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MANAGEMENT OF STAKEHOLDERS IN TRANSPORT SYSTEM DEVELOPMENT PROJECTS CONSIDERING THE POSSIBLE COMMUNICATION CONFLICTS

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The subject of research in the work are the processes of project stakeholder management. Attention is paid to solving the tasks of forming the circle of the main stakeholders for projects of development of transport systems and analysis of their interests. The stakeholder harmonization method uses a formalized view of the relationship between their interests and project objectives based on a value approach. The dynamic stakeholder map model according to the stages of the project life cycle allows to obtain a quantitative assessment of the success of stakeholder management. To resolve possible conflicts between stakeholders, the optimization problem of determining a compromise price for resources with multiple suppliers is used. Based on the developed ones, it is possible to confidently determine the effectiveness of the stakeholder management strategy and adjust the work with them in a timely manner. Practical use of the described problems will help to optimize and improve communication management processes in the project taking into account zones of possible conflicts.

Introduction

The project-oriented approach has recently proven to be an effective mechanism that allows you to effectively manage large-scale projects in the implementation of complex tasks involving the use of significant resources and active intersectoral cooperation [1, 2]. The results of recent research indicate that the project approach develops opportunities for the application of a new system of knowledge, technology that allows to solve the problem of creating values, and also helps to solve problems in conditions of limited resources [3]. In search of further ways to develop the theoretical basis of project management, scientists often agree that this path should be based on models and methods of analysis of structural properties of project management systems [4, 5].

Active development of transport systems in Ukraine, their reorganization in view of the occupation of parts of territories and ambitious goals of Ukraine's transport strategy until 2030 [6], approved by the government in 2018, form new challenges in project management and force to rethink and improve management approaches projects and take into account the sectoral characteristics of the transport sector in the management of such projects. The complexity and complexity of transport systems development projects force to improve and optimize project management processes and look for new ways to solve problems related to stakeholder management, risks and other processes specific to the project-oriented approach.

During the formation and implementation of projects for the development of transport systems, it is important to use the latest methods and technologies of project management. The use of advanced developments in the field of project management will allow the state to increase the pace and quality of project implementation, which in turn will lead to a qualitative economic leap and accelerate the pace of overall economic and social development of the state and separate regions.

1. Interaction of participants in organizational structures of project management

The content of the project sets requirements for the optimal organizational structure of the project in terms of division of responsibilities, responsibilities and labor for the project. All the diversity of organizational structures can be represented in the form of a continuum, the boundaries of which indicate possible solutions for the division of labor - vertical (functional-administrative) division of labor and horizontal (design-target). The classic version of the division of labor into vertical processes is a functional organizational structure. The general advantages and disadvantages of the functional organizational structure are presented in table 1 [7].

Table 1

Advantages and disadvantages of functional organizational structures

Advantages	***Disadvantages***
Stimulates business and professional specialization	Stimulates functional isolation
Reduces duplication of effort and increases resource efficiency in functional areas	Increases the number of cross-functional conflicts and reduces the effectiveness of achieving common goals
Improves coordination in functional areas	Increases the number of interactions between participants in end-to-end, horizontal processes, reducing the efficiency of communications
Helps to increase the manufacturability of operations in functional areas	Functional manufacturability does not contribute to solving complex problems
Employees have the prospect of career growth and professional development	When attracting employees to implement the project, motivation decreases

Within functional organizational structures, mechanisms can sometimes be used to enhance horizontal integration and thus somewhat smooth out the negative aspects of functional structures.

The most commonly used mechanisms of horizontal integration of functional structures are intermediaries and teams. The simplest elements of horizontal connections can be organized in the form of so-called intermediaries. Usually mediators act at the lower levels of the hierarchy and prevent the development of differences at an early stage of their development. Quite broad powers may be delegated to teams, but committees of a purely advisory nature may also be established.

A project-target structure is superimposed on the vertical functional structure, forming a matrix organizational structure for full-fledged horizontal integration. Types of matrix organizational structures have advantages and disadvantages listed in table 2.

Table 2

Advantages and disadvantages of matrix organizational structures

Advantages	***Disadvantages***
The project and its goals are in the center of attention, as well as the needs of the customer	There are conflicts between design and functional structures
The advantages of functional structures for optimizing activities in functional areas and the use of resources for several projects are preserved	There is a need to coordinate the activities of several projects
Staff concerns about careers after the end of the project are reduced	There is a problem of division of powers between project managers and functional units
It is possible to "adjust" the organizational structure from weak to strong matrix	The principle of single-headedness is violated, which causes many conflicts

Matrix organizational structures are effectively used to achieve simultaneous vertical, functional specialization and design-target horizontal integration.

