Сучасний стан наукових досліджень та технологій в промисловості. 2021. № 1 (15)
ISSN 2522-9818 (print)
ISSN 2524-2296 (online)

UDC 005.8:005.591.6
DOI: https://doi.org/10.30837/ITSSI.2021.15.043

S. DANSHYNA

GENERAL APPROACH TO PROJECT MATERIAL RESOURCES MANAGEMENT

The **subject** matter of the article is the processes of managing the material resources of the project. The **goal** of the work is to form a generalized approach to the management of material resources project by determining and formalizing the management processes of them. The following **tasks** were solved in the article: the processes of managing material resources project, which based on the process approach, are formed; place of these processes in the PMBOK structure is defined, these processes are integrated with other project management processes; a formalized presentation of the project management processes of the project is given; tools and methods of managing material resources of the project are identified. The following **methods** used are – methods of system analysis, decision-making theory, and inventory management theory. The following **results** were obtained – with target to make informed management decisions, it was proposed to allocate a separate area of knowledge, within which the processes of the management of material resources of the project are formed, their possible connection with the groups of PMBOK processes is shown. Based on the process approach, presentations of the processes were formalized. They are elements of managing material resources of projects. They define inputs and outputs, show interrelations with other processes of a specific area of knowledge, provide basic recommended tools and methods. **Conclusions**: the processes management resource described in the PMBOK methodology are analyzed. This made it possible to form possible directions for improving the project's resource support. It is noted that the solution to this problem depends on the management of the material resources of the project. A separate area of knowledge has been highlighted, within the framework of the processes of management of material resources project – the processes of evaluating material resources, procurement management and supply, distribution of material resources, managing material resources. They define inputs and outputs, show interrelations with other processes of a specific area of knowledge, provide basic recommended tools and methods. The results obtained can be useful when managing projects at any stage of the life cycle.

Keywords: project management; non-reproducible project resources; project processes; process information flow model.

Introduction

Project management as a scientific direction is in constant development to increase the efficiency of managerial decisions. Analysis of about hundreds of sciencedirect.com databases (https://www.sciencedirect.com) confirmed that among the key factors that require close attention in drafting, the issues of improving the processes of material resources management are the most up-to-date. Even articles dealing with the problem of improving rental planning processes consider the tasks related to their resource provision (for example, in works [1, 2], where one of the reasons for exceeding the duration of the project is called resource shortage). This confirms the statement that "... management of project resources is exactly the curse that does not give a recreation to scientists" [3].

The resource is all that the project has, and therefore the timing, budget, quality of the project implementation and its product depend significantly on effective management by ensuring the optimal use of resources to achieve the project results with the specified indicators [3, 4]. Note that resources are a multifaceted concept that includes material resources, project team, finance, information, knowledge and technology. But existing project methodologies do not contain unambiguous approaches to resource management; new project management methods create new problems in their management, increase the risk of over expenditure and reduce the likelihood of its success [1 - 5]. This is what requires new approaches to project resource management.

Analysis of the problem and existing methods

We focus on the PMBoK methodology from the Project management institute (PMI), as one that has good recommendations, allows to plan a project from start to finish and execute it according to this plan. In PMBoK, project resource management is a field of knowledge that combines the processes of identification, acquisition and management in order to timely provide the necessary resources in the right place [4, 6]. In this case, regardless of the definition in the third edition of the PMBoK, two separate branches of knowledge related to project resources were distinguished – human resources management and supply management [6], in the sixth edition other industries were formed – resource management and procurement management [4] (table 1).

In the early version of the PMBoK standard, there are two types of project resources - non-reproducible and reproducible [6].

Non-reproducible (stored or accumulating resources) - resources that, in the course of the project work, seek to spend completely, preventing their reuse; however, if it is not possible to use a resource of this type at a certain point in time, then it is accumulated for consumption in the future.

Resources of the second type during the project implementation retain their shape and at the end of the work can be used for other works. A striking example of this type of resources is human resources [3].

In the future, the material resources of the project will be understood as resources of the first, non-reproducible type.

As we can see in the early version of PMBoK (Table 1), management processes for different types of resources differ significantly. For the management of material resources of non-reproducible type, the processes of procurement and supply management that occur during the creation of the material flow of the project are defined [4].

ISSN 2522-9818 (print)
ISSN 2524-2296 (online) Innovative technologies and scientific solutions for industries. 2021. No. 1 (15)

Table 1. *Comparison of groups of project resource management processes*

PMBoK version	Field of knowledge	Project resource management processes	
A Guide to the Project Management Body of Knowledge (Guide PMBoK), 3rd ed., USA: PMI, 2004.	Human Resources Management	Planning Process Group	Human resource planning
		Execution Process Group	Project team set Project team development
		Monitoring and Control Processes Group	Project team management
	Supply Management	Planning Process Group	Purchasing and procurement planning Contract planning
		Execution Process Group	Request information from sellers Selection of sellers
		Monitoring and Control Processes Group	Contract administration
		Final Process Group	Closing contracts
A Guide to the Project Management Body of Knowledge (Guide PMBoK), 6th ed., USA: PMI, 2017.	Resource Management	Planning Process Group	Resource management planning Estimation of operations resources
		Execution Process Group	Supply of resources Project team development Project team management
		Monitoring and Control Processes Group	Resource control
	Purchasing Management	Planning Process Group	Procurement management planning
		Execution Process Group	Procurement
		Monitoring and Control Processes Group	Procurement control

But in the latest project management guides there is no fundamental difference between the two types of resources. The field of knowledge of resource management from the same positions considers the issues of project team management and management of materials and components. This is not always appropriate for such reasons:

1. Invalid resources are the resources of type "Energy", reproductive resources - resources of type "Strength", which is manifested by the difference in the approach to management: if in the first case, an important management indicator is the presence, in the second – responsibility, talentance, trigger performance, etc. [7].

2. The attempt to combine resources of different types in one field of knowledge leads to the fact that the tools and methods proposed for the implementation of processes in this field are generalized, heuristic procedures (expert assessments, assessments by analogy, meetings, communication methods) prevail over accurate calculations.

3. The key concepts of resource management are formed as "solving the tasks of acquisition, management, motivation and mobilization of project team members" [4, p. 309], which makes secondary tasks of logistics of the project.

The **aim** of the work is to form a generalized approach to the management of material resources of the project by defining and formalizing the processes of their management.

The **task** of the study:

- based on the process approach, to form processes for managing the material resources of the project;
- to identify the location of the profile material resource management processes in the PMBoK structure and integrate them with other project management processes;
- formalize the processes of material resources management of the project;
- to identify key tools and methods for managing project material resources.

