Assessment of The Level of Value Assurance for IT Project Stakeholders

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Abstract. Focusing on stakeholder's values is a key requirement when IT innovative projects are implemented. Stakeholders decide to participate in the IT project, in case that the IT project results are aimed at ensuring their values. By participating in the IT project, the stakeholder knows his resources in exchange for the IT project products that will be created in the course of its implementation. In this case, the value of the resources given by the interested party must be lower than the value of the products it receives. Such an exchange provides the stakeholder with a steady increase in the level of satisfaction and the provision of priority values. As in the course of the project implementation, there is an exchange of stakeholders' resources and products of the IT project to describe them, the general concept of an artifact was introduced. To ensure the complexity of the approach, both material and intangible artifacts were considered. Building an IT project model, the project management team identifies stakeholders who have a sufficient inventory of artifacts to share effectively. Given that a variety of stochastic processes can affect the progress of the IT project, the IT project management team should monitor the level of homeostasis in the project model. Ongoing analysis of the level of satisfaction of project stakeholders ensures that conflict situations are avoided, which can lead to the loss of the stakeholder and the termination of the IT project.

Keywords: value-oriented approach, homeostatic approach, stochastic approach, project artifacts.

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1 Description of the Problem, Goals, and Objectives of the Study

Value orientation is a core feature of innovative IT projects. At the same time, practical tools that work with IT project values are formed to a greater extent by expert evaluation of stakeholder representatives. Subjectivity, which is a key feature of expert appraisal methods, causes project managers to have low confidence in their results. The inconsistency of the results of different methods is also a negative factor, which is also related to the subjectivity of expert judgment[1-3].

The practical use of stakeholder valuation techniques is only possible if there are clear conclusions and recommendations on the quality of project planning and implementation. This task is quite important, so the question of using a value approach in project planning and management was explored by such well-known scientists as S. Bushuev, V. Oshurkov, V. Makashova, V. Malokanova.

In a number of studies that have been analyzed, the value approach is used to form a strategic plan for the organization's development, combining strategic plans of the organization with the development of Its IT infrastructure [4,5]. The concept of values is also seen as a tool for decision making in projects of various types [6-8]. In addition, the possibility of building a common model of the organization's values and, according to this model, of filling the project portfolio, is being considered. [9-11].

The above studies do not sufficiently address the process of changing the level of stakeholder value in the exchange of products and resources between IT project stakeholders and the management team. Also considered are the approaches to dynamic decision-making while changing the priority level of stakeholder values.

The purpose of the study is to identify methods for assessing the level of satisfaction of stakeholders and ensuring their values.

Research objectives:

- 1. Formalization of IT project's stakeholders and values that will be provided as a result of IT project implementation.
- 2. Formalization of products and resources of project stakeholders that are created and used for IT project implementation.
 - 3. Description of methods for assessing the satisfaction of IT project stakeholders.
- 4. Description of methods to assess the level of stakeholder value assurance as a result of the IT project [12-17].

2 First IT Project Stakeholders and Their Values

Depending on the type of IT project and the methodology used, different types of stakeholders are distinguished for its implementation. Different types of stakeholders are classified by the level of impact on the IT project.

We will describe mathematically the list of IT project stakeholders as follows:

$$Z = \{Z_1, \dots, Z_g\},\tag{1}$$

where

Z – the list of IT project stakeholders, Z_g – g IT project stakeholders, g – the number of IT project stakeholders.

The number of IT project stakeholders may change during the IT project implementation, as well as the stakeholder parameters.

For example, a user group can be divided into territorial groups and groups of devices they use.

Here is a mathematical description of the parameters that describe the project stakeholders:

$$Z_g = \langle p_g^z, C_g, v_g^z \rangle \tag{2}$$

 $Z_g = \langle p_g^z, C_g, v_g^z \rangle$ where C_g – the list of g-stakeholder values, p_g^z – the priority of the g stakeholder of the IT project,

 v_g^z – the indicator of satisfaction with the g stakeholder value of the IT project.