In addition to the system of relations between the participants and the content of the project, the external environment imposes certain requirements on its organizational structure. The more mobile and dynamic the external environment of the project, the more flexible and adaptable its organizational structure should be. Any organizational structure can be implemented in different possible adaptations.

Reporting roles, responsibilities and relationships in the project can be distributed both between individuals and between groups of people. Individuals and groups of persons may be part of the organization - the executor of the project or may take an external position in relation to it.

In most projects, much of the organizational planning is done as part of the early stages of the project. However, the results of this project should be reviewed regularly throughout the life cycle in order to confirm their suitability for the current situation. If the original organization is not effective, it should be reviewed accordingly.

There are organizational interfaces for communication of project participants - formal and informal reporting relations (technical or interpersonal).

The interaction of performers has certain limitations, which are caused by:

– the structure of relationships;

– the level and degree of responsibility of project participants under the concluded agreements;

– preferences of participants;

– personal characteristics of performers.

The distribution of roles and responsibilities may vary over time. At the same time, you should analyze the degree of involvement of participants in the project. Often, a matrix of responsibility allocation is used for this purpose, taking into account the structural decomposition of work (WBS).

2. Harmonization of stakeholder interests of transport systems development projects

For the successful implementation of the project it is necessary to identify the main participants whose interests can significantly affect the achievement of project goals and results. The main participants in the project usually include [8]: customer, investor, project manager, contractor, contractor, project management team, authorities. In addition, project participants may include sponsors, competitors, consumers of project products, consulting and legal organizations.

Management of stakeholders in transport systems development projects plays one of the key roles in the success of the project [9]. Transport systems development projects have a number of features because they are an important factor for the development of the region as a whole, and sometimes may even have an international impact. In addition, during the implementation of such projects, significant changes often occur in the usual space for local residents. Such changes can carry both social and environmental risks. The concept of "public value" was developed by M. Moore [10].

Another special participant in the project of development of transport systems is the representation of the authorities of the region or the state. Government representatives should support the project at all stages of the life cycle, as well as protect the interests of some stakeholders over others. The interests of the community should be the main ones, but the state interest and protection of legality, regularity, environmental friendliness and economic feasibility of construction should not be excluded. Establishing communication with the public, simplification and assistance in obtaining permits, the overall positive political will for the project can significantly eliminate a large number of risks.

Another important stakeholder in the transport systems development project is the regulatory body, of which there may be several. It works closely with government agencies and ensures the interests of the state in the field of both quality requirements for construction and documentation, as well as requirements for environmental and industrial safety.

Other important stakeholders include the project investor, the project manager and his team, as well as contractors, subcontractors, general contractors and general suppliers.

Regular interaction of the project team with stakeholders throughout the project reduces the risk of the project, facilitates changes in the early stages of the LC of the project, reducing time and increasing the likelihood of successful achievement of project objectives.

Among the methods that allow you to form and analyze the characteristics of stakeholder groups can be identified a method of compiling matrices of the ratio of characteristics of power, interests and influence. Stakeholders are grouped on the basis of their level of authority, interest in project results, ability to influence the achievement of the end result and cause changes in the planning or implementation of project work. Another method that is more suitable for complex relationships in the project (including for transport infrastructure projects) is the method of stakeholder analysis, which involves building a model of features (Mitchell's model).

This model describes stakeholder groups based on an assessment of their level of power, urgency and legitimacy.

Project stakeholder management processes include [11, 12]:

– identification of project stakeholders;

– participation of project team members in involvement and communication with stakeholders;

– adjusting the composition of stakeholders taking into account the risks of the project;

– communication with stakeholders whose interests are related to obtaining specific project results;

– using the value of stakeholder involvement and communication.

The information that can be used to include stakeholders in a group with common interests is: general requirements, expectations, opportunities to influence the final results of the project, the phase of the project life cycle when the stakeholder has the greatest impact.

It should be noted that the interests of the formed groups may be contradictory, as well as not at all stages of the life cycle to meet the objectives of the project. Therefore, there is a task of balancing the interests of different groups and harmonizing interests with the objectives of the project.

A comprehensive method of balancing the interests of stakeholders involves the following steps [8]:

– determine the patterns and impact of the project environment, as well as select experts who will be involved in determining the list of stakeholders, as well as in assessing their characteristics;

– identify the most complete range of project stakeholders;

– identify the interests of stakeholders;

– determine the importance of each stakeholder in terms of external, internal factors of the project and in view of the project objectives;

– determine the degree of influence of stakeholders in terms of their own characteristics, based on the current state and capabilities of the stakeholders themselves;

– determine the emotional attachment of stakeholders to the project.