Materials and Methods

The requirement for material resources forms the "material supply chain" of the project. In the context of management, the main goal of this chain is to combine activities that have fallen out of the field of view of projects, but are directly related to material resources (logistics, inventory management), with project management activities (project scheduling, resource planning, resource allocation) in such a way as to ensure the success of the project by saving time and finance, reducing waiting times, improving customer satisfaction, reducing storage space, etc. [7, 8]. For example, the results of research on construction projects (P. F. Tunji-Olayeni and etc. [8]) indicate that logistics management is a more important element of construction project management. According to experts (architects, builders, project managers), the main problems that arise and lead to negative consequences in the projects are related to transportation, improper storage, delays in the supply of materials, etc. [8]. This has made it possible to separate processes directly related to logistics in the management of project resources, in particular [9]:

- material resource assessment processes – processes related to resource management planning in order to form approaches to assessing the type and quantity of materials, equipment and consumables, their supply and use in the performance of project work;

ISSN 2522-9818 (print)
Сучасний стан наукових досліджень та технологій в промисловості. 2021. № 1 (15) ISSN 2524-2296 (online)

- procurement and supply management processes - processes that provide the project with the resources necessary for its implementation;

- material resource allocation processes - processes related to resource allocation in the project supply chain and their delivery to the application site;

- Inventory management processes - processes aimed at managing inventory levels and monitoring project resource management performance.

Project management is an integrative action that requires all of its processes to be structured and linked to other processes to facilitate their coordination for project success [4, 6]. To do this, the PMBoK divides all processes into five groups - initialization, planning, monitoring, and closing process groups [4]. The relationship between process groups and project material management processes is shown in table 2[9].

Table 2. *Relationship of project material resource management processes with groups of project management processes*

Processes related to the logistics of the project	Project process groups according to PMBoK				
	Initiation	**Planning**	**Implementation**	**Monitoring and control**	**Closing**
Evaluation of material resources		Project material resource management planning	Estimation of material resources of project operations		
Management of procurement and supply of material resources		Procurement and supply management planning	Organize the supply and purchase of material resources	Control of procurement and supply of material resources	
Allocation of material resources of the project		Planning the management of the distribution of material resources in the logistics chain of the project	Organize the delivery of material resources to the place of application	Control of the distribution of material resources	
Inventory management of project material resources		Project material inventory management planning	Regulation of the level of stocks of material resources of the project	Monitoring the effectiveness of inventory management	

The process approach assumes that any process is considered, focusing on its inputs and outputs [4, 5], the principles of conceptual modeling allow considering it in relation to a separate field of knowledge (or a separate functional unit). Thus, the processes of material resource management of the project can be represented as a model of information flows of the process [10]

$$I\_\Pr = (V, Z, \varphi, A, O, \psi), \quad (1)$$

where $V = \{v_1, v_2, v_3\}$ is the set of input data, which includes: v_1 – assets of the organizational process project containing standard processes, life cycle project, instructions, template, storage rules, retrospective information on resources types, etc.; v_2 – environmental factors, which include information on the economic conditions of the project, the availability of resources, their location, when these resources may be available, terms of supply, etc.; v_3 – list of suppliers;

$O = \{o_1, o_2, o_3, o_4, o_5\}$ – the set of source data that contains o_1 – resource needs; o_2 – bills to pay; o_3 – consolidated resource management plan; o_4 – consolidated resource calendar (updates); o_5 – project logistics chain structure (updates);

$Z = \{z_1, z_2\}$ – a set of documents that regulate the process and ensure its proper flow: the project charter (z_1), which contains a high-level description of the project, requirements, list of stakeholders, aggregated events, financial resources that may affect the management of material resources; project management plan (z_2), in particular, issues related to schedule, cost, risks, supply, etc.;

φ – update function, the implementation of which is associated with the clarification (correction) of input data in accordance with the requirements of the documents governing the process of managing the material resources of the project;

$A = \{a_1, a_2, a_3, a_4\}$ – set of operations related to the logistics of the project (according to table 2);

ψ – output function, as a result of which the initial data of the process of material resources management of the project are formed.

Supporting the idea of graphical representation of models, we present the obtained model (1) in graphical form (fig. 1).

The internal content of information flows in the process of managing the material resources of the project is regulated by a number of documents, which prescribe the requirements for their design and composition. These documents form a single internal standard for the preparation and maintenance of projects through data modules in a single software and communication environment - the database (library) of the project, which receive when implementing the update function [10]:

$$\varphi : V \times Z \to V, \quad (2)$$

that is, the content of the elements of the set V varies depending on the scope and complexity of the project, updated and adjusted within the overall process of change

ISSN 2522-9818 (print)
ISSN 2524-2296 (online) Innovative technologies and scientific solutions for industries. 2021. No. 1 (15)

management during the receipt of new information on the project.

Execution of update function (2) clarifies the content of the elements of the set V. For example, the assets of the project organizational process that come to the input of processes related to material management, when implementing the function φ taking into account the requirements of the project management plan, are transformed into the initial requirement of "developing a hierarchical resource structure," the form, type and content of which are standardized.

After clarifying the input data by performing the function ϕ for the implementation of material resource management processes of the project, certain functions (operations) are provided, which form a reflection [10]:

$$\psi : A \times V \to O, \quad (3)$$

which unambiguously determines what will be at the exit of the development project process depending on the inputs and certain operations.

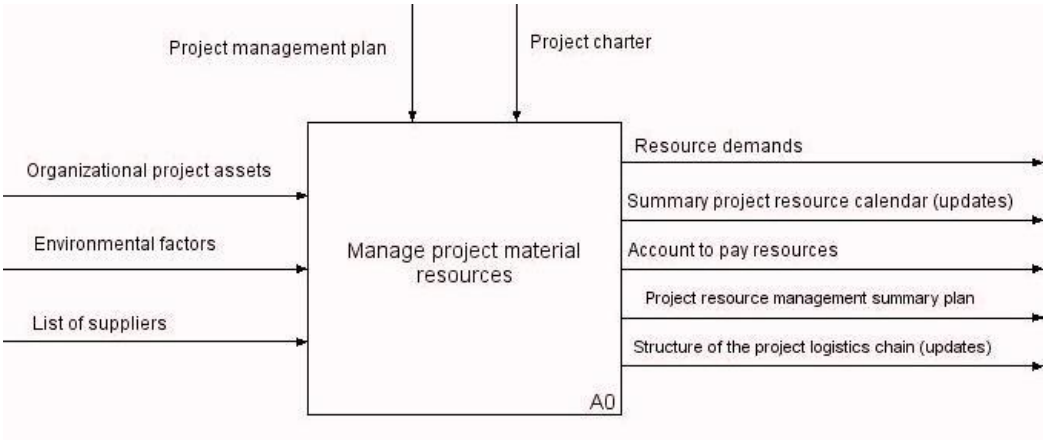

Fig. 1. Graphical representation of the model of information flows of material resources management processes of the project

Analyzing the table 2, let's form a set A. It consists of elements: a_1 – to estimate the material resources of the project; a_2 – to manage the procurement and supply of material resources of the project; a_3 – to allocate material resources of the project; a_4 – to manage stocks of material resources of the project.

