Creation of the Eco-Logistic System Project Products Configuration in the Conditions Of Uncertainty

Sergiy Rudenko[a], Tetiana Kovtun[a]

[a] *Odesa National Maritime University, 34, Mechnikova str., Odesa, 65029, Ukraine*

Abstract

The article considers the issue of creating the project products configuration. The specific features of the eco-logistic system project phases products are revealed and the interrelation between them is established. It is proposed to create a project products configuration in four stages: specification of product parameters, product clustering, structuring of product clusters, product identification. Product parameter specification is intended to create descriptive product models that contain the set of parameters required to characterize the project phase product. Product clustering involves the creation of product clusters information models that contain information about the set of the project phases productst that have similar parameter values. Structuring product clusters leads to a project product clusters network, which allows to take into accountthe links between the products of the project phases and create a potential set of the project phases product, which include products that provide maximum value of the eco-logistic system project. Product identification by creating an information model establishes compliance of a specific product to a cluster and consists in the formation of a real project products chain. In the process of the project products configuration forming , the uncertainty of the project implementation conditions is taken into account.

Keywords 1

Eco-logistic system project, project life cycle, a configuration of project products, project product chain.

1. Introduction

At the beginning of the XXI century, the problem of modern civilization unsustainable development has acquired a new qualitative state and reached its limit. It has become clear that an economy built on the technocracy principles and non-equivalent socio-natural exchange is not able to ensure long-term sustainable development for humanity. The modern requirement for the eco-logistic systems in the mankind sustainable development paradigm is to take into account the eco-destructive impact of the system and the result of its operation - a set of logistics services to promote direct and reverse material flows on the environment. Prevention and elimination of the negative impact consequences require the use of modern approaches, including eco-logistic systems project management. From the standpoint of the project approach, the eco-logistic system is considered as a unique result obtained from purposeful temporary activities. Thus, the project of creating an eco-logistic system is given a limited time, which is called the life cycle of the project. During the project life cycle, which is divided into separate phases, intermediate results are obtained - the products of the eco-logistic system project life cycle phases [1]. The specificity of the products obtained as a result of the phases implementation is reflected in their configuration as a set of functional and physical characteristics of the project products [2].

Proceedings of the 2nd International Workshop IT Project Management (ITPM 2021), February 16-18, 2021, Slavsko, Lviv region, Ukraine
EMAIL: rudsv@i.ua (A. 1); teta.kovtun@gmail.com (A. 2)
ORCID: 0000-0002-1671-605X (A. 1); 0000-0002-5410-4783 (A. 2)

2. Analysis of recent research and problem statement

The project approach involves the division of the project life cycle into phases characterized by obtaining a certain result - the product [3,4]. There are many options for dividing the project life cycle into phases, for different types of projects can be used different phases, which are characterized by obtaining different results, which greatly complicates the coordination of projects. The result of individual phases of the project life cycle is the certain products getting. The important place occupied by the concept of "product" in project management is indicated in [5]. The authors note that the project is a controlled system of actions to change the object of influence state during the life cycle, the result of which is the product of the project but do not take into account the possibility of creating multiple products during the project life cycle. The paper [6] identifies the main types of project product in terms of business level, which is necessary to determine the specifics of project marketing. The relationship "product life cycle - project - organization" is analyzed and a generalized idea of this connection is obtained. The following types of project products are presented: material products, services or ability to provide it, an intangible result (new state of the system), but the main attention is paid to the product as the final result of the project, the possibility of obtaining intermediate products are not taken into account. In [7] there are two interdependent systems: the product of the project and the project itself, the first of which determines the second, but at the same time, which interact closely in the management process. The project and the product of the project which will be synthesized at the end of the project are allocated, classification of products of the project in [8] is carried out, but questions of their configuration are not considered. The concept of project product is closely related to the concept of project configuration. In [9] a conceptual model of the configuration management process in projects was developed, where it is shown that to achieve the goal of this process, it is necessary to manage the configuration of the project, product and project environment. The paper shows the relationship between the tasks of synthesis and configuration management in projects during its life cycle but focuses on the study of the configuration of the project environment. In [10] the scientific and methodological bases of the process of coordination of product-system configurations and their projects, which takes place with four processes: product-system configuration management, product-system configuration, project configuration management and configuration-formation of design-technological structures formation of the product systems configuration. The main attention is paid to the definition of configuration matching, their essence is not sufficiently studied. In [2] a study of the purpose, role and place of the process of configuration management of the project environment in the overall process of configuration management in the project. The purpose of the configuration management process in the project is specified and the terms of the integrity of the project product, the integrity of the project and the integrity of the expectations of the project stakeholders are introduced. When determining the integrity of the product does not take into account the possibility of having many products of the project. Thus, the analysis of current research in the field of project management has shown the lack of a unified vision of the configuration management process in projects in terms of defining objects, entities, processes and management methods [14-20].