The importance of stakeholder involvement in the IT project is determined by the products that the stakeholder intends to receive and the resources that he or she is prepared to contribute to the IT project. To quantify the importance of stakeholder involvement in the IT project, we introduce the parameter - stakeholder priority.

Stakeholder priority is an indicator that reflects how important it is for the IT project management team to engage that particular stakeholder. The priority of other stakeholders depends on the value of the resources they provide to fulfill the tasks of the higher priority stakeholders.

The value, in this research, is a general concept that reflects the stakeholder's attitude to various aspects of the development and further operation of an information system. Examples include the following values: speed of information processing, completeness of the information presented, ease of use of the system, etc.

Stakeholder value will be understood as a formalized description of the needs of the stakeholder represented by the parameters of qualitative assessment of the subjective attitude of the stakeholder to the individual elements of the external environment. The list of values of different stakeholders is different, and different stakeholders may have the same value in their list. The list of stakeholder values is mathematically described as follows:

 $C_g = \{C_{g1}, \dots, C_{gl}\},$ $C_{gl} - i \text{ value of } g \text{ stakeholder},$ $C_{g1} - \text{the first value of } g \text{ stakeholder}.$ (3)

where

The complexity of dealing with stakeholder values is that they are described by qualitative parameters that are subjectively defined. For example, a parameter such as the speed of information of the system can be described by such parameters as high, medium and low. The subjectivity of values is explained by the fact that decisions are made by a person or group of people who are representatives of the stakeholder. The stakeholder may change their attitude to value as a result of external factors. There are two parameters to describe the stakeholder relationship to value in this study: priority and value assurance.

$$C_{gl} = \langle p_{gl}^c, v_{gl}^c, O_{gl}^c \rangle, \tag{4}$$

where p_{gl}^c — the priority of l value for g stakeholder, $p=\overline{0,1}$, $\sum_{l}^{l}p_{l}^c=1$, v_{gl}^c — the indicator of the level of security of the l^{th} value for the g

stakeholder, $v_{al}^c = \overline{0.1}$,

 O_{al}^{c} - the list of indicators of l value for g stakeholder in the project implementation.

Value Priority determines the stakeholder relationship to value. The priority indicator can take values from zero to one. Mathematically, we describe this condition

$$\sum_{k=1}^{l} p_{gk}^{c} = 1 \tag{5}$$

The security level is the parameter that determines the satisfaction level of the stakeholder. The parameter can take values from one to zero.

Determine the value of the level of security using the indicator of the impact of tangible and intangible resources owned by the interested party. To calculate this indicator, we find the sums of the level of influence on the value of the stakeholder of all tangible and intangible resources of the stakeholder, taking into account the rate of reduction of the impact of resources on the value.

It is possible to calculate the level of l value assurance for g stakeholder using the formula:

$$v_{gl}^{c} = \sum_{i=1}^{n} \frac{v_{gli}^{rm}}{\left(1 - R_{gli}^{rm}\right)^{T_{i}^{rm}}} + \sum_{j=1}^{h} \frac{v_{glj}^{rn}}{\left(1 - R_{glj}^{rn}\right)^{T_{j}^{rn}}},\tag{6}$$

where v_{gli}^{rm} - the indicator of the influence level of i material artifact of the resource on l value of g stakeholder, $v_{gli}^{rm} = \overline{0.1}$,

 v_{glj}^{rn} – the indicator of the impact level of j intangible artifact of the resource on l value of g stakeholder, $v_{glj}^{rn} = \overline{0,1}$,

 T_i^{rm} – the attraction period of i material resource artifact, T_j^{rm} – the period of j intangible artifact to the resource,

 R_{ali}^{rm} – the rate of influence change of i material artifact of resource of l value of g stakeholder,

 $R_{glj}^{r\tilde{n}}$ - the rate of influence change of j intangible artifact of resource of l value of g stakeholder.

The calculated value assurance metric can take values from zero to one. The maximum value of this indicator is one, while the value is fully ensured and any project products are not of interest to the interested party. The minimum value is zero, with the value of any product of the project providing this value that will satisfy the interested party.

