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THE PECULIARITIES OF KNOWLEDGE MANAGEMENT IN ENVIRONMENTAL PROJECTS

The paper presents investigations on the application of projects and programs on management methods to solve the problems of nature conservation. The analysis of the types of knowledge required for environmental projects implementation showed the necessity of the basic knowledge in ecology and project management. The realization of the project can be successful if this knowledge is integrated. Thus, in order to achieve long-term ecological targets the processes of project management (PM) must be developed on the basis of environmental management (EM) approaches. The integrated model PM+EM gives the opportunity both to administer the project itself and to determine the potential influences on the environment in managerial decision making processes. In order to increase the efficiency of such projects and programs management it is reasonable to use the universal methods of knowledge and knowledge areas management determined by PMI (Project Management Institute). This approach allowed to determine the peculiarities of knowledge management in environmental projects. As a result the features of different types of knowledge for environmental projects realization have been analyzed, the processes of knowledge management as specific resources of environmental projects management have been described and the extended model of knowledge management in environmental projects has been formed. Such a model gives the opportunity to create and introduce the efficient project management system for achieving strategic and operational targets of the project, to increase its success, to reduce the expenses and negative environmental impacts and to acquire new knowledge for efficient environmental project management.

Keywords: environmental projects, management of knowledge, ecology, system of project management

1. INTRODUCTION

As the environmental impact caused by technology increases, more and more investigations are devoted to the application of projects and programmes management methods to solve the problems of nature conservation. Most projects dealing with the development of industry, infrastructure and agriculture are potential sources of pollution which have a negative impact on the environment. In order to achieve long-term

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environmental targets project management (PM) processes should be developed on the basis of environmental management (EM) approaches.

The successful introduction of environmental management techniques allows to determine the potential negative impact on the environment. The impact can be evaluated so that it can be avoided or reduced due to the changes in the project plan. The overall environmental impact is specified, all resulting benefits and expenses are evaluated, and the value of revenues and expenses is determined.

The combination of project management techniques and environmental management techniques allows to realize project management processes based on Deming cycle of continuous improvement [1]. In this case, the project can be defined as the environmental one, namely as a unique activity that has its beginning and its end in time. And it is aimed at achieving previously determined environmental effects, creating a certain unique product or service that will cause the reduction of negative environmental impacts. The given resources, terms, environmental indicators, quality requirements and the acceptable risk level, including the ecological one are limited [2]. The result of environmental project is the change in the state of the environment which can be expressed in specific values of ecosystem parameters. They include: the reduction of harmful substances in the air, water, and soil; the reduction of generated waste; the rise of public environmental awareness, etc. The integrated model will allow to administer the project and also to determine the potential environmental impacts at separate stages of project life cycle.

One of the problems that significantly reduces the efficiency of such projects and programmes management is the lack of universal techniques of knowledge management and knowledge areas management, defined by PMI (Project Management Institute), taking into account environmental changes. Such methods allow to select the projects and their management with minimal environmental damage.

2. THE ANALYSIS OF CHARACTERISTICS OF KNOWLEDGE TYPES FOR ENVIRONMENTAL PROJECTS REALIZATION

Philosophy sources define knowledge as the result of reality cognition, its adequate representation in the form of ideas, concepts, opinions, and theories.

In philosophical dictionary “knowledge” is defined as “a representation of objective attributes and relations of the world” [3].

Knowledge is the informative basis of intelligent systems as they always compare the external situation with their knowledge and follow it while making decisions. Equally important is the fact that knowledge is the systematized information that can be somehow enlarged and based on which you can get new information, i.e. new knowledge.

Environmental project is aimed at solving a definite ecological problem. Management of such a project, therefore, needs a set of environmental knowledge.

Matviychuk A.V. [4] believes that environmental knowledge is the result of human cognitive activity as a reaction to the environment. Environmental knowledge can be regarded as the ability of the purposeful interaction of a human with the environment. And in the aggregate of these two aspects it can be considered as a certain pattern of behavior in the environment.

Environmental knowledge is formed by a complex system of different structured sets of facts, patterns, theoretical constructs, images that contribute to overall impression about the environment and man's place in nature. They include specialized knowledge of

Environmental legislation, Environmental management and Nature conservation; knowledge about the processes occurring in the atmosphere, water, soil under the action of harmful and hazardous substances. The knowledge of Environmental safety, Environmental Audit, etc. is also important. The peculiarity of environmental knowledge is an unscientific component which has a low level of conceptual and theoretical organization, but to a large extent is determined by a level of social organization.

