# The Semantic Network Creation for an Innovative Project Scope as a Part of Project Knowledge Ontology

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**Abstract.** In the article the subject for research is the content of the innovation project. The project knowledge system and contextual competencies of the project participants are considered. The methods of system analysis, ontological approach and semantic modeling are used. A conceptual model of project knowledge is proposed, which includes the basic knowledge system of the project and competence of the performers. The generalized structure of the project content in a schematic presentation of requirements, project phases and its participants is considered. An ontological model of an innovative project content in the form of a semantic network has been developed. The practical implementation of this model was made on the example of a project for the development of a reconnaissance-strike complex for action in mountain conditions. The description of the project knowledge system and the definition of contextual competencies will allow evaluating the project personnel and solving the problem of maximum adaptation of the already formed and worked out team for a specific project.

**Keywords:** innovative project, knowledge ontology, semantic network, project content, people management.

## 1 Introduction

In a changeable environment and unstable development of enterprises in Ukraine, more and more attention is paid to the issue of effective management of innovative projects. At the same time for the successful project implementation the formation of a suitable project team plays a great importance. Therefore, special attention is paid to the problems of recruitment [1 - 3]. In this work, staff is used as the project management team and the project implementers — heads of departments, specialists or scientific and technical personnel, workers or technical personnel, and support staff.

Existing models and methods do not provide the full solution of such a task as the selection and adaptation of existing staff under the project [4 - 7].

While considering the qualifications of project performers, the contextual competencies of the participants should be taken into account, but not the positions [8, 9]. Contextual competences support project values, they include an understanding of the project, having experience of participating or managing projects at different levels, having knowledge and experience to successfully complete the project, and knowledge to develop criteria for the success of a project in a project-oriented enterprise [10 - 12].

Recently, great attention has been paid to the formation and analysis of the knowledge system in project management. For example, in [13], the information component of knowledge management in an enterprise is considered, which is a source of processes information, serves as reference and control documents when introducing new forms of project management, is a methodical basis for staff training and represents a database of documents in the audit management system. The theoretical substantiation of the formation of core competencies of project managers on the basis of the characteristic properties of adjacency matrices and its degrees creates the main interest [14]. The use of ERP-systems allows to plan various types of resources based on the company knowledge, but this class of systems implements a functional approach, does not take into account the structure of project knowledge. [15].

The theoretical substantiation of the formation of core competencies of project managers on the basis of the characteristic properties of adjacency matrices and its degrees creates the main interest [16, 17].

## 2 Main Material Presenting

Ontological data analysis involves the creation of a terms glossary for studying the characteristics of the objects and processes that make the system. In addition, the basic logical interrelationships between the corresponding terms are documented. Thus, the ontology of knowledge includes a set of terms and rules according to which these terms can be combined to build reliable statements about the state of the system at some point in time. Basis of these statements, appropriate conclusions can be done that allow to made changes to the system in order to increase the efficiency of its functioning [18 - 20].

A conceptual model of knowledge is proposed (Fig. 1), which includes the main areas of knowledge: the project knowledge system and the competences of the executives. The model also describes the process of forming knowledge models:

- definition of the project knowledge ontology, which allows you to a hierarchy of knowledge areas for project content,
- determination of the knowledge ontology of the project staff on the competencies of the performers categories,
- comparison of the project knowledge system with the staff competencies.

Consider the main components of the conceptual model. The ontology of knowledge about the project includes the classification of projects [21, 22] and the project content model in the form of a semantic network.

The ontology of knowledge about the project provides a certain level of flexibility of the knowledge model and the possibility of its gradual development. In addition, this ontology contains the concepts and relations, which is necessary for the formation of a hierarchy of knowledge areas of project management [23].