– build a matrix of balance of interests of stakeholders;

– determine the relationship of project objectives to the interests of stakeholders;

– defining tactics and strategies of interaction with each stakeholder and their group;

– Include stakeholder activities in the project schedule.

To formalize the method, the total set of project stakeholders is denoted by $S = \{S_i\}$, $i = \overline{1,n}$ .We denote the set of interests of individual groups of stakeholders $I = \{I_j\}$, $j = \overline{1,m}$.

The degree of interest of each stakeholder is measured by the value x_{ij}, with $x_{ij} \in [-1,1]$, $i = \overline{1,n}$, $j = \overline{1,m}$. (Table 3).

But on the basis of x_{ij} we cluster stakeholders, i.e. we group them by interests. For each interest group we identify more interested, less interested and opposed people.

Table 3

Stakeholder interest matrix

	I_1	I_2	…	I_m
S_1	x_{11}	x_{12}	…	x_{1m}
S_2	x_{21}	x_{22}	…	x_{2m}
…	…		…	…
S_n	x_{n1}	x_{n2}	…	x_{nm}

The set of stages of the project LC is denoted by E = {el}, $l=\overline{1,t}$. The coefficients of influence of stakeholders on the project are denoted by the elements of the matrix K = || k_{il} ||,, where k_{ij} is the degree of influence of the i-th stakeholder on the l-th stage of the project LC, t is the number of stages of the project LC, $k_{il} \in [0,1]$.

Thus, the procedure of harmonization of interests of stakeholder groups taking into account the degree of their interests and impact on the project will be formally presented in the form of reflection

$$\left\{s_1(k_{11}, x_{11}),..s_i(k_{il}, x_{ij}),..s_n(k_{nt}, x_{nm})\right\} \Rightarrow I \ .$$

Characteristics of stakeholders can be supplemented by estimates of emotional propensity G = {g_i}, where each element has three subsets g_i = {g_{i1}, $g_{i2,}$ g_{i2}}, g_{i1} - the degree of emotional propensity of the i-th stakeholder to use their power, g_{i2} - to urgently solve project problems, g_{i2} - to the use of legitimate means, $g_{ik} \in [0,1]$. Then

$$\left\{s_i(k_{il},\ x_{ij},\ e_{ik})\right\} \Rightarrow I' \ ,\ i=\overline{1,n}\ ,\ l=\overline{1,t}\ ,\ \ j=\overline{1,m}\ ,\ k=\overline{1,3}\ .$$

The harmonization procedure is based on stakeholder satisfaction assessments.

The goals of the project are denoted by the multiple C = {C_1, C_2… C_p}. The degree of compliance of the interests of stakeholder groups with the objectives of the project is denoted by values y_{hj}, $h=\overline{1,p}$, $j=\overline{1,m}$, $y_{hj} \in [0,1]$.

Thus, it is possible to solve the problem of assessing the degree of realization of the project objectives and make decisions on attracting additional project participants or neutralizing the opposing parties at certain stages of the life cycle.

3. Stakeholder management at project life cycle stages

After the identification of stakeholders and their analysis, an initial stakeholder engagement plan is developed, which is updated at the stages of the project LC to reflect the emerging changes.

At all stages of LC, the project is affected by the external environment and itself affects its condition. Therefore, it is proposed to review the indicators of stakeholders at each stage of the project life cycle.

For example, at the planning stage of a transport systems development project, important contractors are design contractors and permitting government organizations that must approve the project. In the next stages, these project participants either have too little influence and significance for the project, or disappear altogether.

Stakeholder maps are usually used to analyze stakeholders in tabular form or in the form of a block diagram [12, 13]. The model of a dynamic stakeholder map, which corresponds to the specific stages of the project life cycle, allows to move the entire system of interaction with stakeholders from one position to another quickly and without much loss.

Formally, the proposed model can be represented as follows.

Denote the total set of stakeholders $S = \{S_i\}$. At separate stages of LC subsets are formed: $S^k \subset S$. In this example, k = 3. At each stage, there is a change in the state of a subset of stakeholders:

$$S^k(t) \to S^{k+1}(t+1).$$

The state of a subset of stakeholders is determined not only by its composition, but also by the relationships of communications between them, which can be specified as a matrix $A = \|a_{ij}\|$. For example, a subset of stakeholders is formed for the first stage

$$S = \{S_1, S_2, S_3, S_4, S_5\},$$

where S_1 is the investor, S_2 is the designer, S_3 is the local government, S_4 is the population, S_5 is the central government.