Unscientific components of environmental knowledge are:

- practical experience, mythological ideas and traditions; this knowledge can be regarded as the necessary basis of logical forms of environmental knowledge;
- pre-environmental knowledge which embodies the output "self-evident" picture of the reality; it denotes nature with the help of some "metaphysical" (basically socio-cultural) images; this knowledge gives certain perception, interpretation of the environment and one's place in it;
- personal environmental knowledge which can be regarded as a result of intellectual dedication in the process of mastering the natural world; it is based on active principle which relies on the surroundings, environment, and nature;
- emotional environmental knowledge acquired by individual mental reality within which understanding and experience have no cognitive limitations and complement each other; the cognition process, which includes emotional environmental knowledge, is characterized by implicating irrational and romantic attitudes in epistemological search.

It can be concluded that a person's awareness and assimilation of environmental knowledge means understanding its importance for studying and protecting the environment and its internal connections. It also means the ability to analyze and compare, to prove and generalize, to evaluate and explain. Modern environmental knowledge is thinking which is based on a definite worldview. And ecological worldview is the idea about the structure and functions of nature, about the world which exists and operates regardless of whether a person is a part of it or not, the interaction with which leads to objective knowledge. One of the functions of environmental knowledge is the ability to determine effective methods of solving problems related to environmental changes. In our opinion, the most effective method of solving the problems concerning environmental improvement is to apply projects and programs management techniques.

It is known that PMBoK (A Guide to the Project Management Body of Knowledge) describes project life cycle and organizational structures found in companies carrying out the project [5]. The Guide determines process groups - initiating, planning, executing, monitoring and controlling, closing and their interaction with each other. Knowledge environment (both project management knowledge and environmental knowledge) should be created at each stage. Its aim is to promote knowledge exchange between the participants of the environment thereby increasing the efficiency of the project management. PMBoK identifies nine areas of project management and it defines basic and additional processes. The guide recognizes nine knowledge areas – project integration management, project scope management, project time management, project cost management, project quality management, project human resource management, project communications management, project risk management, project procurement management. The standard is process-based. Inputs, outputs, tools and techniques for changing inputs into outputs are defined for each knowledge area. The interaction between all the processes, which are included in knowledge areas of project management, is determined.

The knowledge area of project integration management includes processes and operations necessary to ensure that various elements of the plan are properly coordinated and integrated into all knowledge areas and at all stages of project life cycle to guarantee its success.

3. THE DESCRIPTION OF KNOWLEDGE MANAGEMENT PROCESSES AS A SPECIFIC RESOURCE OF ENVIRONMENTAL PROJECTS MANAGEMENT

A great variety of definitions of knowledge management can be found in the literature. According to W.R. Bukowitz and R.L. Williams, "knowledge management is a process through which an organization generates its wealth basing on its intellectual capital or knowledge-based organizational assets" [6]. Intellectual capital or knowledge-based assets in this definition mean something that is closely related to people or arising from organizational processes, systems and culture. And it is relevant to corporate image, employees' individual knowledge, intellectual property, licenses, and such structures associated with knowledge as databases and technologies used both inside and outside the organization. According to D. Zh. Skyrme, knowledge management is a "clear and systematic management of knowledge important for an organization and related processes of management, collection, organizing, diffusion, use and exploitation in order to achieve organizational goals" [7]. R. Ruggles argued that "knowledge management can be defined as an approach to increase or create value through the active support of experience related to know-how and knowledge of what and how to do that are equally existing both inside and outside the organization" [8]. Hence, knowledge management covers a wide range of activities related to wisdom or intellect of individuals and to diverse information used in project activities.

Thus, knowledge management is the management approach that emerged because of the need to take into account the peculiarities of knowledge as a resource. Approaches applied to manage the other types of resources (physical, material, financial) are not used to manage knowledge because it has fundamental differences. For example:

1. A person transferring knowledge remains its owner - knowledge can be transferred unlimited number of times, and being transferred it gets one more owner.
2. Knowledge does not wear out, rather the opposite - being constantly used it develops and becomes more valuable.
3. The possession is virtual and can be formalized (explicit) and personalized (tacit); other resources exist objectively.

There are explicit knowledge that can be put down on paper, the other media, expressed verbally; and implicit (tacit) knowledge that is personalized, for example, intuition, subjective insights, ideals, values and even individual's emotions.