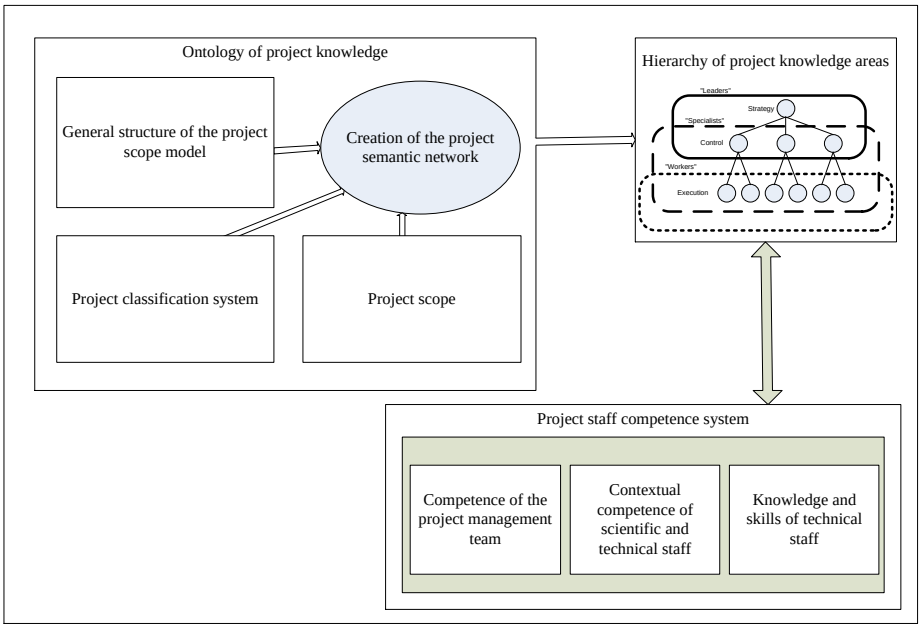


**Fig. 1.** Conceptual model of project knowledge.

The ontology of the project team includes a description of the basic concepts of the team management and project executors - the knowledge of the performers; knowledge of scientific and technical personnel; knowledge of the technical staff.

For objects with knowledge that are described in the ontology of the project team, meta descriptions are created. The meta description of the object *i* has the following form:

$$M_i = \{M_{ik}, M_{ic}\}, \quad (1)$$

where $M_{ik}$ - a set of metadata corresponding to the properties of the ontology concept, and an instance of which is the described object,

$M_{ic}$ - a set of metadata describing the knowledge content about an object.

The structure of the specified metadata in the form of concept properties is described in the ontology of the project team. Metadata element values are either references to other instances of concepts, or literals. Thus, these metadata associate an instance of an object - a source of knowledge with other instances of objects described in the ontology of the project team, and therefore this component can be called "contextual metadata".

The second component of the meta descriptions ($M_{ic}$) directly describes the knowledge that is implicitly or explicitly contained in the object. This part of the meta-description connects the object with instances of concepts from ontologies of knowledge about the project and can be called "content metadata".

Content metadata for object *i* can be described as follows:

$$M_i = \{(tr_{i1}, k_{i1}), \ldots, (tr_{if}, k_{if})\}, \quad (2)$$

where $tr_{ij} = \langle s_{ij}, p_{ij}, o_{ij} \rangle$ – triplet;

$s_{ij}$ –some concept from the ontology of the domain area, knowledge of which is contained in the described object;

$p_{ij}$ – relation defined in the ontology of the domain area;

$o_{ij}$ – reference to the instance of the concept in the domain area ontology;

$k_{ij} \in (0,1]$ – coefficient denoting the relevance of the triplet $tr_{ij}$ for object *i*. While describing a metadata triplet, the elements $p_{ij}$ and $o_{ij}$ may be skipped.

Let consider the features of project knowledge, taking into account the complex classification of projects. For the effective implementation of an innovative project, the description of a new subject area is important. Each domain area has its own specifics, which can greatly affect the way the innovation implementation.

Based on the specifics of the subject area, the structured content of the project is described (Fig. 2).

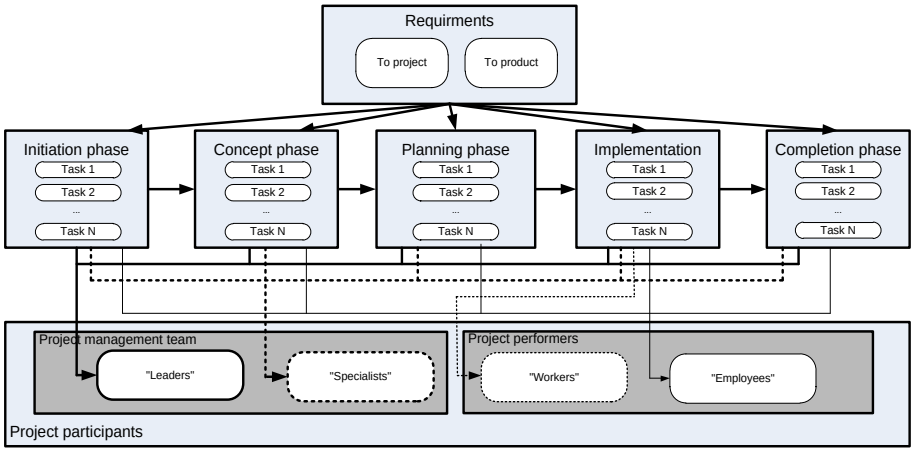


**Fig. 2.** The generalized structure of the project scope.

Typically, project content includes:

- description of requirements;
- list and description of project stages;
- list and description of tasks;
- list and description of project activities;
- the structure of the project executors, etc.