The matrix of relationships between them is shown in table 4. The table also shows the relationship of the project management team (S_0) with all participants.

Note that the elements of the matrix a_{ij} reflect the intensity of communications and the level of influence on the performance of work or decision-making on the

project, i.e. they are a tuple of two values: $a_{ij} = \langle aI_{ij}, aV_{ij} \rangle$ which are the parameters of the stakeholder map.

Table 4

Relationship of stakeholders in the initiation and planning stages

	S_0	S_1	S_2	S_3	S_4	S_5
S_0	-	a_{01}	a_{02}	a_{03}	a_{04}	a_{05}
S_1	a_{10}	-	a_{12}	-	-	-
S_2	a_{20}	a_{21}	-	a_{23}	-	-
S_3	a_{30}	-	a_{32}	-	a_{34}	a_{35}
S_4	a_{40}	-	-	a_{43}	-	-
S_5	a_{50}	-	-	a_{53}	-	-

In addition, the intensity parameter is a symmetric matrix of values:

$$aI_{ij} = aI_{ji}, \forall i, j,$$

and the influence level parameter often has different values relative to the diagonal:

$$aV_{ij} \neq aV_{ji}.$$

When changing the map of stakeholders, it is important to pay attention not only to the relationship between stakeholders and changes in their number, but also to changes in their qualitative and quantitative characteristics. Therefore, the project manager should pay attention to any significant changes in the stakeholder circle and involve the team in reviewing project management decisions based on these changes.

Each stakeholder can be characterized by the following parameters:

– loyalty to the project;

– relevance for the project;

– involvement in the project;

– impact on the project.

Thus, we have a set of stakeholder parameters:

$$R = \langle P, Ac, Z, V \rangle.$$

The given list of parameters is not final and may vary depending on the project and its requirements, but, in turn, it is sufficient for most projects and can be successfully used to assess both stakeholders individually and manager interaction at different stages and situations in project.

For each of these parameters, a semantic scale of values is proposed, which characterizes the intensity of the manifestation of the corresponding characteristic. The scale is the distribution of parameter values into sectors with quantitative or qualitative value.

In addition to the actual positions of stakeholders, it is important to understand the desired characteristics for each stakeholder and the importance of such a position for the project. Table 5 shows an example of loyalty to the stakeholder project with the desired position, where P_{ni} is the actual position, P_{ai} is the desired position, $i = \overline{1,m}$. Thus, on the plane you can place both the actual values of the characteristics of the stakeholder, and its desired position for the project.

Table 5

An example of a scale of stakeholder loyalty to a project with the desired position

Stakeholder	Opponent	Neutral	In general for the project implementation	Ready to support the project	Most interested
S_1			P_{n1}	P_{a1}	
S_2					P_{n2}, P_{a2}
…….					
S_m		P_{nm}	P_{am}		

Together, scales with quantitative or qualitative indicators make it possible to depict the situation graphically in the form of a four-dimensional tesseract, each of

the axes of which would be a characteristic of the stakeholder. Within such a tesseract, you can place both the points of the actual positions of stakeholders, and the desired positions. The vector from P_n to P_a reflects the goal that the manager must achieve in the process of managing project stakeholders.

Since the value of Pn may change over time and at different stages, it is possible to determine the actual movement of the stakeholder in the body of the tesseract. This motion will form a vector from P_n to P_r and may often not coincide with the vector P_n to P_a. Thus, the angle between the vectors (α) will show the deviation from the desired results. Ideally, this angle should be zero.

When managing stakeholders at specific stages of the project LC should take into account the different impact of indicators on the results of work, which can be expressed by a coefficient of importance k_i. The coefficient of importance multiplied by the cosine of the angle and will quantify the deviation of the characteristics of the stakeholder from the desired values on a scale in the range [-1, 1]. Here, a score of 1 gives an ideal result, and -1 is the exact opposite trend. By constructing tesseracts of deviations for each stakeholder, it is possible to investigate the success of their management both according to individual characteristics and in general for global evaluation. Thus, the quantitative assessment of the success of stakeholder management is calculated by the formula:

$$E_R = \frac{\sum_{i=1}^{n} k_i \cos \alpha_i}{n},$$

where n is the number of stakeholders at the stage of the project LC.

This approach allows you to evaluate the work of the manager in some areas of stakeholder management, and in general.

