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ANALYZING THE INTERESTS AND INTERACTION OF THE PARTICIPANTS OF A TRANSPORT SYSTEM DEVELOPMENT PROJECT

The **subject** matter of the article is the communication processes of stakeholders in transport system development projects. The **goal** is to analyze the interests of the stakeholders of a transport project, taking into account the main differences in this industry. The article solves the following **problem**: the features of transport infrastructure project management are considered; the main interests of the stakeholders for transport infrastructure development projects are highlighted and their interests are analyzed; a model of interaction among stakeholders at different stages of the project life cycle is built. The following **methods** are applied: value approach, structural models, optimization models. The following **results** are obtained: the requirements of standards for project management are analyzed regarding the value approach and project management by stakeholders; the main characteristics of the transport project are considered, they include the impact on the nature of the social and economic development of a region, significant cost, duration, the interaction of state bodies and private firms; the set of stakeholders in the transport project are identified; the specific characteristics of the management of transport projects by various stakeholders are analyzed, they are expectations, goals, roles, the level of responsibility and related actions. Asymmetric and symmetric types of communications in the project are considered; a model of stakeholder relations is built as a network where there is a project manager in the centre who is connected with all other peaks and stakeholder peaks that are connected with each other, the model is formalized as a graph with multiple vertices and bidirectional links; a model of the process of interchanging the resources of project participants during its implementation is developed, the model contains resource flows (direct and inverse), takes into account the impact of stakeholders that change over the stages of the life cycle of a transport system development project. **Conclusions.** The conducted analysis of the interests and interaction of the project participants is the basis for developing a model for minimizing the imbalance of stakeholders' resources. The results are based on the value approach and can be used when making decisions on managing communications of a transport infrastructure development project.

Keywords: project management; stakeholders; transport system; interaction model.

Introduction

Modern transport infrastructure is one of the most important conditions for the development of the economy. Inherently the projects of construction and reconstruction of infrastructure objects have a pronounced macrofinancial effect, as the strategic advantages of the state in the long-term perspective, including the development of highly efficient transport-logistic systems, as well as the improving of the conditions and social living of the population.

According to the budget of Ukraine for 2019, it is planned to allocate 51 billion UAH to the roads and transport infrastructure, which is almost 28% more than in the budget of 2018. A significant part of these funds is planned to be spent on major infrastructure projects, such as the Odesa-Reni (1.5 billion), Kropivnitsky-Mykolaiv (1 billion) and 4 billion for the Go Highway national project. Such expenditures shows the state's interest in the development of domestic infrastructure, and the tendency suggests a further increase in the number and magnitude of projects in case of maintaining the rates of economic growth in the country [1, 2].

The growth in the number of infrastructure projects for transport development can significantly revitalize the industry, and application of methods for project management will enable to consolidate success and in matters of qualitative changes.

Analysis of recent research and problem statement

Last time the scientific publications and regulations paid more attention to the peculiarities of project management from the perspective of different

stakeholders and in the context of their relationships with each other.

The main sources for reviewing knowledge systems and project management methodologies are: PMBoK, ICB, P2M, PRINCE2. But, objectively, it should be noted that the theoretical basis of project management is not completely formed and continues to evolve. Such a state, at the time of the active practical use of already published work, can not remain unnoticed by scholars who continue to seek the new theoretical knowledge and build the new models for existing systems.

Among the domestic scientists who were engaged in the research and development of project management, one should highlight the works of K. V. Kolesnikova [3], Yu. Yu. Guseev, M. V. Sidorenko, I. V. Chumachenko, O. S. Martynenko [4, 5].

The issue of classification and description of project stakeholders is discussed in detail in two standards: PMBOK and PRINCE2.

In PMBOK, in particular, there is a separate knowledge sector that includes the following processes: Stakeholder Identification, Stakeholder Management Planning, Stakeholder Engagement Management, and Stakeholder Engagement Control.

The standards described in Prince2, in turn, distinguish only three main stakeholders: business sponsors, users and suppliers.

Reviewing the profile literature, it was noted that the standards pay insufficient attention to the sectoral diversity of project management and related features that arise in the characteristics of stakeholders. Often researchers in their work have to do their own review of the features and characteristics of project management, and in particular stakeholders in certain conditions of the industry [6 – 8].