It should be noted that in order to analyze the provided project, as well as to determine and take into account the specifics of the project knowledge that executors should have, initially it is necessary to classify projects according to various classification criteria: areas of activity, by the nature of the domain area of the project, by scale, by duration, by complexity, etc. [24].

The next step is to determine the knowledge of the project in accordance with the basic processes of the project scope management [25].

1. In the process of project initialization, the knowledge system includes: knowledge of the political, socio-economic, technological, eco-logical state of the external environment of the project; knowledge of the mission, vision, main objectives of the project; knowledge of the project strategy; ability and skills to identify the strengths and weaknesses of the project, opportunities and threats; skills and experience in evaluating the beneficial effect of the project and activities; experience for estimating potential costs etc.
2. In the process of project scope planning, the knowledge system includes: knowledge to create databases and knowledge bases; forecasting experience, including expert and formalized methods; experience in developing scenarios for the development of objects and their environment; skills to identify and analyze the strengths and weaknesses of the object, opportunities and threats; skills to identify and analyze the problems of maintaining the achieved state and achieving the previously set goals; experience in the formation of goals, criteria and priority areas for development etc.
3. In the process of determining the project scope, knowledge and skills are needed for working with templates of hierarchical work structures.
4. In the process of checking the project scope, skills and experience communication with the customer are necessary, as well as a comparative analysis of the planned and current state of the project products, activities, phases and tasks.
5. In the process of monitoring changes in the content of the project are needed: skills of working with reports; knowledge, skills and experience with the project change control system, methods and tools for additional content planning and content determination.

For a detailed structured description of the project domain, it is necessary to form an ontology of its content. One of the effective tools for the formation of ontology is the semantic network. The basis of the semantic network is instances or objects, concepts or classes, attributes, relationships [26].

The construction of a semantic model begins with the selection of composite elements, which act as objects of description. Based on the content of the technical task of the innovation project, we will define the objects for describing the semantics model. It should be noted that each element of the description can be single or represent a group of elements [27].

Nodes and links in the proposed semantic network have the following attributes:

Name – line of text (object name), the corresponding node.

ObjectClass – object class of the corresponding node: Functional, Organization, Specification, Resource, Structural.

ObjectType – the type of the object corresponding to the node: the central concept (Central), the context (Context), the group of concepts (Group).

SemanticType – semantic rank. The main digits are: information (Inform), property (Property), executor (Excuter)

Relation – the type of semantic connection between nodes used to build a network.

The following classes of objects are highlighted here:

- Functional (project name, project purpose, basis for implementation, goal structure, etc.)
  ObjectClass = “Functional”[O1, O2.1, O2.2, O2.3, O3.3];
- Organization (project team, implementing organizations)
  ObjectClass = “Organization”[O2.4, O2.4.1];
- Specification (basic requirements for implementation, requirements for the product and works, etc.)
  ObjectClass = “Specification”[O3.1, O5.1, O5.1.1, O5.1.2, O5.1.3, O5.1.4];
- Structural (development stages, work hierarchy)
  ObjectClass = “Structural”[O3.2, O4.1];
- Resource (work resources)
  ObjectClass = “Resource”[O5.2, O5.2.1, O5.2.2, O5.2.3].

When describing elements, the types of objects were highlighted (ObjectType):

- Central – central concept when building a semantic network (project name, basis for project execution)
  ObjectType= “Central”[O1, O2.1];
- Context – auxiliary, clarifying the concept (the purpose of the project, the structure of goals, the project team, the performers, the basic requirements, stages, tasks)
  ObjectType= “Context”[O2.2, O2.3, O2.4, O2.4.1, O3.1, O3.2, O3.3, O4.1];
- Group – group of concepts (technical requirements, product specifications, quality of work, duration of work, cost of work, resources)
  ObjectType= “Group”[O5.1, O5.2, O5.1.1, O5.1.2, O5.1.3, O5.1.4, O5.2.1, O5.2.2, O5.2.3].

