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The Development of Methodical Approach to Knowledge Mapping in the Digital Economy

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Abstract. Currently, the main value is knowledge. 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 industrial world, the efficiency of production processes was achieved, in particular, through the process of material flows mapping. It allowed to reveal unproductive stages of production, to find reserves and to synchronize various operations in time.
The post-industrial world has identified new priorities in activities and has shifted the focus to new sectors of production. In this regard, the create and use of knowledge has become a major source of companies' competitive advantage.
In the present article, the author's approach to knowledge mapping in modern companies is proposed. Knowledge is mapped based on the creation of ontologies in this approach. The novelty of the proposed approach is to choose the object of knowledge mapping – start-up-companies. In particular, new ontology classes were proposed and new class properties were defined.

1. 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". 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.

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.

Small businesses (particularly, start-up-companies) desperately need to use advanced knowledge management tools as well. In addition, such companies are an attractive object for investment.

Decisions on investing in start-ups are made in high uncertainty conditions. Venture market participants need tools to manage knowledge about start-ups as well. Development of the knowledge map for venture capital market is due to the need to display the entire spectrum of relationships and interdependencies between different concepts of the subject area.

Analysis of existing research in this field demonstrates that work on knowledge modeling in venture business has not yet been carried out [1]. In this regard, the development of an instrumental method of analysis is an important scientific and practical task.

2. Literature review

Knowledge management is important to achieve the organizational objectives, it purpose to manage individual knowledge in organization, which consist of some activities such as discovering, capturing, sharing and applying their knowledge. Whereas, claimed that knowledge management can increase the intellectual capital of company to improve the organizational competitive value and objectives. This process can be done by identify, select, manage, transfer and disseminate the information for problem solving, decision making and strategic planning in the future. Knowledge management in company's aims to create the organizational knowledge by using several activities such as acquire, represent, exchange, maintain and integrated the tacit and explicit knowledge. Knowledge management also embedded in the human resource management and organizational process by create, store, distribute and interpret the knowledge [2].

As Litvaj and Stancekova note in their article "knowledge is acquired and memorized facts and relationships between them, it is information which within itself includes values, attitudes and ideals; knowledge and skills that have an influence on human behavior and are subject to changes" [3]. Describing the type of knowledge-based companies, they indicate that "thus a company, based on the definition above, is ´a learning organization´. That´s why many theorists consider the terms ´knowledge focus´ and ´knowledge creation´ more appropriate than ´knowledge management´, since they express activity, rather than an object. The term ´education management´ is also appropriate since it involves knowledge creation, knowledge sharing and knowledge utilization through knowledge and information" [3].

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:

- 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, 11]. As 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" [4]. 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" [4].

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, 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:

- teaching beginners,
- resources project consolidation,
- improve communications of employees,
- resources and information capabilities visualization, etc.

3. The development of methodical approach to knowledge mapping

Knowledge management in the company is advisable to start with the construction of conceptual knowledge maps, because:

- the creation of a corporate thesaurus (as a special case of ontology) is the initial step of knowledge management in the company. This stage is crucial for russian companies, because they are just beginning to implement knowledge management concept;
- ontologies are used in models and profiles of competence building in a specific subject area. It is the necessary condition for the development of personnel management system in the company;
- employees of the company must operate with common specific terms and definitions.

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)" [13].

In the works [14, 15] a formal ontology model describes in the form of "three sets" $O = <T, R, F>$, 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 [14, 15].

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 [16]:

- 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?

Let's consider an example of knowledge mapping 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 [17].

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. Figure 1 shows the possibility of dividing ontology classes into different levels of generalization.