The list of value metrics contains many metrics that describe the value of the stakeholder. Mathematically, we describe the list of value description metrics as follows:

$$O_{gl}^{c} = \{o_{gl1}^{c}, \dots, o_{glr}^{c}\},\tag{7}$$

where $o_{glr}^c - r$ indicator of l value of g stakeholder,

r – number of indicators of l value of g stakeholder.

Each metric description metric has two dimensions: priority and metric value. Mathematically, we describe the indicator as follows:

$$o_{alr}^c = \langle p_{alr}^{co}, s_{alr}^{co} \rangle, \tag{8}$$

 $o_{glr}^{c} = \langle p_{glr}^{co}, s_{glr}^{co} \rangle, \tag{8}$ where p_{glr}^{co} — the priority of r indicator of l value for g stakeholder, $p_{glr}^{co} = \overline{0,1}$, $\sum_{i}^{r} p_{glr}^{co} = 1,$

 s_{alr}^{co} – the value of r value of l value for g stakeholder.

Value analysis enables you to identify project products and resources that can be used to create them.

3 IT Project Artifacts

The products that are created during the IT project implementation affect the satisfaction of the IT project stakeholders. This study examines both tangible and intangible project products and project resources.

The products that are formed during the implementation of one IT project work can be used as resources for the implementation of other IT project product development tasks. The study proposes to combine the products and resources of the IT project under the general definition of artifacts.

The artifacts transmitted to the stakeholder for the IT project product creation tasks will be a resource for the stakeholder. The artifacts created by the stakeholder as a result of the IT project product creation tasks are transferred as resources to other IT project stakeholders.

Artifacts will mean financial, tangible and intangible elements of the world that are of value to stakeholders and can be a product of the IT project or used as resources in its implementation.

IT project artifacts are divided into:

- Material artifacts are tangible products or resources, including financial, that are used or created in the course of an IT project. An example of a material artifact could be the premises where the development team works, equipment, facilities, etc. A tangible artifact is transferred from one stakeholder of an IT project to another.
- Intangible artifacts are artifacts carried by an information product created in an IT project or an information resource used in its implementation. Examples of intangible artifacts include ownership of the information system, information regarding the use of the system, description of potential users of the system, etc.

By participating in the IT project, the stakeholder expects to receive artifacts that will increase the level of security of its priority values. Stakeholder involvement in the project is possible through the exchange of artifacts owned by them into artifacts created in the IT project. For further analysis, it is necessary to divide artifacts into two sets: resource artifacts and product artifacts.

3.1 **Material Artifacts Resources**

A tangible artifact resource is a financial or material resource owned by an interested party that can be used to implement a project.

When a material resource artifact is transferred to a project, its impact on the values of the transmitted stakeholder is no longer taking place.

The list of material artifacts of resources is mathematically described as follows: $A^{rm} = \{A_1^{rm}, \dots, A_n^{rm}\}, \tag{9}$ where A_k^{rm} – the material artifacts list of project resources, A_{k1}^{rm} - l material artifact is a project resource,

$$A^{rm} = \{A_1^{rm}, \dots, A_n^{rm}\},\tag{9}$$

n –number of material artifacts of project resources.

We describe mathematically the material artifact project resource:

$$A_n^{rm} = \langle O_n^{rm}, w_n^{rm}, v_n^{rm}, T_n^{rm}, R_n^{rm} \rangle, \tag{10}$$

 $A_n^{rm} = \langle O_n^{rm}, w_n^{rm}, v_n^{rm}, T_n^{rm}, R_n^{rm} \rangle,$ where O_n^{rm} – the parameters list describing the n^{th} material artifact resource,

 v_n^{rm} – the indicators list of the influence level of the n^{th} material artifact of a

resource on the stakeholders' values, $v_n^{rm} = \overline{0,1}$, T_n^{rm} – the attraction period of n material artifact of the resource, R_n^{rm} – the indicators list of changes in the influence level of the n^{th} material artifact of a resource on the values of the interested party.