The application of this approach is possible and effective only if the following rules are followed:

1. At the project initialization stage, it is important to correctly select all stakeholder characteristics that are significant for the results of the transport systems development project, correctly determine the importance factors for each of them, and choose an effective rating scale that would give unambiguous estimates. On the other hand, it guaranteed a sufficiently detailed assessment.

2. At each stage of the life cycle and at all stages of the project, it is important to monitor project priorities, ie to review whether project priorities have shifted in stakeholder management and whether the composition and importance of stakeholder projects themselves has changed.

4. Stakeholder communication and conflict analysis

There is an innovative component in transport systems development projects, which can be implemented using the ideas of project participants and increasing the overall innovative activity of stakeholders. It is here, as a result of communication processes, that stakeholders self-organize, when joint efforts are higher than the efforts of an individual performer. Thus the synergetic effect due to:

– common values;

– interpersonal skills;

– internal interdependence;

– coherence and cooperation, organizational culture;

– motivation for joint activities.

Project communication management consists of five stages [14]:

1. Creation of the concept of communications management in the early stages of the project.

2. Communication planning to determine the information and communication needs of project participants.

3. Analysis of communications during the project.

4. Completion of project communications management.

5. Decision-making on further use of the project communication means.

Types of communication are divided according to the composition of stakeholders as follows: interpersonal communication, group and mass [15]. Communications in a group of stakeholders belong to the type of group communications in which information is disseminated through communication networks. These networks are centralized with respect to the project manager. In turn, centralized structures are divided into: frontal, radial and hierarchical.

Internal communications of stakeholders belong to the group of functional relations - these are the processes of communication of a specialist who is authorized to perform a function within the whole project, with other project participants.

In the analysis of communication processes for the project implementation, the following types of interactions are of the greatest interest (table 6):

– planned formalized communications that reflect the standardized exchange of information during the project;

– vertical uplink communications to transmit information in written and spoken forms;

– vertical downlink communications to monitor project implementation;

– horizontal communications to disseminate information.

The communication process involves a dynamic change in the stages of formation, transmission, reception, decryption and use of information in both directions in the interaction of communicators. The communication model reproduces the components and functional characteristics of the communication process in the form of a diagram.

All the variety of models of the communication process in projects can be divided into two large groups: linear and nonlinear models.

The main linear models of communication are [16, 17]:

1. The Lasswell model is both a model for the study of the communication process and a detailed plan of the actual communicative action.

Table 6

Communications that are investigated during the project implementation

Direction of communication	Method of information exchange	Function of the communication process			
		Control	Motivation	Emotional expression	Information transfer
Vertical ascending	Written	-	-	-	+
	Speech	-	-	-	+
	Nonverbal	-	-	-	-
Vertical descending	Written	+	-	-	-
	Speech	+	-	-	-
	Nonverbal	-	-	-	-
Horizontal	Written	+	-	-	+
	Speech	+	-	-	+
	Nonverbal	-	-	-	-

2. The Shannon-Weaver model is abstracted from the meaning of the transmitted information, focusing entirely on its quantity, measuring the number of transmitted signals.

3. M. de Fleur's semiotic model of communications proceeds from the fact that in the process of any information interaction the information invariant is transformed from its pragmatic aspect into the semantic aspect, and then into the syntactic one.

Among the nonlinear models of communications are the following:

1. Theodore Newcomb's nonlinear model of communication has the form of an equilateral triangle, the vertices of which correspond to the communicator, the communicator and the social situation.

2. Circular model of communication R. Maletske, in which a person simultaneously and constantly acts as a source and as a recipient of information.

A common disadvantage of existing models is that they are qualitative rather than quantitative, and do not reflect the obvious dependence of the complexity of the work performed on the communication processes required for their implementation.

Conflicts are inevitable in the project's communication environment with stakeholders. Sources of conflict can be the processes of resource allocation, scheduling, defining authority and responsibility, as well as interpersonal communication. Successful conflict management saves time on negotiation processes.

A combination of the following characteristics of stakeholders should be taken into account when identifying areas of possible conflict: interest, rights, property, knowledge, contribution.

To determine the possibility of conflict, the characteristics of stakeholders should be analyzed and divided into groups according to the project objectives. By comparing the interests of individual groups, it is possible to identify areas of possible conflict and work out compromise solutions.

Factors influencing conflict resolution methods include:

– the importance and intensity of the conflict;

– limited time available to resolve the conflict;

– the relative power of the stakeholders involved;

– the importance of maintaining interest in the project results;

– motivation to resolve the conflict in the long or short term.