The issue of project product configuration management is most often studied, without considering the possibility of obtaining several products during the project life cycle, their integration into a single system and creating a single product configuration of project life cycle phases. Research in this area will allow a thorough analysis of the results to be obtained during the project. The purpose of the article is to develop a mechanism for creation the configuration of the eco-logistic system project products in conditions of uncertainty. To achieve this goal the following tasks are set:

- identify the features of the life cycle and products of the eco-logistic system project;
- to develop the configuration formation mechanism of the eco-logistic system project products in the conditions of uncertainty.

3. Presenting the main material

The need to take into account and eliminate the negative consequences of the eco-logistic system functioning has led to the need to extend its life cycle through the introduction of additional ecooriented phases. It is proposed to divide the project life cycle of the eco-logistic system into the following phases: pre-investment, investment, operational, regenerative, revitalization [1]. The first three phases (pre-investment, investment, operational) are standard phases for modern investment projects, including logistics systems. The presence of the fourth regenerative phase reflects the specifics of the environmentally-oriented logistics system and ensures the closure of the logistics chain. It is during this phase that circular processes take place to return the product (its parts or materials) to the processes of production and consumption. The last, fifth revitalization phase is related to the elimination of the eco-destructive consequences of the ecosystem from the creation and functioning of the logistic system. It can be long-lasting, as the negative impact on the environment may not manifest itself immediately and have a prolonged effect, and the ecosystem also needs time to recover. Each phase of the project ends with a certain result - the product:

1) in the pre-investment phase - a documented project of the eco-logistic system;
2) in the investment phase - the eco-logistic system in the material representation;
3) in the operational phase - a set of logistic services to promote direct material and reverse flows;
4) in the regenerative phase - a set of logistics services to promote reverse recycling flows;
5) in the revitalization phase - a set of actions for the revival, recovery of the ecosystem (Fig. 1).

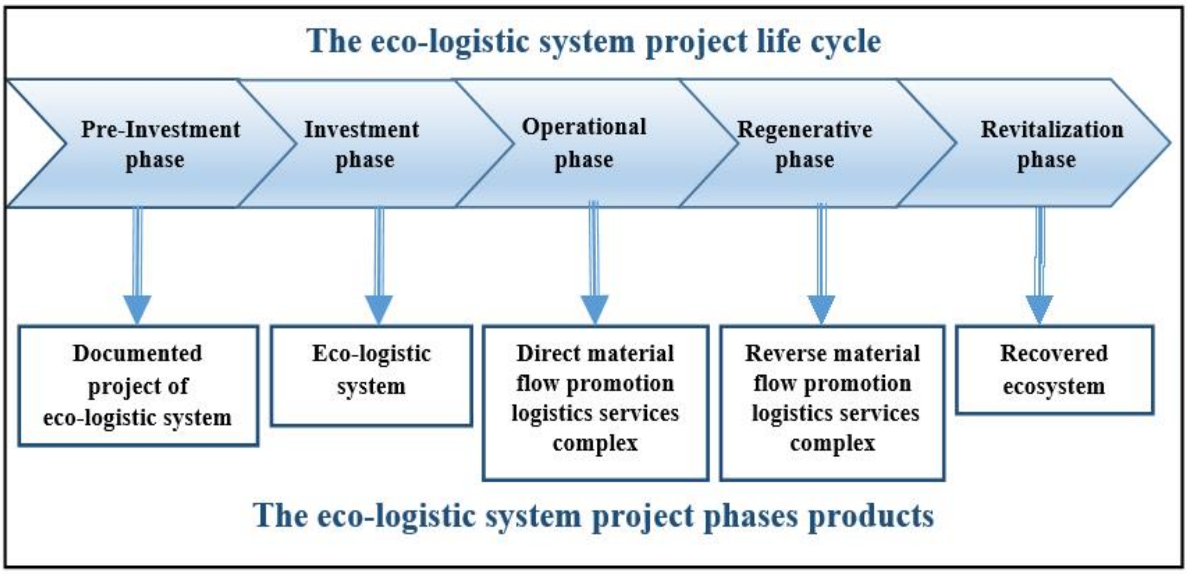

Figure 1: Life cycle and products of the eco-logistic system project

The formation of the configuration of the project phases products is proposed to be carried out in the following sequence:

1. The specification of product parameters is to create descriptive models of products that reflect the set of parameters required to characterize the product phase of the project.
2. Product clustering involves the creation of information models of product clusters that contain information about the set of the project phases products that have similar parameter values.
3. Structuring product clusters leads to the creation of a project product clusters network, which allows you to display the links between the products of the project phases and create a potential set of product chains of the project phases.
4. Product identification shows the compliance of a particular product to a cluster and consists of creating an information model of the real product chain of the project phases (Table 1).

