Domain description methods for creating an industry digital platform

Dilara Musina[1], Azat Yangirov[2] and Sergey Kharitonov[3]

[1] Ufa State Petroleum Technological University, 1, Kosmonavtov Str., Ufa, 450062, Russian Federation

[2] Bashkir State University, 32, Zaki Validi Str., Ufa, 450057, Russian Federation

[3] Ltd "Segment-Pro", 156/3, Mendeleev Str., Ufa, 450080, Russian Federation

musinad@yandex.ru

Abstract. The article outlines the main approaches to modeling the subject area of the industry based on the method of ontologies and cognitive maps. The relevance of describing the subject areas of economic sectors in the process of creating a digital infrastructure of the Russian economy is revealed. In ontological modeling, methods of identifying concepts, relations, and instances that are applicable to all sectors of the economy are indicated. An approach to the formation of an ontological model of the industry, its general form and a method for assessing the quality of the resulting model are proposed. The subordination of applied industry ontologies with meta-ontologies of the upper level is reflected. The universal classes and subclasses of the industry ontology, their properties, and the taxonomy of building hierarchies are indicated. The difficulties that developers of applied industry ontologies may face are described. A two-level cognitive model with the ability to track external impulse influences is proposed. The vertices and connections of the directed graph are described, as well as the qualitative parameters of the vertices, which can be used to track the crisis state of the industry. The proposed approaches can be used by specialists when creating information and communication platforms for the digitalization of industries. The authors propose to apply the developed modeling mechanism in the description of the subject area when creating a digital platform for managing the agro-industrial complex.

Keywords: Ontology, Cognitive map, Industry, Model.

1 Introduction

Taking into account Russia's lag behind the world's leading economies in terms of the introduction of information and communication technologies [1], a corresponding program document was adopted at the legislative level [2]. One of the main indicators of its implementation will be the creation and implementation of industry digital platforms. In this regard, the authors were puzzled by the preparation of the concept of creating a digital platform for the agro-industrial complex, which at this stage occupies a closing position in the Russian "digitalization funnel".

The industry digital platform as a virtual infrastructure of the industry should provide for the maximum set of applied tools for its development. At the same time, the development of the industry will be assessed according to the indicators set by the industry strategy, and the tools should be fully functional in order to provide maximum opportunities for all platform participants. The set of tools will be formed based on the variety of platform users, their needs, goals and objectives (Fig. 1).

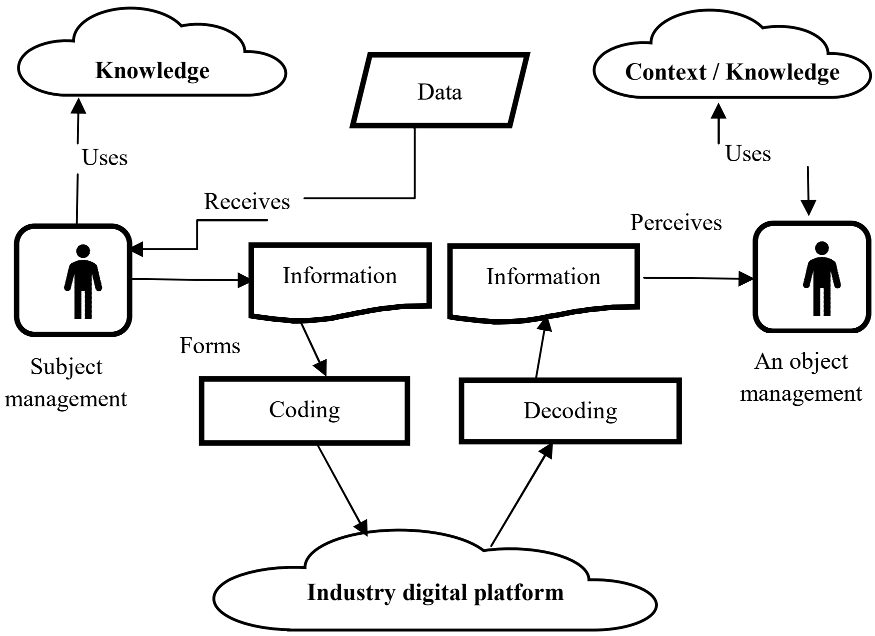

Fig. 1. The scheme of building the interaction of users of the industry digital platform.

In this regard, the first step in creating an industry digital platform as an information system is the description of the subject area.

2 Materials and methods

Modern tools for describing the subject area are the methods of ontological [3] and cognitive modeling [4]. In this aspect, ontology is understood according to T. Gruber's definition, "... as an explicit specification of conceptualization" [5]. Methods of deduction (when passing from ontological classes to instances and describing their properties), principles of taxonomy (when building a hierarchy of classes and subclasses), and the method of semantic networks are used as methods for building an industry ontology. The deduction method in the development of a hierarchy of classes, which was called the "top-down development process" in [6], in our opinion, is most suitable for the development of industry-specific ontologies. At the same time, it should be understood that there are meta-ontologies, such as plant ontologies, animal ontologies, which, for example, will be partially involved in the ontology of the agro-industrial complex in the further taxonomic hierarchy of producers. In this case, the method of building semantic networks from several ontologies will be applied. When constructing a cognitive model, the theory of systems analysis, the method of directed graphs, is used. In terms of building a cognitive map, the developments and approaches set forth in the works [7-8] are applied.