Therefore, according to expression (3), the function ψ converts the set of input data $V = \{v_1, v_2, v_3\}$ into the set of output data $O = \{o_1, o_2, o_3, o_4, o_5\}$, passing through operations $A = \{a_1, a_2, a_3, a_4\}$, taking into account the requirements of the normating documents of the set $Z = \{z_1, z_2\}$. In graphical form, the function ψ is shown in fig. 2.

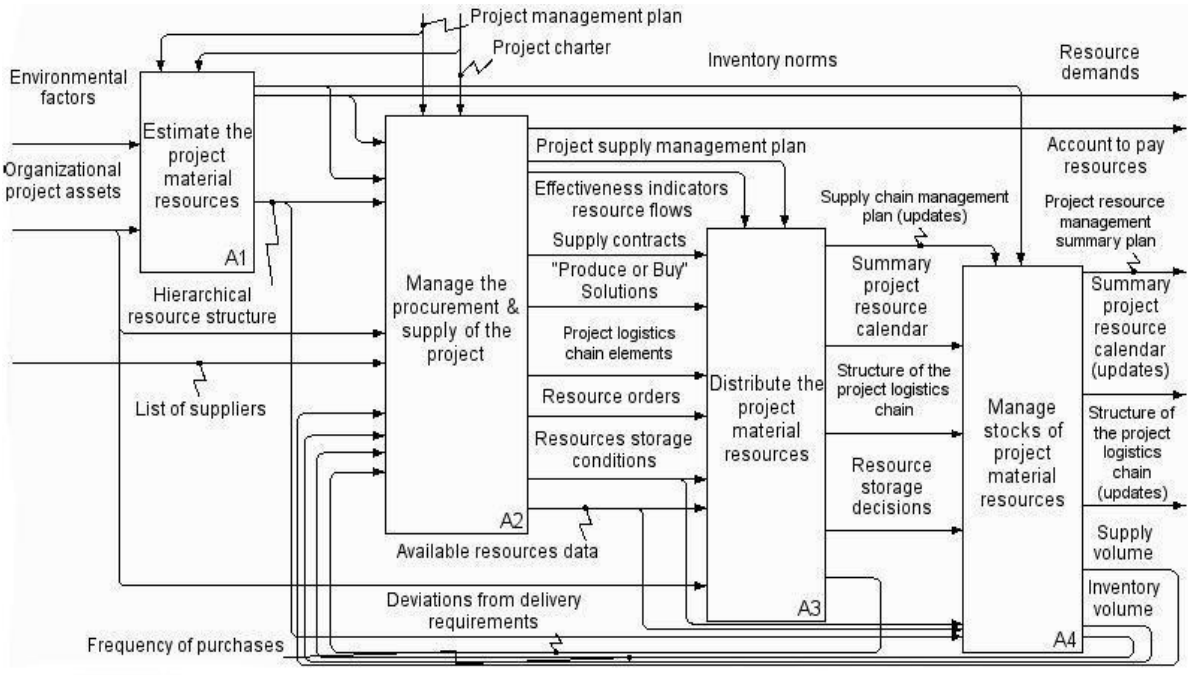

Fig. 2. Graphic view of the function ψ model of information flows of material resource management processes of the project

ISSN 2522-9818 (print)
Сучасний стан наукових досліджень та технологій в промисловості. 2021. № 1 (15) ISSN 2524-2296 (online)

Complex information links between operations (fig. 2) and the hierarchical nature associated with the distribution between groups of PMBoK project management processes (table 2), lead to the need for further transformation of project material resource management processes into a set of hierarchically organized subprocesses.

The information flow model of the A1 subprocess is according to expression (1), a set of objects

$$I\_A_1 = (V_{A_1}, Z_{A_1}, \varphi_{A_1}, A_{A_1}, O_{A_1}, \psi_{A_1}), \quad (4)$$

where $V_{A_1} = \{v_1^{A_1}, v_2^{A_1}\}$ is the set of input data, which according to fig. 2 consists of the assets of the organizational process ($v_1^{A_1}$) and environmental factors ($v_2^{A_1}$);

$Z_{A_1} = \{z_1^{A_1}, z_2^{A_1}\}$ is a set of documents that regulate the subprocess, which in accordance with fig. 2 contains the project management plan ($z_1^{A_1}$) and the project charter ($z_2^{A_1}$);

$O_{A_1} = \{o_1^{A_1}, o_2^{A_1}, o_3^{A_1}\}$ – the set of source data, which according to fig. 2 consists of a hierarchical structure of work ($o_1^{A_1}$), resource requirements ($o_2^{A_1}$) and stock standards ($o_3^{A_1}$);

$A_{A_1} = \{a_{A11}, a_{A12}\}$ – the set of operations of the subprocess, which according to table 2 define a_{A11} planning of management of material resources of the project and a_{A12} estimation of material resources of operations of the project.

In model (4), the output function performs a mapping $\psi_{A_1} : A_{A_1} \times V_{A_1} \to O_{A_1}$, the graphical representation of which is shown in fig. 3.

The main purpose of A_1 subprocess is to determine the integral amount of resources required to p erform the project, to form a hierarchical structure of resources, to find the function of resource needs and to determine the norms of stocks.

The main recommended tools and methods of realization of the subprocess of assessment of material resources of the project are [4, 10]:

- expert assessments;
- methods of displaying data, in particular in the formats of hierarchical schemes, matrices or text;
- analysis of alternatives;
- open estimates;
- software for managing the project;
- evaluations "bottom - up".