One of the important characteristics of stakeholders is the level of their involvement in the project. The following scale can be used to classify levels of stakeholder involvement:

– unaware (UN) - unaware of the project and its potential impact;

– resists (RE) - aware of the project and its potential impact, but has objections to any changes;

– neutral (NT) - aware of the project, does not support the changes, but does not object to them;

– supports (SU) - aware of the project and supports its work and end results;

– leader (LE) - aware of the project, potential impact and actively involved in ensuring the success of the project.

The difference (discrepancy) between the current and desired levels for each stakeholder serves as a basis for determining the level (intensity) of communications required for the effective involvement of stakeholders. To determine the degree of inconsistency, it is necessary to determine the degree of conflict of interest of stakeholder groups.

With the help of Vienna diagrams, you can display the relationship of interests of these groups and display two areas between which conflicts may arise (fig. 1). The whole area of stakeholder groups is divided into two parts, respectively on the right - a positive attitude to changes in the project, on the left - a negative attitude.

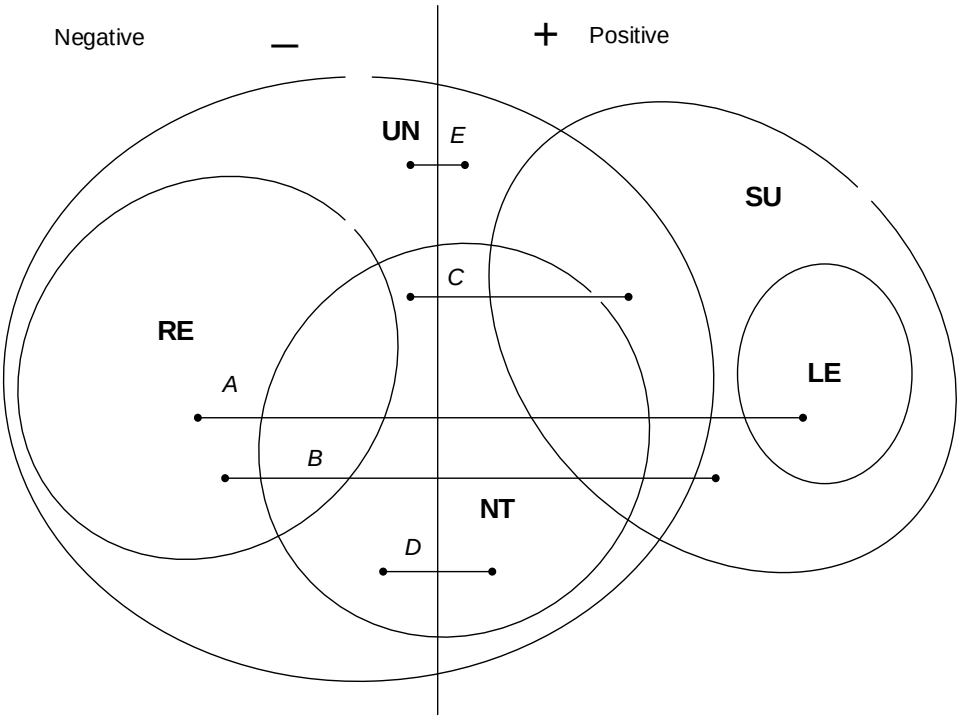

Fig. 1. Zones of possible conflicts between stakeholder groups

The degree of difference in the involvement in the project, and accordingly, the degree of possible conflict with stakeholders is indicated in the figure by horizontal segments, the length of which is proportional to the degree of discrepancy between the elements of the groups. Let’s define five degrees of inconsistency (possible conflict) in the linguistic scale: A - strong, B - significant, C - medium, D - small, E - insignificant.

From the point of view of decision-making tasks in the conditions of uncertainty taking into account the conflicting parties the specified degrees of discrepancy can be presented in the form of the table (matrix) (table 7).

Table 7

The degree of discrepancy between the interests of the conflicting parties

Stakeholder groups	LE	SU	NT	UN
RE	A	B	C	D
NT	B	C	D	E
UN	C	D	E	E

The use of game theory models is effective for decision-making in managing conflicts of stakeholders [18]. In project management, it is applicable to the analysis of strategic management problems in the context of competition, cooperation, risk and uncertainty [19]. As an example for transport infrastructure development projects, we can mention organizational decisions regarding cooperation and creation of joint ventures, identification of leaders and performers, suppliers of material resources, estimation of project completion time, etc. Game theory can be used in the practice of communication between the project team and stakeholders to help the two parties achieve a "win / win" situation".