The parameters list that describe the material artifact resource is a set of indicators that have both quantitative and qualitative forms of description. Mathematically, we describe the parameters of the material resource artifact as follows:

$$O_n^{rm} = \{o_{n1}^{rm}, \dots, o_{nr}^{rm}\},\tag{11}$$

 $O_n^{rm} = \{o_{n1}^{rm}, \dots, o_{nr}^{rm}\},\$ $O_{nr}^{rm} - r$ indicator of n material artifact of the project resource,

r – the number of indicators of h material artifacts of project resources.

The indicator contains values that describe in qualitative or quantitative terms. We will describe mathematically the material artifact indicator of the project resource as follows:

$$o_{nr}^{rm} = \langle s_{nr}^{rm} \rangle, \tag{12}$$

where s_{nr}^{rm} - the value of r indicator of n material artifact of the project resource.

The indicators list of the influence level on the stakeholders' values is a set, each value of which reflects the influence level of material resource artifact on the values of each stakeholder.

The next formula can be used for the value calculation of an indicator of the influence level of the resource material artifact on the stakeholder's value:

$$v_{gli}^{rm} = \sum_{j}^{r} p_{glj}^{co} \frac{s_{glj}^{co} - (|s_{glj}^{co} - s_{ij}^{rm}|)}{s_{glj}^{co}},$$
(13)

where p_{glj}^{co} - the priority of j value of l value for g stakeholder, s_{glj}^{co} - the value of j value of l value for g stakeholder, s_{ij}^{rm} - the value of r indicator of n^{th} material artifact of the project

r - l values for g stakeholder.

The material artifact engagement period of the resource contains the time period when the resource will be invested in the project product creation task.

The indicators list of change in the impact level on the stakeholders' values is the matrix, which lists the individual values of indicators of reducing the impact of material resource artifact on each stakeholders' value.

3.2 **Intangible Artifacts Resources**

The peculiarity of the intangible resource is that when it is transmitted by the interested party to the IT project, the impact on the values does not cease. This is due primarily to the fact that the intangible artifact resource is an information product that can be copied and transmitted to any number of IT project stakeholders.

Intangible Artifact Resource (NAR) is information or other intangible resource owned by a stakeholder that can be used to deliver an IT project.

The next formula is the mathematical description of the intangible artifacts list of resources:

$$A^{rn} = \{A_1^{rn}, \dots, A_h^{rn}\},\tag{14}$$

where

 $A^{rn}=\{A^{rn}_1,\dots,A^{rn}_h\},$ A^r_k – the intangible artifacts list of the IT project,

 $A_1^r - l$ intangible artifact of the IT project,

h – the number of intangible artifacts of IT project resources.

We describe the mathematically intangible artifact IT project resource:

$$A_{h}^{rn} = \langle O_{h}^{rn}, w_{h}^{rn}, v_{h}^{rn}, T_{h}^{rn} R_{h}^{rn} \rangle, \tag{15}$$

 $A_h^{rn} = \langle O_h^{rn}, w_h^{rn}, v_h^{rn}, T_h^{rn} R_h^{rn} \rangle,$ O_h^{rn} - the parameters list that describe h intangible artifact resource,

 v_h^{rn} – the indicators list of the influence level of h intangible artifact of the resource on the stakeholder's values, $v_h^{rn} = \overline{0.1}$,

 T_h^{rn} – the attraction period of h intangible artifact of the resource, R_h^{rn} – the indicators list of change in the influence level of the h-intangible artifact of the resource on the stakeholder's values.

The parameters list that describe an intangible artifact resource is a set of metrics that have only a qualitative description form. It is presented the parameters list mathematically described as an intangible resource artifact below:

$$O_h^{rn} = \{o_{h_1}^{rn}, \dots, o_{h_r}^{rn}\},\tag{16}$$

 $O_h^{rn} = \{o_{h1}^{rn}, \dots, o_{hr}^{rn}\},$ $O_{hr}^{rn} - r \text{ indicator of } h\text{-intangible artifact of IT project resource,}$

r - the number of indicators of h intangible artifacts of IT project resources.