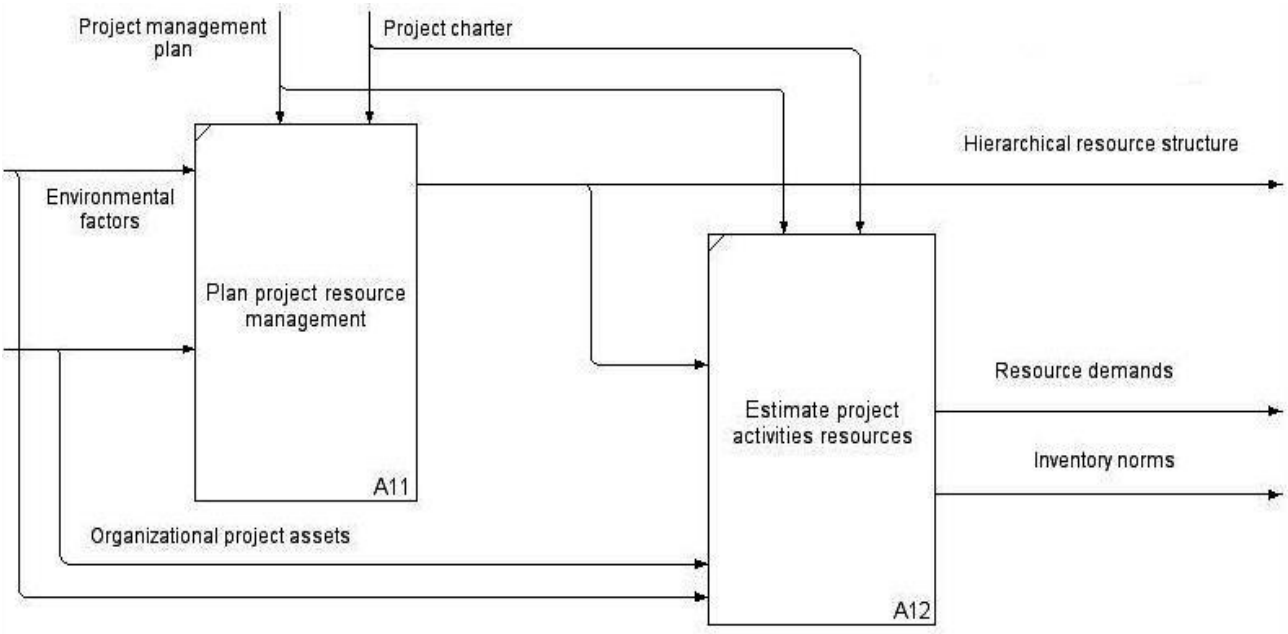

Fig. 3. Graphic view of the function ψ subprocess of evaluation of material resources of the project

But for the adaptation and development of project management, the theory of inventory management can be used [11], for example, in determining inventory norms.

Based on the hierarchical structure of resources, the need (Λ) in a certain type of material resource is evaluated.

Assume that during the project implementation the need for material resources Λ may arise n times at regular intervals. Then the size of the aggregate order is a multiple of Λ, i.e. [12]

$$Q = \Lambda n,$$

and the average resource level is equal to:

$$Q_{cp} = \Lambda \frac{n-1}{2}.$$

In this case, the occurrence of costs associated with stocks will coincide with one of the "points of need". Their value is calculated by the formula:

ISSN 2522-9818 (print)
ISSN 2524-2296 (online) Innovative technologies and scientific solutions for industries. 2021. No. 1 (15)

$$L = S\Lambda\frac{n-1}{2} + \frac{hK}{n}, \quad (5)$$

where S – costs of storing a unit of resources, the value of which determines the assets of the organizational process of the project; K – the cost of order formation, the level of which depends on environmental factors; h – the total frequency of resource demand during the project implementation.

Therefore, analyzing expression (5), we note:

- if the quantity [n] = 1 (where [n] is an integer), then the supply of material resources should be organized in such a way as to directly satisfy the need Λ;
- condition [n]> 1 means that conditions should be provided for storage of material resources;
- inequality $nK - S\Lambda \le 0$ is a necessary and sufficient condition for non-creation of a stock.

The obtained results are the input data of the following subprocess A_2, the model of its information flows according to expression (1) has the form:

$$I\_A_2 = (V_{A_2}, Z_{A_2}, \varphi_{A_2}, A_{A_2}, O_{A_2}, \psi_{A_2}), \quad (6)$$

where $V_{A_2} = \{v_1^{A_2}, v_2^{A_2}, ..., v_9^{A_2}\}$ – the set of input data, which according to fig. 2 consists of norms of stocks ($v_1^{A_2}$), resource requirements ($v_2^{A_2}$), hierarchical structure of resources ($v_3^{A_2}$), assets of organizational process ($v_4^{A_2}$), list of suppliers ($v_5^{A_2}$), volumes of deliveries ($v_6^{A_2}$), frequency of purchases ($v_7^{A_2}$), size of stocks ($v_8^{A_2}$), deviations in deliveries ($v_9^{A_2}$);

$Z_{A_2} = \{z_1^{A_2}, z_2^{A_2}\}$ – a set of documents that regulate the subprocess, which in accordance with fig. 2 contains the project management plan ($z_1^{A_2}$) and the project charter ($z_2^{A_2}$);

$O_{A_2} = \{o_1^{A_2}, o_2^{A_2}, ..., o_{10}^{A_2}\}$ – the set of source data, which according to fig. 2 consists of "produce or purchase" ($o_1^{A_2}$) decisions, project supply management plan ($o_2^{A_2}$), project logistics chain elements ($o_3^{A_2}$), resource conservation conditions ($o_4^{A_2}$), supply contracts ($o_5^{A_2}$), resource orders ($o_6^{A_2}$), resource promotion performance indicators ($o_7^{A_2}$), invoices for payment of resources ($o_8^{A_2}$), data on available resources ($o_9^{A_2}$), deviations in deliveries ($o_{10}^{A_2}$);

$A_{A_2} = \{a_{A21}, a_{A22}, a_{A23}\}$ – the set of operations of the subprocess, which according to table 2 determine a_{A21} planning of procurement and supply management, a_{A22} organization of supply and procurement of material resources; a_{A23} control of procurement and supply of material resources.

In the model (6) the output function has the form $\psi_{A_2} : A_{A_2} \times V_{A_2} \to O_{A_2}$, the graphical representation is shown in fig. 4.