Table 1
Characteristics of the stages of formation of the phases products of the eco-logistic system project

Stage	Research Tools	Model	Result
Specification	Theory of pattern recognition	Descriptive models of products	Set of parameters of products of the project phases

Clustering		Information models of product clusters	Sets of values of parameters of clusters of products of the project
Structuring	The morphological method, fuzzy set theory	A network of product clusters	The set of potential product chains of the project phases
Identification	Fuzzy set theory	Chain information model project products	The optimal set of products of the project phases

The specification of product parameters is to create descriptive models that reflect the properties of products that characterize the products of the project phases as objects of consumption. It is proposed to use the tools of pattern recognition theory (frame modelling) for identification. It is possible to give the characteristic of the eco-logistic system products using frame models containing the information on the properties of separate phases products. The frame is a universal information structure that not only stores the necessary information about the characteristics of the object, phenomenon or process under study but also indicates the relationships between them and other information objects [11]. Such properties of frames allow creating a network of frames in which interrelations between elements are reflected that is an adequate tool for research not only communications between products but also between separate parameters of products of an eco-logistic system project phases. The product frame of the project phase has a certain structure and consists of elements - slots (characteristics, attributes, properties, parameters), which show the characteristics of the frame - specific information about the product. Depending on the amount of information that contains the content of the frame, they are divided into:

- sample frames (prototypes, photo frames) - templates for describing entities that have a common structure and behaviour (for example, a prototype frame of a project product);
- instance frames - the implementation of a frame that reflects specific entities, phenomena, processes, etc. (for example, a frame instance of the project product) (Table 2).

Table 2
Types of frames on the information load in the project

Type frames	Characteristics of frames	Slots frame	Interpretation of frames in the project	Example of a frame in a project
Frames-prototypes	Templates for describing abstract entities that have a common structure and behaviour.	Characteristics (parameters) of the frame without specific values.	Reflect knowledge of general concepts in the project.	Project phase, a product of the project phase, process, operation, event, risk situation.
Copies frames	Implement a frame that reflects specific objects, phenomena, situations, processes, etc.	Characteristics (parameters) with specific values and corresponding procedures.	Reflect knowledge of specific concepts in the project.	Product of the investment phase of the eco-logistic system project, recycling a circular process.

The frame model is universal and can, depending on the content, display information through frame-objects (frame of the product cluster of the investment phase of the project), role-frames (frame of the project investor), frames-operations (processes) (frame of the planning process), scenario frames (project product chain frame), situation frames (project underfunding risk frame) (Table 3).

Table 3
Types of frames on the content in the project

Type frames	Interpretation of frames in the project	Example of a frame in a project
Frames-objects	Reflect the elements of the project content, basic concepts and components of the project.	Project life cycle, life cycle phase, a product of the project phase, project resource potental.
Frames-roles	Reflect the roles of project stakeholders, team members, project executors.	Project participant, project customer, investor, project team leader.
Frames-situations	Reflect situations that are planned to occur or can occur in the project.	Milestone event of the project, risk situation in the project.
Frames-operations (processes)	Reflect the processes (management and operational) of the project and their components (functions, operations, works).	WBS-structure, work package, project management process, logistics business process.
Frames-scripts	Reflects alternative ways of project development.	The alternative project, project product chain, etc.

At the stage of a specification to determine the characteristics that are inherent in the products of the project phases, it is possible using of product prototype frames. In the frame model, each product is described by a set of slots - parameters. Formation of a set of parameters $X^f = \left\{x_1^f;...;x_j^f;...;x_{J_f}^f\right\}$, characterizing the product of the phase f, $\left(f=\overline{1;F}\right)$ the project, is a heuristic operation and depends on the required amount of information about the product for further research. Relationships are observed between the products of the eco-logistic system project phases, which reflect the dependence of the some products characteristics on the properties of others. The formation of project products over time is the result of an orderly sequence of each project phase works and is carried out, starting with the pre-investment and ending with the revitalization phase. From the point of view of the goal-setting process during project development, the sequence of product parameters formation has the opposite direction and is carried out starting from the products of the operational and regenerative phase and ending with the product of the pre-investment phase (Fig. 2).

The product of the operational phase - a set of services to promote direct material flow generates a product of the regenerative phase - a set of services to promote reverse material flow. The characteristics of the direct material flow (volumes and composition of the product; properties of the substances that make up the product; consumption and reusability, etc.) depend on the characteristics of the reverse recycling flow (volumes, composition, flow intensity, recycling processes that can be used, etc.). It also affects the composition of the participants and the structure of the eco-logistic system (its straight linear section).

The characteristics of the investment phase product are influenced by the regenerative phase product - a set of services to promote the reverse material flow. The eco-logistic system itself produces the product of the revitalization phase - a set of actions to eliminate the negative consequences of the eco-logistic system creation and functioning and the ecosystem recovery.