Different stakeholders may differ in expectations, roles, responsibilities and actions. This is despite the fact that they all act as partners in the project and participate in the joint process, but their personal goals can vary considerably. Thus, each side may have different criteria for success, assessing the degree to which their goals are achieved, different values and ways to succeed. These conditions significantly influence the process of project implementation, it is especially important to take into account when constructing communication processes. It is important to use correct and effective methods, tools and technologies in solving management tasks that would be oriented specifically to these problems [9, 10].

Therefore, the purpose of this article is to analyze the interests of the parties involved in the transport project, taking into account the main features of this industry.

The article solves the problem:

- consideration of the peculiarities of transport infrastructure projects management;
- allocation of key stakeholders for transport infrastructure development projects and analysis of their interests;
- building a model for interaction between stakeholders at different stages of the project's life cycle.

Materials of research

Management of transport projects involves the creation of new or reconstruction of the country's old infrastructure systems for modernization or restoration. Management of transport projects should be distinguished from other types of conventional construction. The transport project in its classification is included in the definition of the infrastructure project, and therefore has a certain number of identical characteristics.

The main characteristics of the transport project are:

- significant influence on the nature and pace of socio-economic development of the region;
- exceptionally high capacity of funds;
- durability;
- close interaction between public authorities and private firms.

The competitiveness of the region is mostly dependent on transport accessibility than on the geographical location of production or service. The high development of the transport system in the region and the mobility of material and labor resources in it provides ample opportunities for both trade and production, which makes the area attractive for investment. Implementation of transport infrastructure projects generates the so-called impulses of development, which increase the attractiveness of the mainland territories, increasing the market value of surrounding lands and other natural resources.

Infrastructure projects are worth the cost. For example, the construction of one kilometer of road may amount to 5 to 78 million hryvnia [11]. At the same time, the terrain, climatic conditions and the development of the territory can increase the costs at one time. For this reason, and also because road construction is often not commercial, the main burden of funding is divided into

budgets of different levels. Public-private partnerships and other similar instruments of division of responsibilities and financial injections are created specifically for solving this problem. A slightly different situation with transport terminals, there, mainly, financing is carried out by private entrepreneurs and companies.

A transport project often has a strategic component that determines the competitiveness of the region in which the project was implemented. That is why transport projects can be implemented for decades. Even if the project does not require significant funds, but the timing of repayment of these funds and receipt of investment gains may take considerable time. Sometimes, even the first phase of the life cycle of a project with expertise and approvals, as well as the process of buying and disposing of land, may last for years and sometimes last longer than construction itself. Very often, transport projects may be suspended due to significant changes in conditions or inconsistencies in funding plans with realities. That is why the transport infrastructure of the regions is often planned in advance and for a long time with the calculations for further development and the state of the region.

Often, before the project is implemented, it is necessary to solve a huge number of conflicts in order to regulate public, private, social and economic interests.

The main risk and the main problem of any transport project is the risk of losing funding [12]. First of all, as there is always a temptation to invest in social projects that will benefit much faster, rather than in the case of infrastructures that spend the money spent over the years. When allocating budget funds, there is also the question of giving preferences to the region. High-level officials often have to choose the infrastructure of which region or city to improve, and work on which objects should be postponed at another time. This often creates a conflict between regions and competition for funding, which can lead to individual risks during the project implementation. And, finally, the construction of a transport infrastructure changes the territory itself and sometimes destroys the habitual location for people, or even their place of life. The construction of a transport facility requires the alienation of a large amount of land and is accompanied by pollution of the environment, both during construction and during operation.

Research results

1. Determination of the stakeholders of the transport project

Stakeholders, in other words, interested parties, are the parties that are directly involved in the implementation of the project at different or all stages of the life cycle and directly affect it. Stakeholders can include the public, civil servants, owners, managers, investors and all other actors directly influencing and participating in the life cycle of the project.

Transport project, unlike some other projects, is interrelated with the public at all stages of its life cycle. The community and the interests of the inhabitants of the region have a significant impact on the project, from the

design phase and throughout the time of exploitation to the stage of project closure. Because the transport project is primarily aimed at solving the interests and needs of society. Some studies and organizations even believe that a proper assessment of the role of society and determining the main characteristics of a society as a stakeholder can play a key role in the implementation of a transport project [14]. Significant public participation in project management also requires significant transparency of project processes and documentation to be disseminated to public resources.

Politicians who embody the side of the state also play a significant role at all stages of the project. First, because the transport project has such a close relationship with the public in the region. In addition to financial issues, civil servants can also resolve public-conflict issues as well as control information channels about the project's progress to the general public. The state may also be responsible for obtaining different types of permits. Obtaining permits is one of the most likely risks of a transport project, which is why the role of state bodies in this matter is difficult to overestimate. And political will can significantly reduce political and some economic risks, which greatly accelerates the process of project implementation.