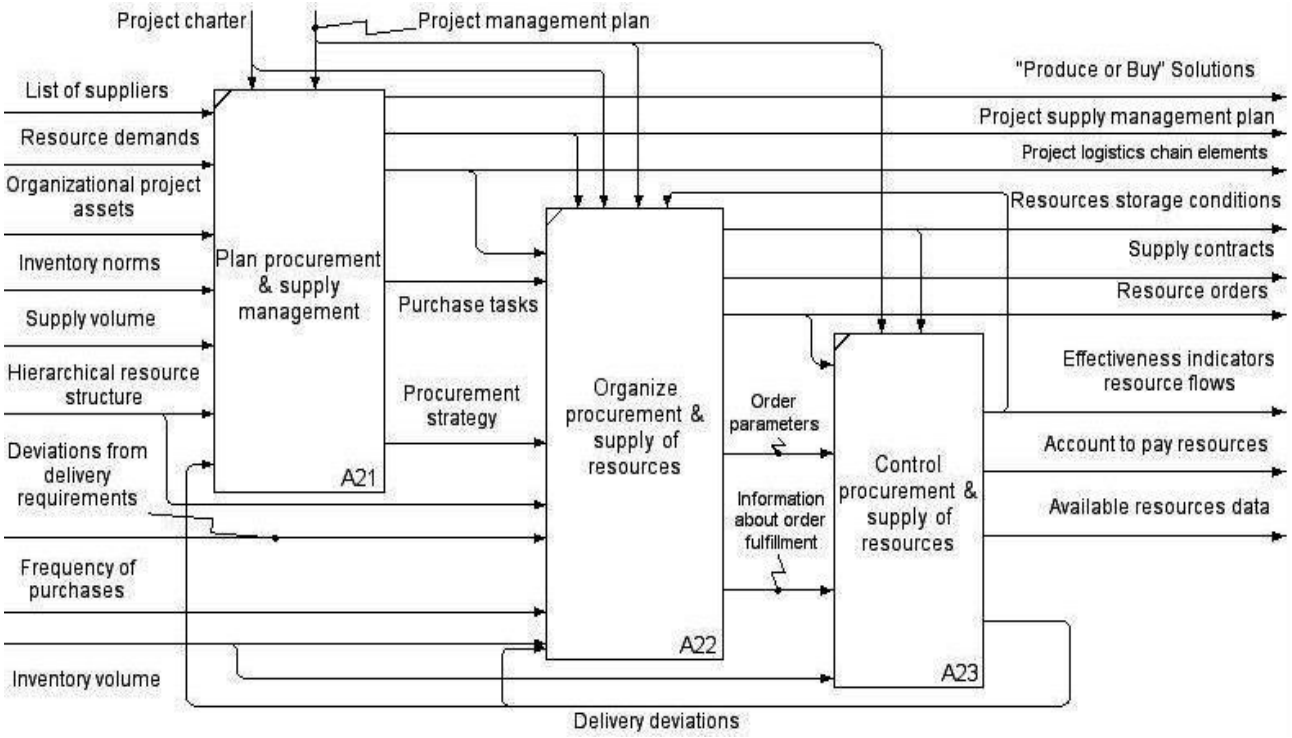

Fig. 4. Graphical presentation of the function ψ subprocess of procurement and supply management of material resources

Unlike others, subprocess A_2 may be related to existing legal obligations and penalties. This subprocess can be started at the initial phase of the project life cycle, when developing its feasibility study, then at the planning stage, when the need for material resources is specified, the possibilities of providing them are assessed [13].

ISSN 2522-9818 (print)
Сучасний стан наукових досліджень та технологій в промисловості. 2021. № 1 (15) ISSN 2524-2296 (online)

Personnel in charge of procurement and supply of material resources may not always be a member of the project team [4].

The most common tools and methods for implementing this subprocess are [4, 6, 13]:

- expert assessments;
- data collection and analysis;
- inspections and audits.

The model of information flows of the subprocess of distribution of material resources of the project has the form:

$$I\_A_3 = (V_{A_3}, Z_{A_3}, \varphi_{A_3}, A_{A_3}, O_{A_3}, \psi_{A_3}), \quad (7)$$

where $V_{A_3} = \{v_1^{A_3}, v_2^{A_3}, ..., v_7^{A_3}\}$ is a set of input data, which consists of assets of the organizational process ($v_1^{A_3}$), conditions for saving resources ($v_2^{A_3}$), supply contracts ($v_3^{A_3}$), elements of the logistics chain of the project ($v_4^{A_3}$), data on available resources ($v_2^{A_3}$), orders for resources ($v_3^{A_3}$), decisions to "produce or purchase" ($v_7^{A_3}$);

$Z_{A_3} = \{z_1^{A_3}, z_2^{A_3}\}$ – a set of documents that regulate the subprocess, which is determined by the project supply management plan ($z_1^{A_3}$) and resource efficiency indicators ($z_2^{A_3}$);

$O_{A_3} = \{o_1^{A_3}, o_2^{A_3}, ..., o_5^{A_3}\}$ – the set of source data formed by the structure of the logistics chain of the project ($o_1^{A_3}$), the decision to save resources ($o_2^{A_3}$), the project supply management plan (update) ($o_3^{A_3}$), the consolidated calendar of resources ($o_4^{A_5}$), deviations from the supply requirements ($o_5^{A_3}$);

$A_{A_3} = \{a_{A31}, a_{A32}, a_{A33}\}$ – the set of subprocess operations, which in accordance with table 2 determine a_{A31} as a planning the management of resource allocation in the logistics chain of the project, a_{A32} – the organization of resource delivery to the place of application; a_{A33} – controlling the distribution of material resources.

In model (7) the output function is given by the mapping: $\psi_{A_3} : A_{A_3} \times V_{A_3} \to O_{A_3}$ Its graphical representation is shown in fig. 5.