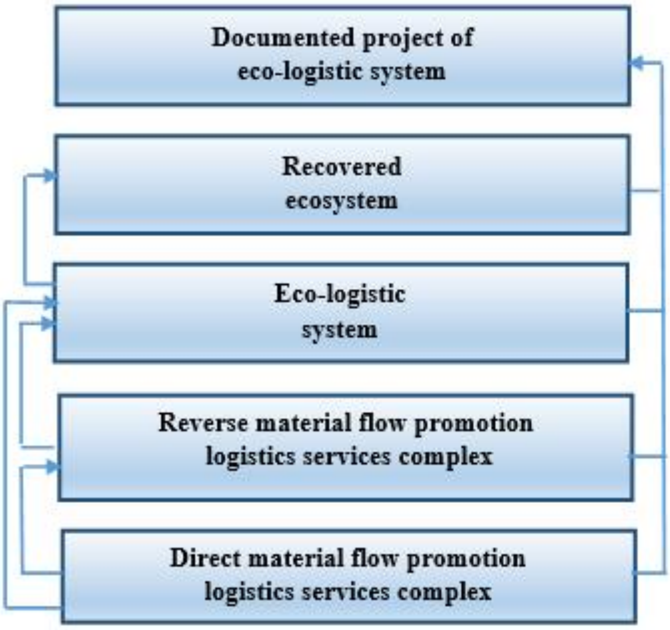

Figure 2: Relationships between the products of the phases of the eco-logistic system project

Clustering of the project phases products consists in creation of products clusters the having close values of parameters. Since the formation of product characteristics is carried out at the beginning of the project life cycle, to accurately determine the values of the parameters is quite problematic. The necessary information is not enough for this procedure. The problem can be solved by creating clusters of the project phases products with similar parameter values. It is proposed to represent product clusters using the product cluster instances, which are created based on product prototype frames and contain information about the values of product parameter slots included in this cluster.

The clustering task is to divide the space of product parameter values into areas corresponding to specific clusters $C^f_{g_f}$, $\left(f=\overline{1;F}\right)$, $\left(g=\overline{1;G_f}\right)$, to minimize the possible number of errors in assigning the product to the cluster. Sets of project phases products clusters are formed $C^f=\left\{c^f_1;\ldots;c^f_{g_f};\ldots;c^f_{G_f}\right\}$, $\left(f=\overline{1;F}\right)$. As a result of clustering, the product of the project described by the set of parameters $X^f=\left\{x^f_1;\ldots;x^f_{j_f};\ldots;x^f_{J_f}\right\}$, $\left(f=\overline{1;F}\right)$, which take values $X^f_j=\left\{x^f_{j1};\ldots;x^f_{jn};\ldots;x^f_{jN}\right\}$, $\left(j=\overline{1;J_f}\right)$, refers to a specific cluster $C^f_{g_f}$. It is possible to characterize the products of the project using of quantitative and qualitative parameters. Depending on whether the parameter belongs to a certain group, the measurement scale and the method of determining the similarity of the parameter are chosen. The frame instance of the cluster must contain information about the value of the qualitative parameter or the range of the quantitative parameters values.

The structuring of product clusters is the next step in the formation of project product parameters, which leads to the creation of a network structure, nodes of which are clusters of project products, represented by appropriate instances, between which there are links to create many alternatives to potential project product chains. The apparatus of fuzzy set theory allows taking into account the uncertainty when creating product chains of the project phases. It is used to analyze the structural links between clusters, which is not only to determine the presence or absence of links between certain products clusters of different project phases, but also to identify levels of these links dominance , which is important for further chain creation of the project phases products.

It is suggested that the relationships between products be displayed as fuzzy relationships between product clusters $C^f_{g_f}\underset{\sim}{R}C^{f+k}_{g_{f+k}}$, $\left(k=\overline{-K,K}\right)$, $\left(g=\overline{1,G_f}\right)$. Under fuzzy relations is understood as a fuzzy relation $\underset{\sim}{R}$ on the direct product of universal sets $C_{g_f}^{f}$ and $C_{g_{f+k}}^{f+k}$, that takes values on the set of membership functions [12]. Fuzzy relationships between product clusters of project phases are defined by their membership functions $\mu_{\underset{\sim}{R}}\left(C_{g_f}^{f}, C_{g_{f+k}}^{f+k}\right)$, which reflect the degree of correspondence (affinity) between product clusters that are at the appropriate network levels and have connections.

Fuzzy relations between clusters of products are represented in the form of matrices of relations, rows and columns of which are matched by clusters of products, and at the intersection of rows and columns are the functions of belonging to fuzzy relations (Table 4).