In the world classification it is used to allocate the project owner as a separate stakeholder. That is, the side which becomes the owner of the object after construction. But in the Ukrainian realities, all transport arteries of the country belong to the state, and since the issue with the appearance of concession roads is still not resolved, the role of the owner should also be given to state structures.

Stakeholders may also include different supervisory authorities that are related both to the investor or the contractor, that is, those who control the quality of the work, as well as various organizations at the request of the state that control environmental norms and norms of law [15].

Also, an investor, a project team leader, a contractor with their own subcontractors and a supplier participate in the implementation of the transport project. Their role in the transport project is classical and has no pronounced features.

Specific characteristics regarding the management of transport projects by various stakeholders are presented in table 1. The table serves as a visual indicator of the main differences and peculiarities in the positions of stakeholders on those or other issues.

Table 1. Table of interests and visions of different stakeholders

Stakeholders of transport project	Interests of stakeholders in specific project issues		
	Project vision	Target in a project	Expectations
Society	Creating a product that you will need to take and which will bring additional convenience or opportunity	To get a project under construction that will bring the minimum number of inconveniences and risks, and at the end will give the greatest possible convenience and new opportunities	Finished product that brings additional convenience and features
Government agencies	Budget streams and reputation events	To master the maximum possible budgetary resources and to gain more reputational and economic benefits from the project, while reducing risks.	The ready project which is to become the brand of the political program and will bring economic and social benefits
Regulatory authorities	Technological process, limited by the norms and requirements. Granting permissions	To ensure the implementation of all processes within defined norms, eliminate or punish violations.	Avoid all possible violations until the project is complete. Complete all penalty procedures
Investor	Financial flows, the dynamics of expenses and revenues	Profit through investment	Return of invested funds with maximum profit
Project Manager and his team	Product creation management process	A result that meets quality, deadlines, budget and requirements. Satisfaction from the project of all stakeholders	Team success after project implementation, financial and reputational benefit
General contractor	Execution of works on all points of the contract	Maximum financial benefit from the work	The company gained profit from the project and received a reputable profit from successful execution
General supplier	The process of supply fulfillment according to the contract	Maximum financial benefit from supply fulfillment	The company gained profit from the project and received a reputable profit from successful execution

2. Model of interconnection of stakeholders of a transport project

Project implementation is accompanied by constant efforts of the project manager to meet the requirements of project stakeholders. But in addition to interacting with project management, stakeholders are also interacting with each other. The purpose of such interaction is often only

one – the exchange of resources for each of the parties. And resources in this case can be the most diverse things, from information to certain actions, in short, everything that can cause the interest of the parties. As a result of this situation, a network of relationships is created [8, 16].

All links between vertices act as an interaction between stakeholders, where resources are exchanged.

There are three types of exchanges:

- asymmetrical to the benefit of the target element;
- symmetrical with mutually beneficial relationship;
- asymmetric with benefit to the other party and deterioration of the resource base of the target element.

One of the tasks of the project manager and team is to weigh and control the relationships among other stakeholders, not allowing, or trying to prevent resource distortion. Such distortions may include, for example, non-fulfillment of the terms of an agreement by one of the parties, non-fulfillment of their powers by state bodies despite considerable tax pressure, etc. Similarly, a project manager may also give less resources in the process of exchange, for example, failing to fully exercise their authority or demonstrating unprofessionalism in the decisions. In the event of such problems, there is always a certain tension between the parties and the desire of the injured party to align the situation by reducing the leakage of resources on its part.

Thus, the relationship model has the form of a network where the project manager has a link with all other vertices in the center and other stakeholders with or without a different relationship. To construct the model of the interaction of participants, define the graph in fig. 1 as a set of vertices and relationships: $G = (V, A)$. The node corresponding to the project manager is marked V_0 .

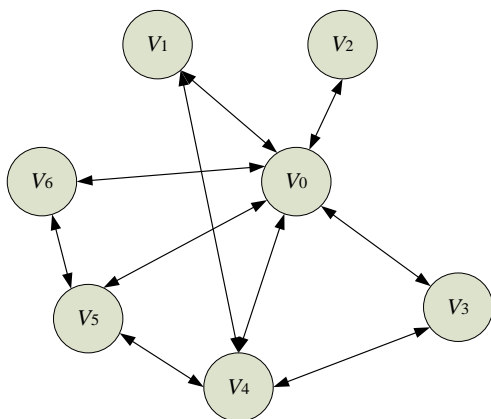


Fig. 1. An example of a network of interaction between project stakeholders

At the same time, it should be noted that such a network may have different views and structures at different stages of the life cycle of the project. That is, at the start of the next stage of the project, a network of stakeholders should be reviewed and balanced..