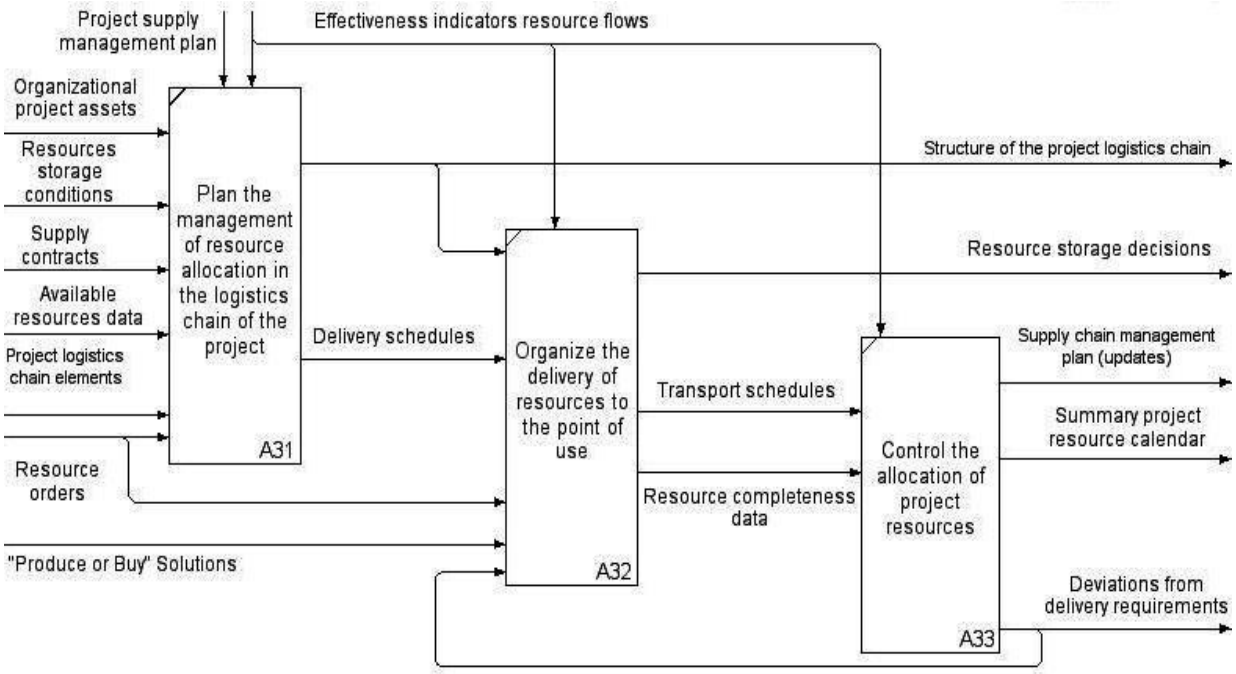

Fig. 5. Graphic view of the function ψ subprocess of allocation of material resources of the project

Implementation of subprocess A_3 is aimed at solving a number of problems, among which we highlight [9, 13]:

- creation of delivery schedules;
- development of decisions regarding the structure of the logistics chain of the development project, which is created during the movement of material resources from supplier to consumer;
- organization of transport flows on the basis of transport work schedules;
- substantiation of decisions on storage of resources and their completeness and organization of storage.

Therefore, the main tools and methods of the subprocess of allocation of material resources of the project are:

- expert assessments;
- data display methods;
- grid methods;
- project management software;
- methods of logistics.

ISSN 2522-9818 (print)
ISSN 2524-2296 (online) *Innovative technologies and scientific solutions for industries. 2021. No. 1 (15)*

Project inventory management refers to monitoring and making decisions to save time and money by minimizing the retention costs required to implement the project effectively. The goal of the inventory management system is to ensure the continuous execution of the project by supplying resources at the scheduled quality date with minimal maintenance costs [9, 14, 15].

The model of information flows of the A_4 subprocess has the form:

$$I\_A_4 = (V_{A_4}, Z_{A_4}, \varphi_{A_4}, A_{A_4}, O_{A_4}, \psi_{A_4}), \quad (8)$$

where $V_{A_4} = \{v_1^{A_4}, v_2^{A_4}, ..., v_6^{A_4}\}$ is the set of input data formed by: consolidated resource calendar ($v_1^{A_4}$), hierarchical structure of resources ($v_2^{A_4}$), data on available resources ($v_2^{A_4}$), resource conservation decisions ($v_4^{A_4}$), project logistics chain structure ($v_5^{A_4}$), resource conservation conditions ($v_6^{A_4}$);

$Z_{A_4} = \{z_1^{A_4}, z_2^{A_4}\}$ – a set of documents regulating the subprocess, which consists of stock standards ($z_1^{A_4}$) and an updated supply management plan ($z_2^{A_4}$);

$O_{A_4} = \{o_1^{A_4}, o_2^{A_4}, ..., o_7^{A_4}\}$ – a set of input data consisting of an updated resource summary calendar ($o_1^{A_4}$), supply quantities ($o_2^{A_4}$), inventory quantity ($o_3^{A_4}$), purchasing frequency ($o_4^{A_4}$), project resource summary plan ($o_5^{A_4}$), updated supply chain structure ($o_6^{A_4}$), inventory dynamics data ($o_7^{A_4}$);

$A_{A_4} = \{a_{A41}, a_{A42}, a_{A43}\}$ – the set of operations of the subprocess, which according to table 2 define a_{A41} project resource inventory management planning, a_{A42} – regulation of the level of resource stocks; a_{A43} – monitoring inventory management performance indicators.

In model (8), the output function has the form: $\psi_{A_4} : A_{A_4} \times V_{A_4} \to O_{A_4}$; its graphical representation is shown in fig. 6.

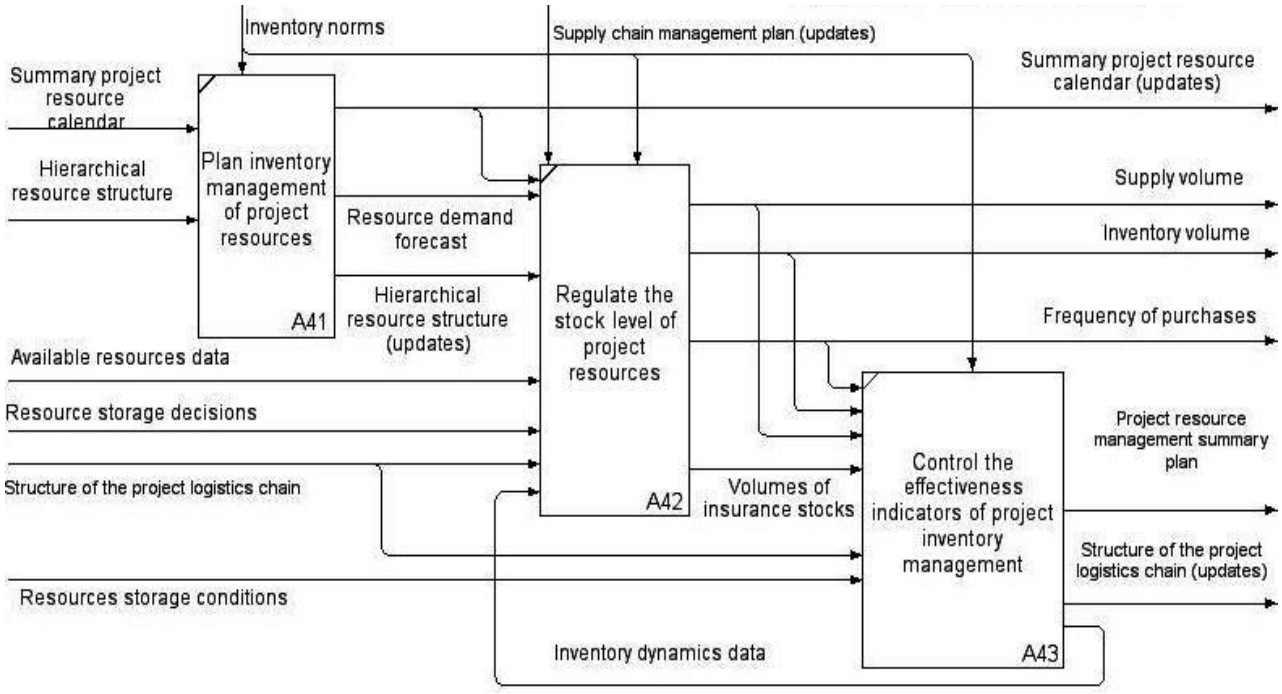

Fig. 6. Graphical view of the function ψ subprocess of inventory management of material resources of the project