Table 4

Matrix of fuzzy relationships between clusters of products

Product clusters of project *f* phase	Product clusters of the *f+k* phase of the project				
	C_1^{f+k}	...	$C_{g_{f+k}}^{f+k}$	...	$C_{G_{f+k}}^{f+k}$
C_1^f	$\mu_{\underset{\sim}{R}}\left(C_1^f, C_1^{f+k}\right)$	...	$\mu_{\underset{\sim}{R}}\left(C_1^f, C_{g_{f+k}}^{f+k}\right)$	...	$\mu_{\underset{\sim}{R}}\left(C_1^f, C_{G_{f+k}}^{f+k}\right)$
...	...	...	...	...	...
$C_{g_f}^f$	$\mu_{\underset{\sim}{R}}\left(C_{g_f}^f, C_1^{f+k}\right)$	...	$\mu_{\underset{\sim}{R}}\left(C_{g_f}^f, C_{g_{f+k}}^{f+k}\right)$	...	$\mu_{\underset{\sim}{R}}\left(C_{g_f}^f, C_{G_{f+k}}^{f+k}\right)$
...	...	...	...	...	...
$C_{G_f}^f$	$\mu_{\underset{\sim}{R}}\left(C_{G_f}^f, C_1^{f+k}\right)$	...	$\mu_{\underset{\sim}{R}}\left(C_{G_f}^f, C_{g_{f+k}}^{f+k}\right)$	...	$\mu_{\underset{\sim}{R}}\left(C_{G_f}^f, C_{G_{f+k}}^{f+k}\right)$

Information about fuzzy relationships between product clusters allows you to form on the product network many variants of the project phases product chains, based on fuzzy relationships and the degree of dominance of these relationships. In hierarchical order, the network levels are arranged as follows (bottom to top):

- clusters of the operational phase products - complexes of logistics services to promote direct material flow $C_g^3 = \left\{C_1^3;...;C_{g_3}^3;...;C_{G_3}^3\right\}$;
- clusters of the regenerative phase products - complexes of logistics services to promote the reverse material flow $C_g^4 = \left\{C_1^4;...;C_{g_4}^4;...;C_{G_4}^4\right\}$;
- clusters of the investment phase products - eco-logistic systems $C_g^2 = \left\{C_1^2;...;C_{g_2}^2;...;C_{G_2}^2\right\}$;
- clusters of the revitalization phase products - options for ecosystem revival $C_g^5 = \left\{C_1^5;...;C_{g_5}^5;...;C_{G_5}^5\right\}$;
- clusters of the pre-investment phase products - documented projects of the eco-logistic system $C_g^1 = \left\{C_1^1;...;C_{g_1}^1;...;C_{G_1}^1\right\}$ (Fig.3)

When creating a chain link between clusters at different levels of the network, those clusters are selected, the degree of dominance of fuzzy relationships between which reaches the maximum possible value.

Also, when advancing on the network, it is necessary to take into account the threshold values of the relations dominance degree $\alpha_{\mu_{\underset{\sim}{R}}}$, which is determined by the priority of creating a link between products clusters in terms of achieving the maximum value of the project. The value of this type of projects is proposed to be considered from the standpoint of compliance with the basic rules of eco-logistic: the necessary product, in the right quality, in the right quantity, in the right place, at the right time, the right consumer, with minimal costs and minimal eco-destructive impact [13].