Explicit and implicit knowledge is an essential component of the development of knowledge management strategy. The purpose of knowledge management is to build a bridge between those who need knowledge and those who have it. It is the interaction between people (sharing ideas, decisions, relevant information) that facilitates decision making and effective management of increasing volumes of information within the project.

Knowledge management, therefore, can be defined as a process aimed at creation, accumulation and application of knowledge in the project. The criterion of its efficiency is the ability of each project participant to gain required knowledge in time.

There are two main approaches based on the division of knowledge into explicit and implicit:

1. Formalized knowledge management
2. Personalized knowledge management.

When creating new knowledge explicit and implicit knowledge interact due to the processes of knowledge conversion. This model is called knowledge spiral [9].

The basic process of new knowledge creation is an aggregation of individual knowledge with organizational knowledge, i.e. the "socialization of knowledge". For environmental projects individual environmental knowledge integrates into project management procedures. Thus, it takes some form, i.e. it is converted into concepts – the process of "externalization". In classification ("combination") process it is important to build a model, archetype of organizational knowledge use. It is also important for this organizational knowledge in the form of, for example, project product, service, or environmental change to reach the consumer – the process of "internalization".

The specification of the spiral can lead to the formation and development of technologies for knowledge accumulation in environmental project. This process is the basis for achieving the project success.

4. AN EXTENDED MODEL OF KNOWLEDGE MANAGEMENT IN ENVIRONMENTAL PROJECTS

The purpose of forming the extended model of knowledge management in environmental projects is to develop and implement an effective project management system. Hence, it will help achieve strategic and operational goals of the project, improve its performance, reduce costs, and reduce negative environmental impact.

The systems model of knowledge management in environmental projects, including inputs and outputs, model restrictions, controlling and uncontrollable parameters, is shown in Table 1.

Knowledge management in environmental project has to solve the following problems:

1. Assessment of sufficient knowledge for tactical tasks performance.
2. Assessment of necessary knowledge for strategic decision making.

The first task brings to formalized knowledge management. And it requires project workflow system to be constructed to manage individual processes (cost management, risk management, quality management, etc.). For the project of environmental management system implementation this is the 3rd and the 4th level documentation. These are special procedures, lists, instructions and other primary documents and documentation of monitoring and control.

Table 1. Systems model of knowledge management in environmental projects

Input parameters	$X = \{x_1, x_2\}$, where x_1 is a set of environmental knowledge, x_2 is a set of project management knowledge
Output parameters	$Y = f\{x_1 \cup x_2\}$, where Y is new knowledge as an integration of project management methods and environmental management methods
Restrictions	$U = \{u_1, u_2, u_3, u_4, u_5\}$, where u_1 is legal indicators, u_2 is social and political indicators, u_3 is financial and economic indicators, u_4 is organizational indicators and u_5 is environmental safety indicators
Controlling parameters	$G = \{g_1, g_2\}$, where g_1 is formalized knowledge management, g_2 is personalized knowledge management
Uncontrollable parameters	$V = \{v_1, v_2, v_3, v_4\}$, where v_1 is subjective indicators of separate knowledge carriers; v_2 is social factors caused by a low level of administrative discipline; v_3 is financial risks of knowledge management system introduction caused by external and state factors; v_4 is force-majeure situations.

The second task is strategic management of environmental project, its integration and scope. The example of knowledge management at the strategic level for the project of EMS implementation is the development of environmental policy of a company, its goals, objectives, EMS Manual and other documents established and controlled by top managers.

The formation of new knowledge is based on the integration of environmental knowledge with project management knowledge. Table 2 shows the model for the formation of new knowledge for effective management of environmental projects at the strategic level.

The peculiarities of environmental knowledge integration for other knowledge areas of project management at the **organizational level**. For the development of project management criteria it is necessary to use environmental knowledge and to decompose the problem to the local level as well as to choose problem solving method. With the application of project management knowledge project product and result can be determined and a project from the project portfolio can be chosen.

Project cost management takes place using environmental knowledge of costs relating to environmental influences (permissions, quotas, fines) and project management knowledge of financial aspects of project realization, budgeting and cost control. It is applied to resource expenses necessary for finishing the project. As a result it can be determined that the peculiarities of investment attraction lie in applying clean development mechanism and joint implementation mechanism under the Kyoto Protocol concerning the restrictions on greenhouse gas emissions.