It is easy to notice that the main tasks of the sub-process of inventory management of the project are atypical for project management. This determines that the tools and methods used to implement this sub-process are more applicable in logistics [11, 12, 15]. Among them we note:

- methods of selective management;
- methods of linear and dynamic programming;
- forecasting methods;
- methods of inventory management theory;
- methods of logistics.

Conclusions and prospects for further development

An analysis of the project resource management processes described in the project management methodologies, in particular in PMBoK, showed that human and material resource management issues are not separated, and among other project resource issues, only procurement management issues are considered. This can lead to negative consequences in management and, for some projects, become a prerequisite for the deterioration of the financial stability of the project, slow down the pace of business activity, and increase the risks of exceeding

ISSN 2522-9818 (print)
Сучасний стан наукових досліджень та технологій в промисловості. 2021. № 1 (15) ISSN 2524-2296 (online)

the project budget and deadlines. It is noted that the solution to this problem depends on the management of material resources of the project – processes that have a significant impact on the cost of the project, its schedule, risks, quality.

In order to adopt more thorough management decisions, it is proposed to allocate a separate field of knowledge, in which the processes of management of material resources are formed, their possible connection with PMBoK processes is shown. Formal representations of processes that make up management of material resources of the project are formed based on a process approach. The inputs and exits are identified, the relationships with other processes of the defined field of knowledge are shown, the main recommended tools and methods are shown.

Thus, the principles are generalized and an approach is applied that is applicable in the field of project management, which formalizes and structures the processes of material resources management of the project so that they can be used in many projects. This approach, based on processes, is integrated into project management, contains a description of the knowledge required for the organization and implementation of activities to provide material resources of the project.

The results obtained can be useful in project management at any stage of the life cycle.

References

1. Chand, Sh., Singh, H., Ray, T. (2019), "Evolving heuristics for the resource constrained project scheduling problem with dynamic resource disruptions", *Swarm and Evolutionary Computation*, Vol. 44, P. 897–912. DOI: https://doi.org/10.1016/j.swevo.2018.09.007
2. Markou, Ch., Koulinas, G. K., Vavatsikos, A. P. (2017), "Project resources scheduling and leveling using Multi-Attribute Decision Models: Models implementation and case study", *Expert Systems with Applications*, Vol. 77, P. 160–169. DOI: https://doi.org/10.1016/j.eswa.2017.01.035
3. Teslya, Yu. N., Egorchenkova, A. V., Egorchenkova, N. Yu., Kataev, D. S. (2012), "Product Planning Systems Projects" ["Produktovyie sistemyi planirovaniya proektov"], *Project Management and Production Development*, No. 1 (41), P. 13–19.
4. National standard (2017), "Guide of project management body of knowledge" ["Rukovodstvo k svodu znanij po upravleniju proektami (Rukovodstvo PMBOK)"], Project Management Institute, Inc.
5. Mishra, Pr., Mishra, P., Purohit, R. (2018), "Material delivery problems in construction projects: A possible solution", *Materials today: proceeding of 7th Int. Conf. of Materials Processing and Characterization*, Vol. 5, Issue 2, Part 1, P. 6497–6501. DOI: https://doi.org/10.1016/j.matpr.2018.01.135
6. National standard (2004), "Guide of project management body of knowledge" ["Rukovodstvo k svodu znanij po upravleniju proektami (Rukovodstvo PMBOK")], Project Management Institute, Inc.
7. Matos, P.V., Romão, M., Sarmento, J. M., Abaladas, A. (2019), "The adoption of project management methodologies and tools by NGDOs: A mixed methods perspective", *Journal of Business Research*, Vol. 101, P. 651–659. DOI: https://doi.org/10.1016/j.jbusres.2019.01.067
8. Tunji-Olayeni, P. F., Afolabi, A. O., Eshofonia, E. E., Ayim, B. A. (2018), "Dataset for material logistics on construction sites", *Data in Brief*, Vol. 20, P. 1142–1147. DOI: https://doi.org/10.1016/j.dib.2018.08.194
9. Danshyna, S. Yu. (2018), "Methodological support for managing material resources management of development projects" ["Metodolohichne zabezpechennia protsesu upravlinnia materialnymy resursamy proektu rozvytku"], *Mathematical models and latest management technologies for economic and technical systems: collective monograph*, edited by I. Chumachenko, V. Timofeyev, Kharkiv, P. 79–88.
10. Danshyna, S., Fedorovich, O., Djakons, D. (2020), "Formalization of the processes of projects for the development of high-tech enterprises", *Intelligent computer-integrated information technology in project and program management: collective monograph*, edited by I. Linde, I. Chumachenko, V. Timofeyev, Riga, P. 23–28. DOI: https://doi.org/10.30837/MMP.2020.023
11. Rolfe, B. (2013), "Doing Project Management Ironically", *Procedia – Social and Behavioral Science*, Vol. 74, P. 264–273. DOI: https://doi.org/10.1016/j.sbspro.2013.03.022
12. de Vries, J. (2020), "Identifying inventory project management conflicts: Results of an empirical study", *International Journal of Product Economics*, Vol. 226, P. 897–912. DOI: https://doi.org/10.1016/j.ijpe.2020.107620
13. Mazur, I., Shapiro, V., Olderogge, N., Polkovnikov, A. (2011), *Project management* [*Upravlenie proektami*], Moscow, 960 p.
14. Meyer, Ch. M., Garsia Torres, E. L. (2019), "Success Factors for Supply Chain Management Projects: An Empirical Analysis", *Proceeding of 9th IFAC Conf. on Manufacturing, Modelling, Management and Control "MIM-2019"*, Berlin, Germany, Vol. 52, Issue 13, P. 153–158. DOI: https://doi.org/10.1016/j.ifacol.2019.11.168
15. Trojet, M., H'Mida, F., Lopez, P. (2011), "Project scheduling under resource constraints: Application of the cumulative global constraint in a decision support framework", *Computers & Industrial Engineering*, Vol. 61, Issue 2, P. 357–363. DOI: https://doi.org/10.1016/j.cie.2010.08.014

Received 10.02.2021

Відомості про авторів / Сведения об авторах / About the Authors

Даншина Світлана Юріївна – кандидат технічних наук, доцент, Національний аерокосмічний університет імені М. Є. Жуковського "Харківський авіаційний інститут", доцент кафедри геоінформаційних технологій та космічного моніторингу Землі, Харків, Україна; email: s.danshyna@khai.edu, ORCID: https://orcid.org/0000-0001-7354-4146.

