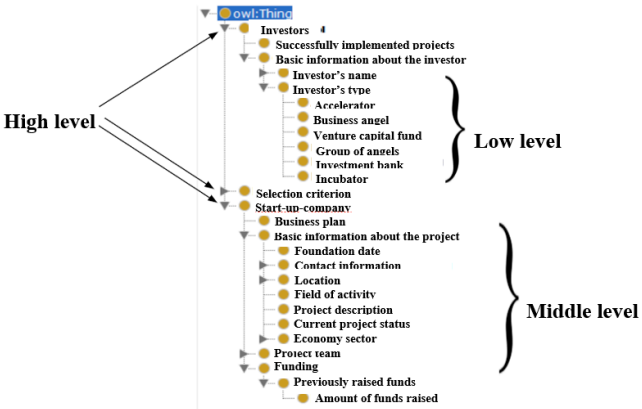

Fig. 1. Division into different levels of generalization.

Description of the internal structure of concepts is carried out after the definition of classes. Each class must have a set of properties that describe it. These properties are called slots. The following types of object properties are distinguished in ontology:

- "internal" property;
- "external" properties;
- parts, if the object has a structure (physical or abstract);

- relationships between individuals (these are relationships between instances of classes and other elements).

It is possible to determine which properties of classes are inherited by sub-classes when ontology modeling. The slot and the shared class must be linked. The Protégé 5.0 editor uses two main types of properties: object properties (owl:ObjectProperty) and data type properties (owl:DataProperty). Let's consider the object properties in more detail. Object properties are used to link classes and individuals together. Fig. 2 shows a list of properties used to describe the subject area of start-up projects.

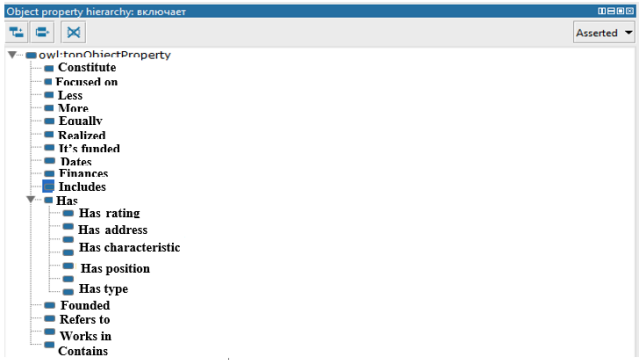

Fig. 2. Internal structure of concepts (class properties).

For qualitative analysis and verification of the adequacy of the developed ontology, it is required to fill it with a sufficiently large amount of data. The data should contain all the information according to the structure of the classes of the developed ontology and be available for further conversion into an ontological view.

The main source of incoming data was Crunchbase database of companies and investors [19]. The Protégé editor provides an Excel Import plugin that allows to load format files into the ontology *.xls* and *.csv*. Data from the Crunchbase website was successfully downloaded into the ontology. Thus, practical material for personnel training was obtained.

V. Conclusion

This article analyzes the use of ontological modeling as a task of personnel training of digital economy companies. The decision-making process on investing in start-ups was used as an example of knowledge structuring. This process is poorly structured and therefore the company's personnel must acquire formal knowledge in this area.

The process of making investment decisions using the developed ontological model of start-ups was described. Data on start-ups from Crunchbase were loaded into the ontology to check the correctness of the developed ontological model.

The developed approach to knowledge mapping as a way of personnel training will allow employees to make the right management decisions in the conditions of poorly structured information. It is an effective knowledge management tool, in turn.

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