When describing the elements, semantic types were identified. (SemanticType):

- Inform - the name of the project, the basic requirements, steps, tasks. These elements are textual, they are purely informational characteristics of the development object
  SemanticType = “Inform” [O1, O3.1, O3.2, O3.3, O4.1];
- Property - the basis for the development, the purpose of the project, the structure of goals, requirements for the project, product characteristics, quality of work, duration, cost of work, resources, logistics. These elements are characterizing, they describe the properties of an innovative product and the conditions for its development
  SemanticType = “Property”[O2.1, O2.2, O2.3, O5.1, O5.2, O5.1.1, O5.1.2, O5.1.3, O5.1.4, O5.2.1, O5.2.2, O5.2.3];

- Executor - project team, performers. Are objects of the semantic network that describe the project participants

SemanticType = “Executor”[O2.4, O2.4.1].

Define the types of relationships used to build a semantic network (Relation):

- clar - a link that indicates that the lower level object is a top-level refinement object;
- dep - expresses the relationship between objects;
- deagr - expresses the decomposition of a single top-level object into several low-level objects;
- inv - connection shows that one object is a consequence of another element of the semantic network.

These types of links allow to display the relationship of elements with regard to their semantic features (Fig. 3). Dotted arrows indicate the connections between the elements, which reflect the innovative properties of the project.

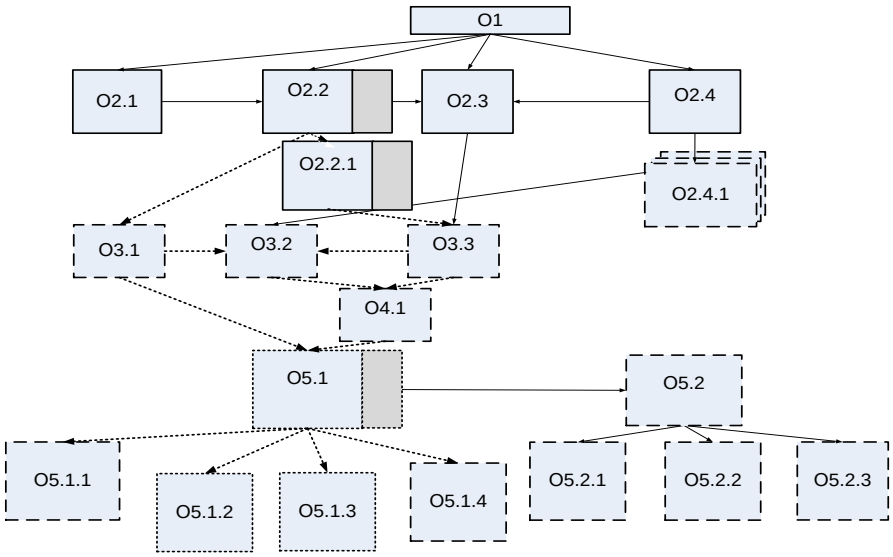


**Fig. 3.** The semantic model structure of the project scope.

An important step in building a semantic model is the partitioning of the semantic network in accordance with the phases of the innovation project life cycle.

Four phases are most often distinguished: the initiation phase, the planning phase, the implementation phase and the completion phase.

However, for the innovative project the most complete, it seems to be the allocation of another phase before the planning of the project - the concept phase. A diagram that reflects the involvement of staff at different stages is presented in fig. 4.

As at the last stage there is only the closure of all documentation, the compilation of reports, the termination of contracts, this work is typical for most types of projects and does not require the acquisition of additional specialized knowledge to perform such work. Therefore, from the ontology of knowledge, the first four phases of the innovation project life cycle are more important, as well as the works and participants that are involved in these stages.

The semantic model of the project scope from its division into phases of the innovation project life cycle is structured as a tree-visible model, that is, the connections between its elements are directed from top to bottom, which allows them to be considered in accordance with the development of the project life cycle phases. The initiation phase includes the following elements: the name and purpose of the project, as well as the basis for its development. Elements such as: project goals, executives, requirements, stages, tasks, and project work relate to the concept phase. The remaining elements (all types of resources and technical requirements) belong to the planning and implementation phase.