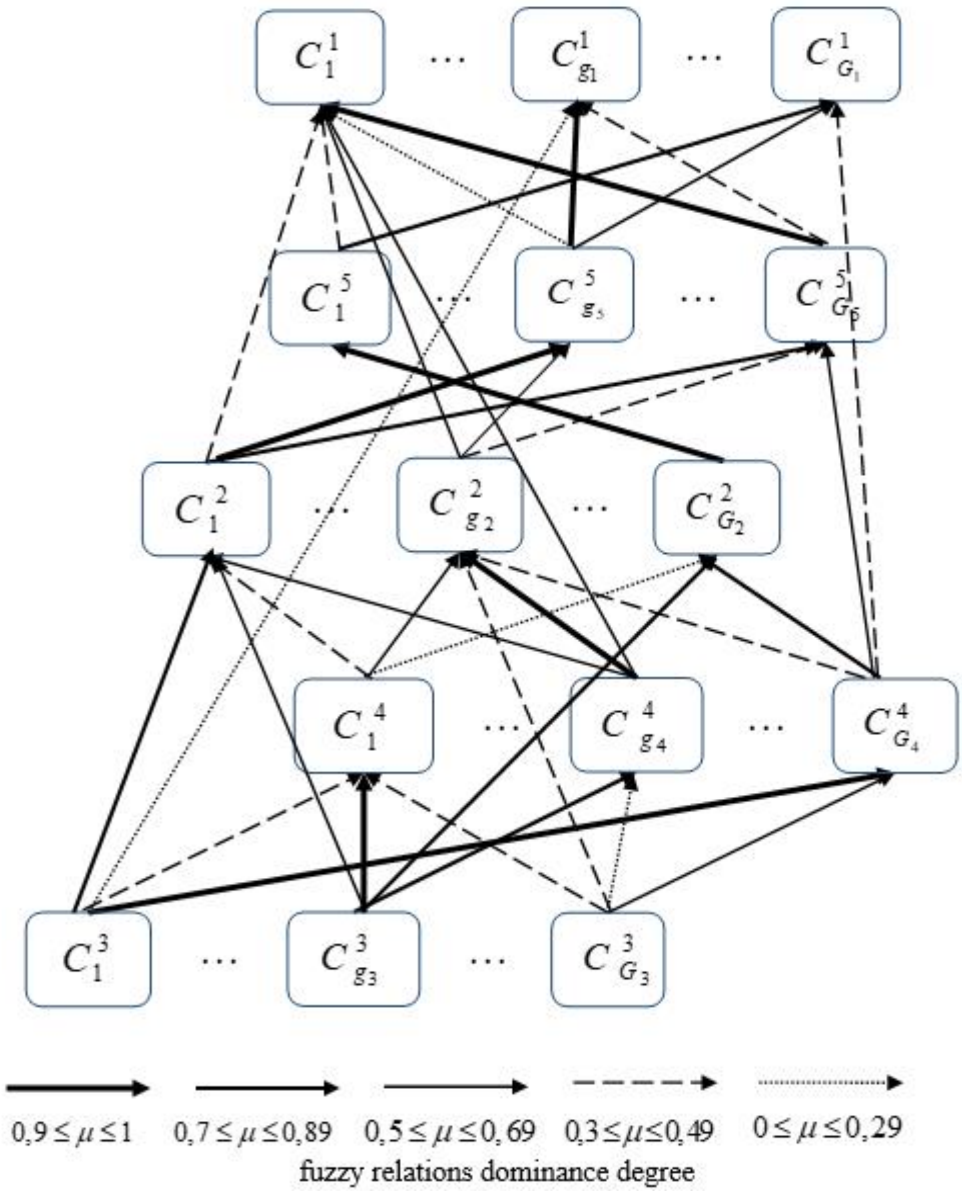

Figure 3: Network of products of the phases of the project of the eco-logistic system

If the membership function does not reach the threshold value,

$$\mu_{\underset{\sim}{R}}\left(C_{g_f}^{f}, C_{g_{f+k}}^{f+k}\right) < \alpha_{\mu_{\underset{\sim}{R}}} \tag{1}$$

the fuzzy ratio is considered insignificant. Therefore, progress in this direction and the inclusion of this area in the production chain is not appropriate. Otherwise, when the membership function has exceeded the threshold value

$$\mu_{\underset{\sim}{R}}\left(C_{g_f}^{f}, C_{g_{f+k}}^{f+k}\right) \ge \alpha_{\mu_{\underset{\sim}{R}}} \tag{2}$$

advancement to another level of the network on this branch is possible. We propose to apply fuzzy relations as a threshold value of the membership function. Many variants of pairs of clusters of products of project phases are formed

$$D^{f;f+k}=\left\{\left(C^{f}_{g_f};C^{f+k}_{g_{f+k}}\right)_1;...;\left(C^{f}_{g_f};C^{f+k}_{g_{f+k}}\right)_{s_{f;f+k}};...;\left(C^{f}_{g_f};C^{f+k}_{g_{f+k}}\right)_{S_{f;f+k}}\right\},\left(f=\overline{1;F}\right),\left(g=\overline{1;G}\right),$$

$\left(k=\overline{-K;K}\right)$, which include pairs of clusters at certain levels of the cluster network, between which connections have been established that have crossed the membership function of fuzzy relations threshold.

The following cluster pairs sets are created on the network of the eco-logistic system project phases product clusters:

$$D^{3;4}=\left\{\left(C^{3}_{g_3};C^{4}_{g_4}\right)_1;...;\left(C^{3}_{g_3};C^{4}_{g_4}\right)_s;...;\left(C^{3}_{g_3};C^{4}_{g_4}\right)_{S_{3;4}}\right\},$$

$$D^{3;2}=\left\{\left(C^{3}_{g_3};C^{2}_{g_2}\right)_1;...;\left(C^{3}_{g_3};C^{2}_{g_2}\right)_s;...;\left(C^{3}_{g_3};C^{2}_{g_2}\right)_{S_{3;2}}\right\},$$

$$D^{4;2}=\left\{\left(C^{4}_{g_4};C^{2}_{g_2}\right)_1;...;\left(C^{4}_{g_4};C^{2}_{g_2}\right)_s;...;\left(C^{4}_{g_4};C^{2}_{g_2}\right)_{S_{4;2}}\right\},$$

$$D^{2;5}=\left\{\left(C^{2}_{g_2};C^{5}_{g_5}\right)_1;...;\left(C^{2}_{g_2};C^{5}_{g_5}\right)_s;...;\left(C^{2}_{g_2};C^{5}_{g_5}\right)_{S_{2;5}}\right\},$$