The metric contains the value that is described in qualitative or quantitative terms.

The indicator of an intangible artifact of an IT project resource can be described:

$$o_{hr}^{rn} = \langle s_{hr}^{rn} \rangle, \tag{17}$$

 s_{rh}^{rn} – the value of r indicator of h intangible artifact of the IT project where

The indicators list of the impact level on an intangible artifact resource is a matrix, which shows indicators from zero to one that determines the impact level of the resource on the stakeholders' values. The value calculation of the indicator of the influence level of intangible artifact of the resource on the stakeholder's value is carried out by the following formula:

$$v_{gli}^{rn} = \sum_{j}^{r} p_{glj}^{co} \frac{s_{glj}^{co} - (|s_{glj}^{co} - s_{ij}^{rn}|)}{s_{glj}^{co}},$$
(18)

where p_{glj}^{co} - the priority of j indicator of l value for g stakeholder,

 s_{glj}^{co} - the value of j value of l value for g stakeholder,

 s_{ij}^{rn} - the value of r indicator of n intangible artifact of the IT project

r - l values for g stakeholder.

The intangible asset artifact engagement period metric indicates the time at which the artifact will be used to complete the IT project product creation tasks.

The list of impact level change indicators contains the matrix that lists the changes in the impact of the artifact on each IT project stakeholder value.

3.3 **Material Artifacts Products**

A tangible product artifact is a product that is intended to be obtained as a result of the IT project's product creation tasks. The peculiarity of the material artifact of the product is the presence of quantitative values of the parameters that describe the product. The values of these parameters do not include the subjective attitude of the stakeholders towards the material artifact of the IT project product.

A tangible product artifact (TPA) is a financial or tangible product of an IT project, which is formed when the task of creating an IT project is completed and communicated to the IT project stakeholders.

The mathematical description of the IT project product artifacts is: $A^{pm} = \left\{A_1^{pm}, \dots, A_m^{pm}\right\}$ where A^{pm} – the material artifacts list of products

$$A^{pm} = \{A_1^{pm}, \dots, A_m^{pm}\} \tag{19}$$

 $A_m^{pm} - m$ material artifact product,

m – the number of material artifacts of the products that are formed during the IT project implementation.

The mathematical material artifact of the IT project product is described as: $A_m^{pm} = \langle O_m^{pm}, w_m^{pm}, v_m^{pm}, T_m^{pm}, R_m^{pm} \rangle,$

$$A_m^{pm} = \langle O_m^{pm}, w_m^{pm}, v_m^{pm}, T_m^{pm}, R_m^{pm} \rangle, \tag{20}$$

 O_m^{pm} – the parameters list of m material product artifact,

 v_m^{pm} - the indicators list of the influence level of m material product artifact on the stakeholder's value, $v_m^{pm} = \overline{0,1}$, T_m^{pm} – the receipt period of m material artifact of the product, R_m^{pm} – the indicators list for reducing the impact level of m material

product artifact on the stakeholder's value.

The parameters list describing the material artifact product is a set of indicators that have both quantitative and qualitative forms of description. The description of these parameters makes it possible to determine the future product and its quantitative and qualitative characteristics. The list of parameters is determined by the IT project management team during the implementation of the IT project artifact description procedure. Mathematically, we describe the list of material artifact parameters as follows:

$$O_m^{pm} = \{o_{m1}^{pm}, ..., o_{mr}^{pm}\},$$
 (21)
$$O_{mr}^{pm} - r \text{ indicator of } m \text{ material artifact of the project product,}$$

where

r – the number of indicators of m material artifact of the project product.