Даншина Светлана Юрьевна – кандидат технических наук, доцент, Национальный аэрокосмический университет имени Н. Е. Жуковского "Харьковский авиационный институт", доцент кафедры геоинформационных технологий и космического мониторинга Земли, Харьков, Украина.

ISSN 2522-9818 (print)
ISSN 2524-2296 (online) *Innovative technologies and scientific solutions for industries. 2021. No. 1 (15)*

Danshyna Svitlana – PhD (Engineering Sciences), Associate Professor, National Aerospace University "Kharkiv Aviation Institute", Associate Professor of the Department of Geo-Information Technologies and Space Monitoring of the Earth, Kharkiv, Ukraine.

УЗАГАЛЬНЕНИЙ ПІДХІД ДО УПРАВЛІННЯ МАТЕРІАЛЬНИМИ РЕСУРСАМИ ПРОЄКТУ

Предметом дослідження в статті є процеси управління матеріальними ресурсами проєкту. **Мета** роботи – формування узагальненого підходу до управління матеріальними ресурсами проєкту шляхом визначення та формалізації процесів управління ними. В статті вирішуються такі **завдання**: ґрунтуючись на процесному підході, сформовано процеси управління матеріальними ресурсами проєкту; визначено місце процесів управління матеріальними ресурсами проєкту в структурі PMBoK та інтегровано їх з іншими процесами управління проєктами; наведено формалізоване представлення процесів управління матеріальними ресурсами проєкту; визначено інструменти та методи управління матеріальними ресурсами проєкту. Використовуються загальнонаукові **методи** системного аналізу, теорії прийняття рішень, теорії управління запасами. Отримано такі **результати**: з метою прийняття більш ґрунтовних управлінських рішень запропоновано виділити окрему галузь знань, в рамках якої сформовано процеси управління матеріальними ресурсами проєкту, показано їх можливий зв'язок з групами процесів PMBoK. Базуючись на процесному підході, розроблено формалізоване представлення процесів, що складають управління матеріальними ресурсами проєкту. Для них визначено входи та виходи, показано взаємозв'язки з іншими процесами визначеної галузі знань, наведено основні рекомендовані інструменти та методи. **Висновки**: проаналізовано процеси управління ресурсами проєкту, описані в методології PMBoK, що дало змогу сформувати можливі напрямки покращення ресурсного забезпечення проєкту. Зазначено, що рішення цієї проблеми залежить від управління матеріальними ресурсами проєкту. Виділено окрему галузь знань, в рамках якої сформовано процеси управління матеріальними ресурсами проєкту – процеси оцінювання матеріальних ресурсів, управління закупівлями та постачанням, розподілення матеріальних ресурсів, управління запасами матеріальних ресурсів. Для них визначено входи та виходи, показано взаємозв'язки з іншими процесами визначеної галузі знань, наведено основні рекомендовані інструменти та методи. Отримані результати можуть бути корисними при управлінні проєктами на будь-якому етапі життєвого циклу.

Ключові слова: проєктний менеджмент; невідтворювальні ресурси проєкту; процеси проєкту; модель інформаційних потоків процесу.

ОБОБЩЕННЫЙ ПОДХОД К УПРАВЛЕНИЮ МАТЕРИАЛЬНЫМИ РЕСУРСАМИ ПРОЕКТА

Предметом исследования в статье являются процессы управления материальными ресурсами проекта. **Цель** работы – формирование обобщенного подхода к управлению материальными ресурсами проекту путем определения и формализации процессов управления ними. В статье решаются следующие **задачи**: основываясь на процессном подходе, сформированы процессы управления материальными ресурсами проекту; определено их место в структуре PMBoK, их интегрировано с другими процессами управления проектам; приведено формализованное представление процессов управления материальными ресурсами проекта; определены инструменты и методы управления материальными ресурсами проекта. Используются **методы** системного анализа, теории принятия решений, теории управления запасами. Получены следующие **результаты**: с целью принятия обоснованных управленческих решений предложено выделить отдельную область знаний, в рамках которой сформированы процессы управления материальными ресурсами проекта, показана их возможная связь с группами процессов PMBoK. Основываясь на процессном подходе, разработано формализованное представление процессов, являющихся составляющими управления материальными ресурсами проекта. Для них определены входы и выходы, показаны взаимосвязи с другими процессами определенной области знаний, приведены основные рекомендуемые инструменты и методы. **Выводы**: проанализированы процессы управления ресурсами проекту, описанные в методологии PMBoK. Это позволило сформировать возможные направления улучшения ресурсного обеспечения проекта. При этом отмечено, что решение этой проблемы зависит от управления материальными ресурсами проекта. Выделена отдельная область знаний, в рамках которой сформированы процессы управления материальными ресурсами проекту - процессы оценки материальных ресурсов, управления закупками и поставками, распределения материальных ресурсов, управления запасами материальных ресурсов. Для них определены входы и выходы, показаны взаимосвязи с другими процессами определенной области знаний, приведены основные рекомендуемые инструменты и методы. Полученные результаты могут быть полезными при управлении проектами на любом этапе жизненного цикла.

Ключевые слова: проектный менеджмент; невоспроизводимые ресурсы проекта; процессы проекта; модель информационных потоков процесса.

Бібліографічні описи / Bibliographic descriptions

Даншина С. Ю. Узагальнений підхід до управління матеріальними ресурсами проєкту. *Сучасний стан наукових досліджень та технологій в промисловості*. 2021. № 1 (15). С. 43–52. DOI: https://doi.org/10.30837/ITSSI.2021.15.043

Danshyna, S. (2021), "General approach to project material resources management", *Innovative Technologies and Scientific Solutions for Industries*, No. 1 (15), P. 43–52. DOI: https://doi.org/10.30837/ITSSI.2021.15.043