Project quality management implies that environmental aspects are considered and the compliance with the requirements of environmental legislation, standards, nature conservation regulations is taken into account. Project management knowledge allows to ascertain whether project quality and project product quality are up to quality standards and whether preventative approach is used to guarantee quality assurance. The integration of this knowledge facilitates the determination of accordance with ISO 9000 and ISO 21500 standards.

Table 2. The model of integration of environmental knowledge with project management knowledge at the strategic level

	Environmental knowledge	**Integrated knowledge**	**Project management knowledge**
Tasks	Understanding the heart of the problem. Understanding the consequences of activity or inactivity. Understanding the ways of problem solving.	The development of programme mission, project strategy, and performance indicators.	The determination of project product and result. The development of project or programme realization indicators. Projects and programmes portfolio formation.
Processes			
Project integration management	Monitoring and control of the state of the environment, the analysis of impact on the other processes.	The integrated environmental changes control. The influences on all processes of project management are taken into account in decision making. The environment is an aspect that is included in every process of decision making.	All the processes of project management are combined and the interaction of different aspects of the project is identified.
Project scope management	The environment is assessed with every change and is broken down into components in every process of decision making.	The environmental changes, affecting project scope, are assessed, analyzed, and taken into account in decision making.	Management is concentrated on project boundaries, the control of project activities necessary for finishing the project.

Based on knowledge of environmental safety and project uncertainty and risk management *project risk management* occurs. Identification, analysis, planning of prevention or risk response measures are carried out for this purpose.

As for *project procurement management* it is necessary to use environmental knowledge and to choose the suppliers with the highest level of environmental safety. As the suppliers are demanded to satisfy the requirements of environmental standards and environmental aspects in their project activity are identified. Knowledge of resources, products or services procurement management; the conclusion of necessary contracts is used for this knowledge area management.

Thus, the model of knowledge integration allows to determine project strategic and operational aims, the direction of their achievement, and to acquire new knowledge for efficient environmental project management.

5. CONCLUSIONS

The analysis of the types of knowledge required for environmental projects implementation showed the necessity of the basic knowledge of Ecology and Project management. The realization of the project can be successful if this knowledge is integrated. Current knowledge management in project realization is its specific resource the study of which requires a systems approach. The model of knowledge management allowed to form the systems model of knowledge management in environmental projects. The model includes inputs and outputs, model restrictions, controlling and uncontrollable parameters. The peculiarities of creating new knowledge for efficient environmental project management at the strategic and organizational levels were determined.

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CECHY ZARZĄDZANIA WIEDZĄ W PROJEKTACH ŚRODOWISKOWYCH

W pracy przedstawiono badania nad zastosowaniem projektów i programów dotyczących metod zarządzania w celu rozwiązywania problemów związanych z ochroną przyrody. Przeanalizowano cechy rodzajów wiedzy do realizacji projektów ekologicznych, opisano procesy zarządzania wiedzą oraz zarządzania zasobami środowiska, utworzono uogólniony model zarządzania wiedzą w projektach środowiskowych. Taka analiza wykazała konieczność podstawowej znajomości ekologii i zarządzania projektami. Realizacja projektu może być skuteczna jeśli wiedza ta jest zintegrowana. Tak więc, w celu osiągnięcia długoterminowych celów ekologicznych należy opracować procesy zarządzania projektami, które to powinny opierać się na podejściu zarządzania środowiskowego. Tak zintegrowany model daje możliwość administrowania zarówno samego projektu, jak i określenia potencjalnych wpływów na środowisko w procesie podejmowania decyzji menedżerskich. Aby zwiększyć skuteczność takich projektów oraz zarządzania programami rozsądnym jest korzystanie z powszechnych metod zarządzania wiedzą i obszarów wiedzy określone przez PMI (Project Management Institute). Takie podejście pozwola na określenie specyfiki zarządzania wiedzą w projektach środowiskowych . W rezultacie cechy różnych rodzajów wiedzy o realizacji projektów na środowisko mogą zostać przeanalizowane. Taki model daje możliwość stworzenia i wprowadzenia skutecznego systemu zarządzania projektami do realizacji strategicznych i operacyjnych celów projektu w celu zwiększenia jego sukcesu, w celu zmniejszenia kosztów i negatywnego wpływu na środowisko oraz w celu zdobycia nowej wiedzy do skutecznego zarządzania projektami ochrony środowiska.

Słowa kluczowe: projekty środowiskowe, zarządzanie wiedzą, ekologia, system zarządzanie projektami.

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