The experience of managing transport development projects shows that in many cases central and local governments have different interests, sometimes conflicting. For example, the implementation of national road construction projects requires the use of land owned by the local community. At the same time, the local community may have its own vision for the use of the relevant plots, taking into account the interests of the residents of the territory. In this case, at the stage of project initiation, local governments and central executive bodies should be involved in the communication (negotiation) process as stakeholders who have their own interests and may be subject to the risks of the project. Otherwise, local governments and local communities should establish communications with private business to

attract investment resources of private business for the implementation of transport infrastructure projects.

If we consider the process of satisfying the interests of the population and describe the interaction of the parties in terms of game theory as "seller - buyer", the "seller" will be local governments and private business, and "buyer" - the population of this community.

Thus, three game models can be described between the five stakeholders (fig. 2):

1) central authorities and local governments have a conflict of interest regarding the allocation of territories for the construction (development) of transport infrastructure;

2) local governments (together with territorial communities) find a compromise solution with representatives of private business to attract investment;

3) local governments (together with representatives of private business) find a compromise solution with the inhabitants of the surrounding areas, taking into account their interests (satisfaction of transport requirements and living conditions).

Note that two of these situations are described by models of the coalition game.

In the general case, it is impossible to predict how the benefits will be distributed between the parties, i.e. the participants may not reach a mutually beneficial agreement from the standpoint of compliance with the Pareto principle. Thus, it is advisable to use game theory, which analyzes the decision-making of the subjects (players) in situations where the result is influenced by other subjects.

To prevent conflicts in the management of stakeholders, it is necessary to decide on the optimal behavior of the parties in a potential conflict situation. Among the various areas of game theory will be appropriate to use models of cooperative play [20].

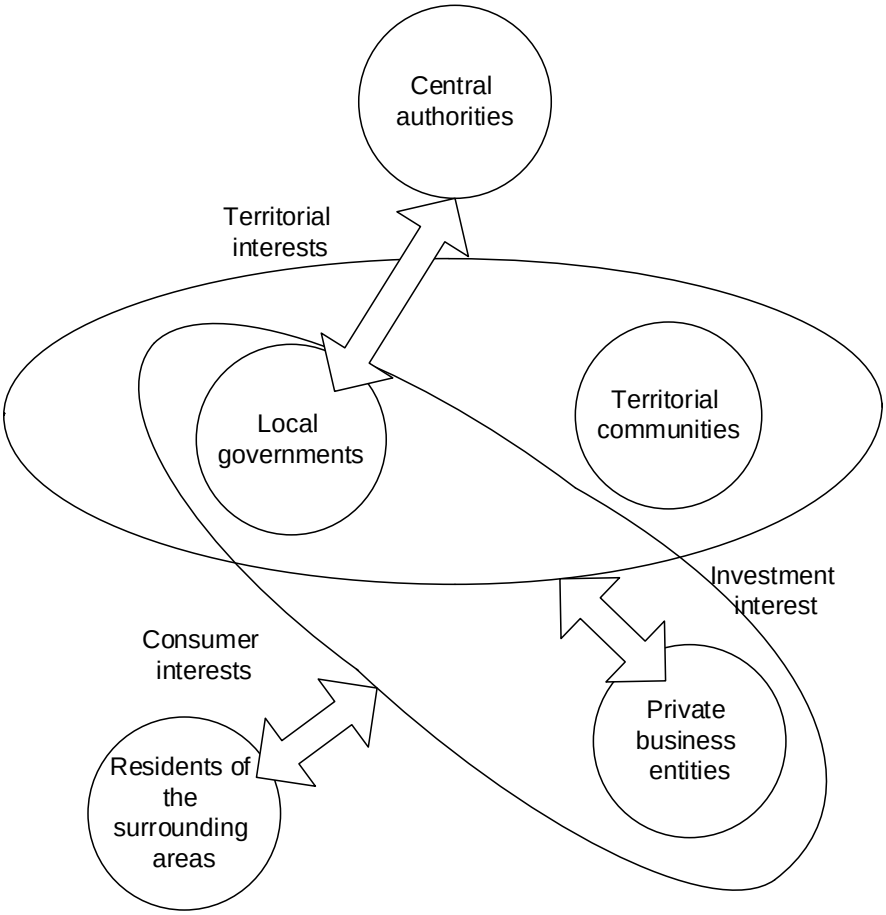

Fig. 2. Examples of conflicts of interest between stakeholders with the formation of coalitions

Denote by N the set of all players, N = {1, 2, 3, ..., n - 1, n}, and by K - any subset of it. Unions of players in the subset K form a coalition, which then acts as a single player and acts against the other players who are not in the coalition. Coalition K can guarantee itself the value of the maximum guaranteed win of the players of coalition K (denote it v(K)). After the game, the winnings v(K) are distributed among the coalition members [21].