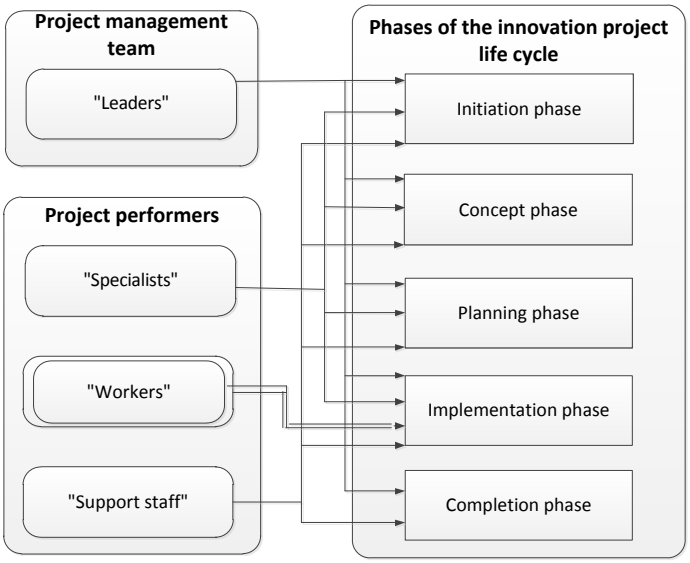


**Fig. 4.** Scheme of staff participation at different stages of the innovation project life cycle.

In the first three phases, considerable attention is paid to the management staff, researchers and engineering and technical personnel, since it is mainly these participants who are involved in the preparation of the project. In the fourth phase, the emphasis in the selection of personnel is shifted to the working-production personnel.

The practical implementation of this model was made on the example of a project for the development of a reconnaissance-strike complex for action in mountain conditions (Fig. 5). A hierarchy of classes and subclasses of the project scope was formed and a semantic network was built in the form of a graph in the Protégé system. Structured presentation of knowledge and concepts about the project allowed to determine

the relationship in the knowledge system and appropriately determine the necessary competence of the project staff.

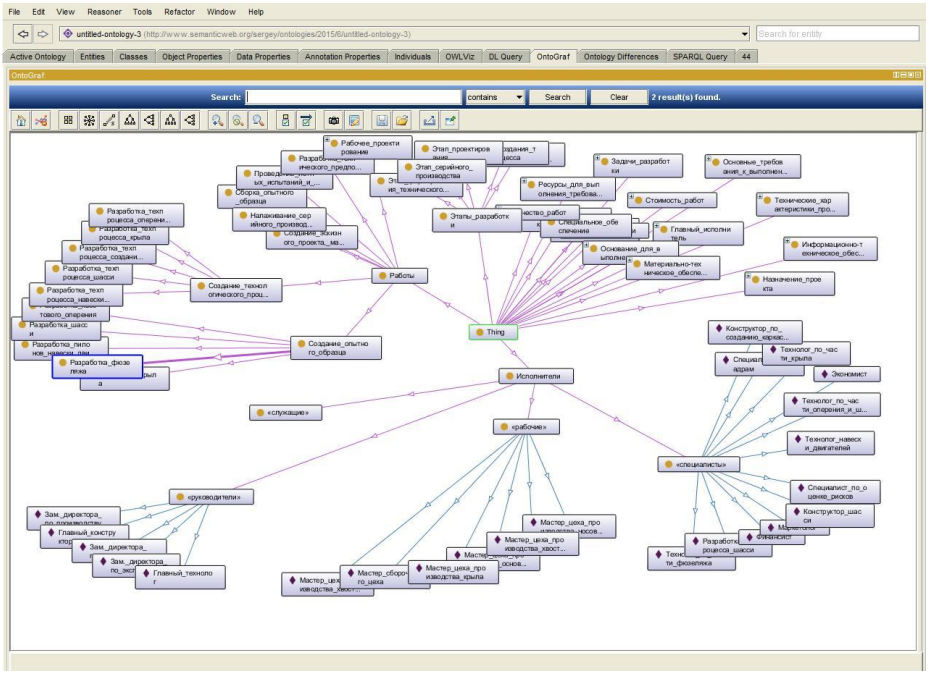


**Fig. 5.** The semantic web of a project for the development of a reconnaissance-strike complex for action in mountain conditions.

## 3 Conclusion

The developed ontological model of the innovation project scope is used to determine the classes of objects that correspond to the knowledge classes for functional specialists and specialists in general. The advantage of this model is the possibility of structuring the project content in the form of a hierarchy of knowledge about the project requirements, the main tasks and performers. However, this model is static, does not allow to display the dynamics of interrelations during the project implementation.

The next stage of the research is the selection of the required amount of knowledge from each class of the semantic model, in accordance with the role in the project management team; definition of knowledge set required for the full implementation of the project, and further - the comparison of object classes and functional roles of the project management team.

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