When considering the network of stakeholders interaction, the balancing of the process of transferring resources between stakeholders is of paramount importance. To do this, it is customary to allocate the target steward and separately consider the situation on his part, taking into account its features and characteristics, as well as features of a particular stage of the project life cycle. It is in this form that one needs to pay attention to the situation when the stacker receives less resources than gives, this situation is the main problem that the network model is trying to solve.

In some situations, the vertices may be uneven, or rather, have a priority over other vertices. For example,

the public, which is the most important stakeholder of the transport project and influences the critical number of decisions, may be more important than other stakeholders. It means that the situation with the exit from the balance, when a certain stakeholder will receive more resources, and the priority stacker receives less resources, always remains completely unacceptable. Thus, the project manager must make efforts to balance the model. In the long run, the goal of the project team is to balance all relationships among stakeholders, taking into account their weight at a particular stage.

Note that the set of bonds A is bi-directional, that is, it consists of two subsets (fig. 2): $A^+ \cup A^-$, where A^+ is the volume of resources transmitted by the participants of the communication in the forward direction (from the initiator of action), A^- is the volume of resources transferred in the opposite direction (as the corresponding reaction).

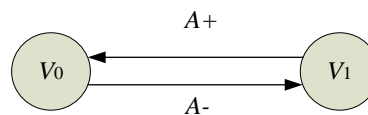


Fig. 2. Scheme of interaction between two stakeholders

According to fig. 2 we can record the condition:

$$A^+ \geq A^-, \quad (1)$$

which states the process of interchange of resources of project participants during its implementation.

Indicate a_{ij} as a volume of the resources transferred between V_i and V_j by project participants when $i = \overline{1, n}, j = \overline{1, n}$. Thus, the graph of interconnections can be divided into separate subgraphs with a dedicated target holder and obtain conditions for the absorption of resources for a plurality of participants:

$$\sum_{i,j=1}^n a_{ij}^+ \geq \sum_{i,j=1}^n a_{ij}^-. \quad (2)$$

Formula (2) can be supplemented by the factor of the importance of a stakeholder for a certain stage of the project life cycle [17]. To determine such a factor, for example, you can use the Mitchell model to identify the importance of the parties. Thus, formula (2) will look like:

$$\sum_{l=1}^m \sum_{i,j=1}^n k_i(T^l) a_{ij}^+ \geq \sum_{l=1}^m \sum_{i,j=1}^n k_j(T^l) a_{ij}^-, \quad (3)$$

where $k_i(T^l)$ and $k_j(T^l)$ are the coefficients of significance (influence) of stakeholders on the first stage of project implementation.

The main task of communication management is to achieve a balance of interactions, that is, to minimize the difference

$$\left(\sum_{l=1}^m \sum_{i,j=1}^n k_i(T^l) a_{ij}^+ - \sum_{l=1}^m \sum_{i,j=1}^n k_j(T^l) a_{ij}^- \right) \rightarrow \min. \quad (4)$$

In the event that an imbalance can not be avoided, it is possible to align the overall system by creating artificial

imbalances in relation to other stakeholders. But this approach will work only when stakeholders know about the approach and only in this case they will consider the system of exchange of resources to be fair.

Conclusions

In the article the features of management of transport infrastructure development projects are considered. A set of stakeholders is identified. Their vision, goals and interests in the project are analyzed. The structural model of interaction in the graph representation is proposed. A

model for minimizing imbalance of resources in the process of interaction is developed. The unevenness of the stakeholder's influence over the life cycle of the project is taken into account.

The results obtained are based on a value-based approach and can be used in decision-making on communications management of transport infrastructure development projects.

The research will continue in the direction of constructing a mathematical model of compromise solutions with the interaction of different groups of stakeholders.