$$D^{3;1}=\left\{\left(C^{3}_{g_3};C^{1}_{g_1}\right)_1;...;\left(C^{3}_{g_3};C^{1}_{g_1}\right)_s;...;\left(C^{3}_{g_3};C^{1}_{g_1}\right)_{S_{3;1}}\right\},$$

$$D^{4;1}=\left\{\left(C^{4}_{g_4};C^{1}_{g_1}\right)_1;...;\left(C^{4}_{g_4};C^{1}_{g_1}\right)_s;...;\left(C^{4}_{g_4};C^{1}_{g_1}\right)_{S_{4;1}}\right\},$$

$$D^{2;1}=\left\{\left(C^{2}_{g_2};C^{1}_{g_1}\right)_1;...;\left(C^{2}_{g_2};C^{1}_{g_1}\right)_s;...;\left(C^{2}_{g_2};C^{1}_{g_1}\right)_{S_{2;1}}\right\},$$

$$D^{5;1}=\left\{\left(C^{5}_{g_5};C^{1}_{g_1}\right)_1;...;\left(C^{5}_{g_5};C^{1}_{g_1}\right)_s;...;\left(C^{5}_{g_5};C^{1}_{g_1}\right)_{S_{5;1}}\right\}.$$

The number of possible combinations of product clusters will be determined by the formula:

$$Q=\prod_{e=1}^{E}\left(C^{f}_{g_f};C^{f+k}_{g_{f+k}}\right) \qquad (3)$$

The approach, which involves considering all possible variants of cluster pairs, guarantees their participation in further study of product chains and requires considerable time for calculations. To reduce the problem to a smaller dimension and significantly reduce the number of calculations allows the use of morphological synthesis of product chains, which is aimed at creating the optimal criterion for the value of the chain. The priority of the application of the chain l_h, $\left(h=\overline{1;H}\right)$, the products of the project phases from the set of circuits $L=\{l_1;...;l_h;...;l_H\}$ is determined by calculating the total value of fuzzy relations dominance degree. Formalization of the process is carried out using the operation of combining the functions of membership of fuzzy relationships between clusters of products in individual sections of the network branch

$$\mu_{\underset{\sim}{R}}\left(l_h\right)=\bigcup\mu_{\underset{\sim}{R}}\left(C^{f}_{hg_f};C^{f+k}_{hg_{f+k}}\right) \qquad (4)$$

$$\left(f=\overline{1,F}\right),\left(g=\overline{1,G}\right),\left(k=\overline{-K,K}\right),\left(h=\overline{1,H}\right).$$

Thus, the product chains include those clusters that provide the maximum possible products total value that fall into the clusters located on the chain. The project phases products identification is to recognize the compliance of a particular product to a particular products cluster and is carried out by creating an information model of the product chain - a code structure that reflects the compliance degree of slot parameters a frame instance of the product cluster. It is possible to display the affiliation of a product variant $P_{m_f}^{f}$, belonging to a set of product variants $P^{f} = \left\{ p_1^{f};...;p_{m_f}^{f};...;p_{M_f}^{f} \right\}, \left(m = \overline{1;M_f} \right)$, a certain phase *f*, $\left(f = \overline{1,F} \right)$a project, to a cluster of this phase products, thanks to a comparative analysis of product variant parameter values to product cluster parameters $C_{g_f}^{f}$, $\left(g = \overline{1,G_f} \right)$. The belonging of a product to a certain cluster is expressed by the membership degrees of the product parameters values to the values of product parameters belonging to a certain cluster $\left\{ \left(x_{m_f jn}, \mu_{C_{g_j}^{f}} \left(x_{m_f jn} \right) \right) \right\}$. The product of the project belongs to the cluster for which the value of the general characteristic function, which reflects the degree of the product membership, reaches the maximum value. The parameters can vary in importance, it should be taken into account when calculating the total membership function using normalized weights β_j.

$$\mu_{C_g^f}\left(P_m^f\right) = \bigcup \left(\beta_j \cdot \mu_{C_{gj}^f}\left(x_{mjn}\right) \right), \ \forall x_{mj} \in X_{mj}^{f}$$
$$\left(f = \overline{1,F} \right), \left(g = \overline{1,G_f} \right), \left(m = \overline{1,M_f} \right), \left(j = \overline{1,J_f} \right), \left(n = \overline{1,N} \right) \quad (5)$$

where β_j - normalized weighting factor, which reflects the level of the j parameter product importance, $\mu_{C_{gj}^f}(x_{mj})$ - the degree to which the values of the product j parameter P_m^f belong to the set of values corresponding to the cluster C_g^f.

Areas for determining the membership functions of individual parameters should have a lower limit of the threshold value

$$\left\{ x_{mj} / \mu_{C_{gj}^f}\left(x_{mj}\right) \geq \gamma_j \right\} \quad (6)$$

where $\gamma_j \leq 1$.