The metric contains a value that is described in qualitative or quantitative terms. Mathematically, the description of the material artifact of an IT project product is described as follows:

$$o_{mr}^{pm} = \langle s_{mr}^{pm} \rangle, \tag{22}$$

 $o_{mr}^{pm} = \langle s_{mr}^{pm} \rangle, \tag{22}$ s_{mh}^{rn} - the value of r indicator of m material artifact of the IT project where

The list of impact indicators for intangible product artifacts contains the matrix with separate impact level values for each stakeholder value. The calculation of the value of the influence level of material product artifact on the stakeholder's value is carried out by the following formula:

$$v_{gli}^{pm} = \sum_{j}^{r} p_{glj}^{co} \frac{s_{glj}^{co} - (|s_{glj}^{co} - s_{ij}^{pm}|)}{s_{glj}^{co}},$$
 (23)

where p_{glj}^{co} - the priority of j indicator of l value for g stakeholder, s_{glj}^{co} - the value of j value of l value for g stakeholder, s_{ij}^{pm} - the value of r indicator of n material artifact of the project product,

r-l values for g stakeholder.

The period of engagement of a tangible product artifact contains the time the product was received as a result of the IT project product creation tasks.

The list of indicators of change in the impact level of a material artifact of a product on the stakeholder's value contains the matrix of individual values of the change in the influence level of the product on each value of the IT project stakeholders. The individual metrics of this matrix indicate how much the impact of a product's material artifact on an IT project's stakeholder value changes per unit of time.

3.4 **Intangible Products Artifacts**

Intangible product artifacts are the results of the implementation of the IT project product creation tasks that are described by qualitative criteria.

Intangible artifact product is an informational or intangible product of a project that is generated during the IT project implementation and is passed on to the IT project stakeholders.

$$A^{pn} = \{A_1^{pn}, \dots, A_d^{pn}\},\tag{24}$$

Mathematically, we describe the list of product artifacts as follows: $A^{pn} = \{A_1^{pn}, \dots, A_d^{pn}\},$ here A^{pn} – the list of intangible artifact product of the IT project,

 A_d^{pm} – m intangible artifact product of the IT project,

d – the number of intangible artifacts of products that are generated during the IT project.

$$A_d^{pn} = \langle O_d^{pn}, w_d^{pn}, v_q^{pn}, T_d^{pn}, R_d^{pn} \rangle, \tag{25}$$

We describe a mathematically intangible artifact of an IT project product: $A_d^{pn} = \langle O_d^{pn}, w_d^{pn}, v_g^{pn}, T_d^{pn}, R_d^{pn} \rangle, \qquad (25)$ where O_d^{pn} – the parameters list that describe the *d*-intangible product artifact, v_d^{pn} – the indicators list of the influence level of *d*-intangible product artifact on the stakeholder's values, $v_d^{pn} = \overline{0,1}$,

 T_d^{pn} – the receipt period of d intangible product artifact, R_d^{pn} – the indicators list for reducing the influence level of the d material product artifact on the stakeholder's value.

The parameters list that describe an intangible artifact product is a set of indicators that have only a qualitative form of description. The description of these parameters makes it possible to determine the future product and its quality characteristics. Mathematically, the list of parameters will describe the intangible product artifact as follows:

$$O_d^{pn} = \{o_{d1}^{pn}, \dots, o_{dr}^{pn}\},\tag{26}$$

 $O_d^{pn}=\big\{o_{d1}^{pn},\dots,o_{dr}^{pn}\big\},$ d -r indicator of the d-intangible artifact of the IT project product, where

r is the number of indicators of h-intangible artifacts of the IT project product.

The metric contains the value that is described in qualitative or quantitative terms. Mathematically, we describe the intangible artifact of an IT project product as

$$o_{dr}^{pn} = \langle s_{dr}^{pn} \rangle, \tag{27}$$

 $o_{dr}^{pn} = \langle s_{dr}^{pn} \rangle, \tag{27}$ d_{dr}^{pn} – the value of r indicator of d intangible artifact of the IT project

The list of indicators of the level of impact on an intangible artifact product is a matrix, which gives indicators from zero to one that determines the level of impact of the product on the stakeholders' values. The value calculation of the influence level of an intangible product artifact on the stakeholder's value can be made using the next formula:

$$v_{gli}^{pn} = \sum_{j}^{r} p_{glj}^{co} \frac{s_{glj}^{co} - (|s_{glj}^{co} - s_{ij}^{pn}|)}{s_{glj}^{co}},$$
 (28)

where p_{glj}^{co} - the priority of j value of l^{th} value for g stakeholder, s_{glj}^{co} - the value of j value of l^{th} value for g stakeholder, s_{ij}^{pn} - the value of r indicator of r intangible artifact of the IT project

r – the l values for g stakeholder.