3 Results

In the process of ontological modeling, the terminology was defined that describes the industry in a virtual environment, classes of system objects, relations, and instances were identified.

The ontological model has a general form:

$O = \langle C, L, B, I \rangle$,

Where C – many classes $\{C_1, C_2, ..., C_q\}$ and their interpretation in the subject area;

L – many relationships $\{L_1, L_2, ..., L_k\}$;

B – class properties;

I – many class instances $\{I_1, I_2, ..., I_k\}$.

Terminology is described through the creation of a thesaurus.

If we proceed from the purpose of the industry to produce goods or provide services, then suppliers, consumers, producers, government structures can be distinguished as universal industry classes. In turn, the classes must be subclassed. For example, suppliers can be divided into subclasses on one basis for individuals and legal entities, on another basis for suppliers of material resources, services, labor resources, financial. Consumers can also be divided into subclasses for different reasons (classification criteria): individuals and legal entities; wholesale, small wholesale, retail; consumers of raw materials, semi-finished products, finished products, etc.

Each subclass can also be refined and instantiated. Further detailing, for example, the subclass of suppliers of material resources, will make it possible to single out suppliers of equipment, means of labor, raw materials, semi-finished products, spare parts, etc. Another basis for their classification may be the country of origin: a domestic supplier or a foreign one. Concretization will make it possible to form a list of domain instances. For example, if an ontological model is drawn up for the agro-industrial complex of the Russian Federation, then the class of producers at the level of the formation of a list of copies of the ontology will cover all producers of agricultural products in the country. The maximum number of concepts of one level, or the depth of the "branch", should not exceed the known Yngve-Miller number (7 ± 2).

Relationships in different sources are called differently: slots, roles, properties. They describe the properties of classes and instances. For example, headcount and revenue will be important slots for manufacturers and suppliers. It is in the context of industries that this is important, since these parameters, for example, for a supplier determine participation in purchases, and for a manufacturer - participation in some government programs to support manufacturers.

To check the competence of the created industry ontology, it is proposed to use the expert approach proposed in [6]. They asked the experts to form a list of questions to test the competence of the ontology. At the same time, when assessing the quality of ontology, where the subject area is an industry, it is necessary to involve industry experts, IT specialists and ontology analysts. To test the ontology of the agro-industrial complex, specific questions of the following type can be formulated:

- What characteristics should be considered when choosing a resource provider?
- LLC "Pervomay" is a large wholesale or small wholesale intermediary?
- Does Kumys LLC belong to producers of agricultural raw materials or end products?
- Does Kumys LLC work with buyers directly or through a reseller?
- Does Garant LLC provide consulting or leasing services?

After creating an ontological model of the industry, the next stage is the formation of a cognitive model. Cognitive modeling is based on cognitive (cognitive-target) structuring of knowledge about an object and its external environment. The cognitive model develops the ontological one by adding links between concepts and instances of the ontological model. We propose to build a two-level cognitive model for the industry. The cognitive model of the upper level will represent a directed graph of the form: $G = \langle P, R \rangle$.

The vertices of the graph (set $P = \{p_i\}$, $i =$) are the concepts of the industry ontology (producers, consumers, suppliers, intermediaries, government agencies). The edges of the graph ($R = \{r = (p_i, p_j)\}$; $i, j =$; $i \neq j$) are connections between concepts. In this case, the directions of the edges of the graph are determined by the influence of one vertex of the graph (p_i) on another (p_j).

The lower-level cognitive model will be a directed graph, the vertices of which will be instances of the industry ontology. The number of vertices and the number of links of such a graph will be an order of magnitude larger.

Realizing that the economic category industry implies the implementation of the management functional, we propose to supplement the directed graph of the lower level with beacons signaling the state of system elements (ontology instances). The indicators of the quality state will become such beacons for the vertices, and the resistance coefficients for the edges. Then, based on the mathematical description of the approach to tracking the impulse impact on the system from destabilizing factors, borrowed from the publication [9], it is possible to build a cognitive model of the industry, which will allow implementing the methods of soft management of the industry. Methods of soft management of the industry are described in [10].

For example, indicators of the qualitative state of manufacturers can be the level of the tax burden, sales volumes for several specified periods, which will be reflected by the coefficient of variation, etc. and crisis zones for manufacturers, intermediaries, suppliers,...). For example, it is possible to agree that the system enters a state of crisis if the indicator of the quality state of 20% or more of the system's elements is below a given critical level.

4 Discussion

The problem in the formation of this ontology can be unambiguously designated the problem of combining ontologies. All applied ontologies face this problem [11-12]. Differences in ontologies of the same subject areas are explained by the subjectivity of the ontology authors. In addition, the approach to the construction of ontological models for industry systems is subject to discussion, the method of constructing ontologies differs from one author to another; there is no unambiguity in the set of model elements. In this work, the authors proceeded from the recommendations [13], where the model contains four parameters, but a number of authors insist on introducing into the model such parameters as axioms and inference algorithms on ontologies. Axioms set the conditions for correlating concepts and relationships. The question is subject to comprehension: should the expert and formalized methods be combined when assessing the quality of industry ontology? The expert method is a priority when creating ontological models of specific industries. While formalized should also not be swept aside. It will allow at the initial level of building universal industry ontology to identify the differences between the industry ontology from all others.

5 Conclusion

Thus, the proposed methods of ontological and cognitive modeling will almost completely describe the subject area for creating an industry digital platform. The next level of domain description should be a business process model.

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