The problem of redistribution can be solved by various methods. One of them (the Neumann-Morgenstern solution) allows us to define a negotiating set. This defines the guaranteed win for each of the participants as the price of the game, which he receives in case of withdrawal from the coalition. The difference between the gain of the coalition v(K) and the sum of its guaranteed winnings is the so-called effect of cooperation. This additional effect can be shared by agreement between the

participants. The second way to redistribute the effect is to distribute it in proportion to the guaranteed gains of the coalition members. But on the contrary: a smaller share of the guaranteed gain corresponds to a larger share of the effect - such a distribution is called compensatory.

There are five main methods used to resolve conflicts, the essence of which is presented in table 8 [22].

Table 8

Conflict resolution in terms of game theory

Stakeholder strategy	**Project team strategy**	**The essence of the decision**	**Winning or losing sides**
Evasion	Avoidance	Deviation from the actual or potential conflict situation, postponement of the problem to a later date	Temporary equilibrium
Adaptation	Smoothing	Emphasizing common positions instead of areas of contradiction, abandoning one's position in favor of the needs of others	Loss of one side
Compromise	Settlement	Finding solutions that will be to some extent satisfactory for all parties	There are no winners
Coercion	Adoption	Lobbying someone's point of view at the expense of others	One wins, the others lose
Cooperation	Problem solving	Combining different points of view and perspectives, willingness to cooperate and open dialogue	Both sides win

The last three categories of conflicts (compromise, coercion and cooperation) can be described using game theory.

Consider the problem of resolving conflicts of interest in the interaction of resource managers and suppliers, the result of which is the decision to compromise on resource prices [23]. We formulate an optimization problem in the form of a game of two people with opposite interests.

Let's mark:

$U = (u_1, u_2, \ldots, u_n)$ - vector of mixed strategy of resource manager (player A) on supplier selection u_i;

$Z = (z_1, z_2, \ldots, z_m)$ - vector of mixed supplier strategy (player B) for the choice of supplied resources z_j.

The condition is fulfilled for component strategies

$$\sum_{i=1}^{m} u_i = \sum_{j=1}^{n} z_j = 1.$$

where $u_i \geq 0$, $i = \overline{1,m}$, $z_j \geq 0$, $j = \overline{1,n}$.

The price of the game:

$$\nu = \sum_{j=1}^{n} \sum_{i=1}^{m} a_{ij} u_i^o z_j^o,$$

where a_{ij} – the price of the i-th resource from the j-th supplier, u^o – optimal strategy of the resource manager (probability of choosing a supplier), z^o - optimal supplier strategy.

For the value ν to be the price of the game, and u^o and z^o - the optimal strategies, it is necessary and sufficient to perform the following inequalities:

$$\begin{cases} \sum_{i=1}^{m} a_{ij} u_i^o \geq \nu, \ j = \overline{1,n}, \\ \sum_{j=1}^{n} a_{ij} z_j^o \leq \nu, \ i = \overline{1,m}, \\ z_j^o = \dfrac{1}{m}, \ j = \overline{1,n}, \\ \sum U_i^o = 1 \end{cases}$$

With the help of game theory models it is possible to determine the optimal decisions about the pricing policy for new products, plans to capture new markets, cooperation of enterprises, the distribution of project work, etc. [24]. Thus, the provisions of game theory can be used for all types of decisions, if their adoption is influenced by other actors.

Conclusions

Consideration of the main features of transport systems development projects and their differences in relation to projects in other industries allowed to determine the range of stakeholders given the specifics of these projects.

The comprehensive method of balancing the interests of stakeholders is based on the main achievements of modern science of project management and focuses on the use of the most relevant and effective methods of analysis and evaluation of project stakeholders. A formalized representation of the relationship between stakeholder interests and project objectives in the form of matrix models will formalize and structurally present the main components of the stages of working with project stakeholders.

An analysis of the composition of project stakeholders in relation to the stages of its life cycle has been done. Models have been created that allow evaluating the means of working with stakeholders and determining the correctness of the adopted strategy by the project management team.

The application of game theory for decision-making to resolve possible conflicts of stakeholders is substantiated. The optimization problem of determining the compromise price for resources with multiple suppliers is formulated.

Correct use of the developed models will allow to define precisely and confidently correctness of strategy on management of stakeholders and in due time to correct work with them in the conditions of possible conflicts of interests.

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