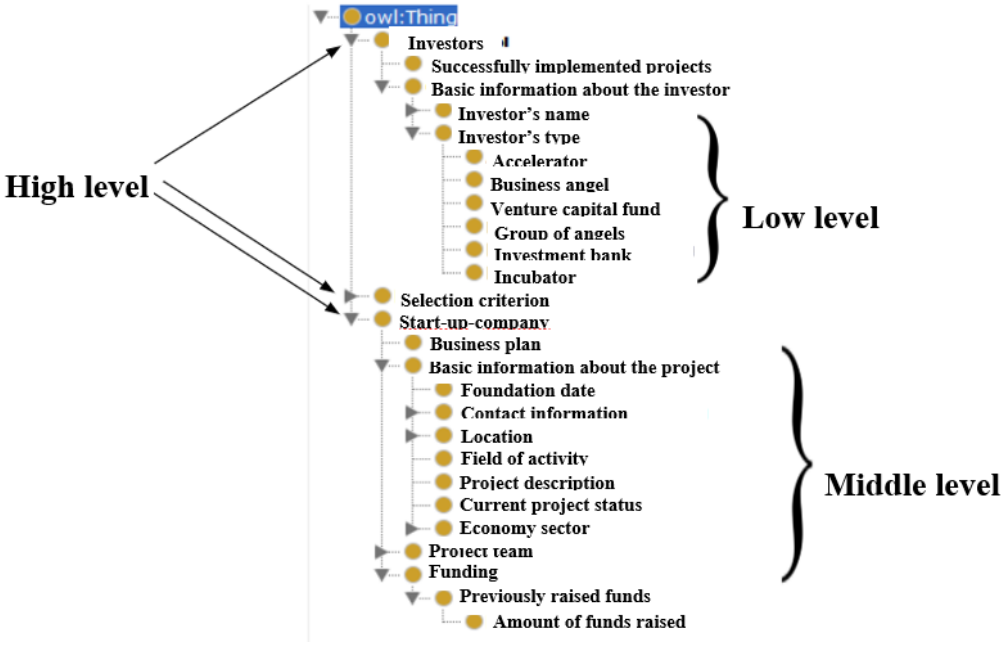

Figure 1. Division into different levels of generalization.

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. Figure 2 shows a list of properties used to describe the subject area of start-up projects.

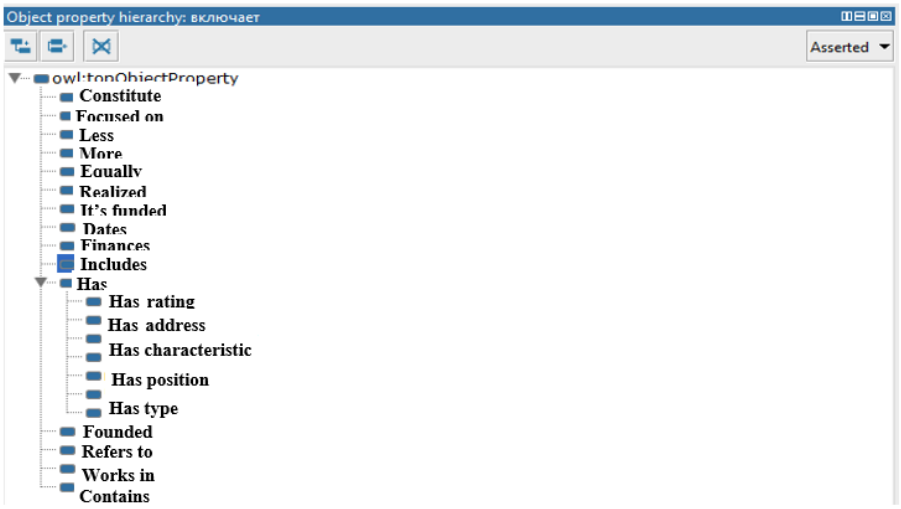

Figure 2. Internal structure of concepts (class properties).

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 [18, 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.

4. Conclusion

In this article, an analysis of the use of ontological modeling as a means of supporting decision-making about investing in start-ups was carried out. It was revealed that the use of this method is promising in the processing of poorly structured data about start-ups.

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 in the future can be used as a means of supporting management decisions when investing in start-ups. It is an effective knowledge management tool, in turn.

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