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АНАЛІЗ ІНТЕРЕСІВ ТА ВЗАЄМОДІЇ УЧАСНИКІВ ПРОЕКТУ РОЗВИТКУ ТРАНСПОРТНИХ СИСТЕМ

Предметом дослідження в статті є процеси комунікації зацікавлених сторін в проектах розвитку транспортних систем. **Мета** – аналіз інтересів зацікавлених сторін транспортного проекту з урахуванням основних особливостей цієї галузі. В статті вирішуються **завдання**: розгляд особливостей управління проектами транспортної інфраструктури, виділення основних зацікавлених сторін для проектів розвитку транспортної інфраструктури та аналіз їх інтересів, побудова моделі взаємодії стейкхолдерів на різних етапах життєвого циклу проекту. Застосовані **методи**: ціннісний підхід, структурні графові моделі, оптимізаційні моделі. Отримані **результати**: Проаналізовано вимоги стандартів з управління проектами стосовно ціннісного підходу і управління зацікавленими сторонами проекту. Розглянуто основні характеристики транспортного проекту: вплив на характер соціально-економічного розвитку регіону, значна вартість, довготривалість, взаємодія державних органів та приватних фірм. Визначено множини зацікавлених сторін транспортного проекту. Проаналізовано специфічні характеристики щодо управління транспортними проектами різними зацікавленими сторонами, такі як очікування, цілі, ролі, ступінь відповідальності та можливі дії. Розглянуто асиметричні та симетричні типи комунікацій у проекті. Побудовано модель взаємовідносин стейкхолдерів у вигляді мережі, де в центрі знаходиться менеджер проекту, що має зв'язок з усіма іншими вершинами, та вершини-стейкхолдери, що мають зв'язок між собою. Формалізовано подання моделі у вигляді графу з множиною вершин та двонаправлених зв'язків. Розроблено модель процесу взаємообміну ресурсами учасників проекту при його реалізації. Модель містить потоки ресурсів (прямі та зворотні), урахує коефіцієнти впливу стейкхолдерів, які змінюються на протязі етапів життєвого циклу проекту розвитку транспортної системи. **Висновки**. Проведений аналіз інтересів та взаємодії учасників проекту є основою розробки моделі мінімізації дисбалансу ресурсів стейкхолдерів. Отримані результати ґрунтуються на ціннісному підході та можуть бути використані при прийнятті рішень з управління комунікаціями проекту розвитку транспортної інфраструктури.

Ключові слова: управління проектами; стейкхолдери; транспортна система; модель взаємодії.

АНАЛИЗ ИНТЕРЕСОВ И ВЗАИМОДЕЙСТВИЯ УЧАСТНИКОВ ПРОЕКТА РАЗВИТИЯ ТРАНСПОРТНЫХ СИСТЕМ

Предметом исследования в статье являются процессы коммуникации заинтересованных сторон в проектах развития транспортных систем. **Цель** – анализ интересов заинтересованных сторон транспортного проекта с учетом основных особенностей этой отрасли. В статье решаются **задачи**: рассмотрение особенностей управления проектами транспортной инфраструктуры, выделение основных заинтересованных сторон для проектов развития транспортной инфраструктуры и анализ их интересов, построение модели взаимодействия стейкхолдеров на разных этапах жизненного цикла проекта. Применены **методы**: ценностный подход, структурные графовые модели, оптимизационные модели. Полученные **результаты**: Проанализированы требования стандартов по управлению проектами относительно ценностного подхода и управления заинтересованными сторонами проекта. Рассмотрены основные характеристики транспортного проекта: влияние на характер социально-экономического развития региона, значительная стоимость, продолжительность, взаимодействие государственных органов и частных фирм. Определено множество заинтересованных сторон транспортного проекта. Проанализированы специфические характеристики по управлению транспортными проектами различными заинтересованными сторонами, такие как ожидание, цели, роли, степень ответственности и соответствующие действия. Рассмотрены асимметричные и симметричные типы коммуникаций в проекте. Построена модель взаимоотношений стейкхолдеров в виде сети, где в центре находится менеджер проекта, который имеет связь со всеми другими вершинами, и вершины-стейкхолдеры, имеющие связь между собой. Формализовано представление модели в виде множества вершин и двонаправленных связей. Разработана модель процесса обмена ресурсами участников проекта при его реализации. Модель содержит потоки ресурсов (прямые и обратные), учитывает коэффициенты влияния стейкхолдеров, которые меняются на протяжении этапов жизненного цикла проекта развития транспортной системы. **Выводы**. Проведенный анализ интересов и взаимодействия участников проекта является основой разработки модели минимизации дисбаланса ресурсов стейкхолдеров. Полученные результаты основаны на ценностном подходе и могут быть использованы при принятии решений по управлению коммуникациями проекта развития транспортной инфраструктуры.

Ключевые слова: управление проектами; стейкхолдеры; транспортная система; модель взаимодействия.