The preliminary setting of threshold values of parameters belonging degrees will allow avoiding inclusion in project phases products chains those products which have inadmissible values of separate parameters. Thus, it is possible to form a project products configuration in the form of a real productschain with such values of product parameters, through which it is possible to implement an eco-logistic system project in compliance with environmental rules and achieve the maximum possible value of the project.

4. Conclusion

The offered mechanism of the eco-logistic system project products configuration creation allows forming products chains whereby which it is possible to reach the maximum of the general value of the received project results. The formation of the configuration is carried out in four stages. The specification of product parameters is to create descriptive models of products that contain the set of parameters required to characterize the project phase product. Product clustering involves the creation of product clusters information models that contain information about the set of the project phases products that have similar parameter values. Structuring product clusters leads to a network of project product clusters, which allows to reflect the links between the products of the project phases and create a potential set of product chains, which include products that provide maximum value of the project eco-logistic system. Product identification, by creating an information model, reflects the compliance of a particular product to a particular cluster and consists in the synthesis of a real project products chain.

References

[1] T. Kovtun, Frame modelling of eco-logistic system project products. Transport Development. Science. Journal, 2020, Vip. 1 (6), pp.17–29.

[2] V. Morozov, S. Rudnitsky, Model of the influence of the external environment on the process of configuration management in the project. Management of complex systems development 16 (2013) 46–52.

[3] A Guide to the Project Management Body of Knowledge (PMBoK), Six Edition, USA, 2017.

[4] Practice Standard for Project Configuration Management. Project Management Institute, Four Campus Boulevard, Newton Square, PA 19073-3299 USA, 2007.

[5] A. Litvinchenko, V. Rach, Problems of development of the science of project management. Project management and production development, 2004, № 4, pp. 5–12.

[6] S. Onishchenko, T. Bernevek, The main objects of marketing in project activities. Eastern European Journal of Advanced Technologies 3/2 (53), 2013, pp. 8–12.

[7] I. Babayev, Formirovanie vileniya produkta projekta razvitiya organizatsii. Upravlinnia projektami ta rozvytok vyrobnytstva, № 2, 2006, pp. 30–38.

[8] A. Litvinchenko, Management of project cost: essential relations. Project management and production development, № 1, 2006, pp. 124–128.

[9] V. Morozov, S. Rudnitsky, Conceptual model of the configuration management process in projects. Eastern European Journal of Advanced Technologies, 1/10 (61), 2013, pp. 187–193.

[10] O. Sidorchuk, Coordination of system-product configurations and their projects. Management of complex systems development, № 25, 2016, pp. 58–65.

[11] M. Minsky, Frames for the presentation of knowledge, Per. with English M, Energy, 1979.

[12] A. Coffman, Introduction to the theory of fuzzy sets, Moscow, Radio and communication, 1982.

[13] S. Rudenko, T. Kovtun, Greening of logistics as a direction of the realization of the concept of sustainable development. Project and logistics management: new knowledge based on two methodologies. Volume 3: monograph, ed. count S. Rudenko, I. Lapkin and others. Odessa, 2020, pp. 7–24.

[14] V. Obradović, M. Todorović, S. Bushuyev, Sustainability and agility in project management: contradictory or complementary? Springer Nature Switzerland AG, 2018

[15] N. Rusan, S. Bushuyev, and D. Bushuyev, Emotional intelligence — the driver of the development of breakthrough competences of the project, IEEE, International Scientific and Technical Conference on Computer Sciences and Information Technologies (CSIT), Lviv, Ukraine, 2017, pp. 1-7.

[16] R. Kaminskyi, N. Kunanets, A. Rzheuskyi, A. Khudyi, Methods of statistical research for information managers, in: Proceedings of the 13th International Scientific and Technical Conference on Computer Sciences and Information Technologies, CSIT 2018, 2018, pp. 127–131.

[17] A. Rzheuskyi, H. Matsuik, N. Veretennikova, R. Vaskiv, Selective Dissemination of Information – Technology of Information Support of Scientific Research. Advances in Intelligent Systems and Computing 871 (2019) 235–245.

[18] V. Tomashevskyi, A. Yatsyshyn, V. Pasichnyk, N. Kunanets, A. Rzheuskyi, Data Warhouses of Hybrid Type: Features of Construction. Advances in Intelligent Systems and Computing book series 938 (2019) 325–334.

[19] R. Kaminskyi, N. Kunanets, V. Pasichnyk, A. Rzheuskyi, A. Khudyi, Recovery gaps in experimental data. CEUR Workshop Proceedings 2136 (2018) 108–118.

[20] M. Odrekhivskyy, V. Pasichnyk, A. Rzheuskyi, V. Andrunyk, M. Nazaruk, O. Kunanets, D. Tabachyshyn, Problems of the intelligent virtual learning environment development. CEUR Workshop Proceedings 2386 (2019) 359–369.