The Intangible Product Artifact Retrieval Indicator indicates the time the artifact will be received as a result of the IT project product creation tasks.

The list of impact level change indicators contains a matrix that lists the changes in the impact of the artifact on each project stakeholder value. This indicator indicates how much the stakeholder value level of the intangible product artifact per unit will change.

4 Satisfaction Level Assessment of IT Project Stakeholders

The satisfaction level of project stakeholders is a key indicator as it reflects how interested the stakeholders are in the outcome of the IT project and agrees to continue to participate in it. In order to maintain homeostasis in the IT project, the IT project management team should monitor this index and not allow significant deviations between the planned and actual indicators within the iteration.

Stakeholder satisfaction metrics are calculated by calculating the impact of material and intangible product artifacts on stakeholder values. The calculation also takes into account the priority of all stakeholder values. The mathematical calculation of the planned values of the satisfaction level of the stakeholders' values will be described as follows:

$$v_g^{zp} = p_g^z * \sum_{k=1}^l \left(p_k^c * \left(\sum_{i=1}^n \frac{v_{gli}^{pm}}{\left(1 - R_{gli}^{pm} \right)^{T_i^{pm}}} + \sum_{j=1}^h \frac{v_{glj}^{pn}}{\left(1 - R_{glj}^{pn} \right)^{T_j^{pn}}} \right) \right)$$
(29)

where v_g^{zp} – planned values of the satisfaction level of g stakeholder's values.

The value of the actual indicators of the satisfaction level of the stakeholder is calculated by calculating the values of the impact of tangible and intangible artifacts of the resources on all the stakeholder's values. The calculation also takes into account the priority of the stakeholder's values. We will mathematically calculate the actual values of the satisfaction level of the stakeholder values as follows:

$$v_g^{zf} = p_g^z * \sum_{k=1}^{l} \left(p_k^c * \left(\sum_{i=1}^{m} \frac{v_{gli}^{rm}}{\left(1 - R_{gli}^{rm} \right)^{T_i^{rm}}} + \sum_{j=1}^{b} \frac{v_{glj}^{rn}}{\left(1 - R_{glj}^{rn} \right)^{T_j^{rn}}} \right) \right)$$
(30)

where v_q^{zp} - the actual values of the satisfaction level of the g stakeholder.

The deviation of the satisfaction level of the interested party is calculated as the difference between the values of the planned and actual indicators of the satisfaction level of all stakeholders' values. The mathematical calculation of the deviation of values of the satisfaction level of the stakeholder values will be described as follows:

$$v_g^{zo} = v_g^{zp} - v_g^{zf} \tag{31}$$

where v_q^{zo} – deviation in satisfaction of g stakeholder values.

The results of the indicators calculation are recorded in the table, the template of which is presented in Table 1.

Table 1. Results of the analysis of the satisfaction level of IT project stakeholders

Stakeholders	Stakeholder	Stakeholder	Satisfaction with
	satisfaction, plan	satisfaction, fact	values, rejection
Z_1	v_1^{zp}	v_1^{zf}	v_1^{zo}
Z_2	v_2^{zp}	v_2^{zf}	v_2^{zo}
	•••	•••	•••
Z_g	v_g^{zp}	v_g^{zf}	v_g^{zo}

Based on the collected data on the satisfaction level of the IT project stakeholders, a petal chart is constructed, which shows data on the values of the planned and actual satisfaction level of the stakeholders. An example of a petal diagram is shown in Figure 1.

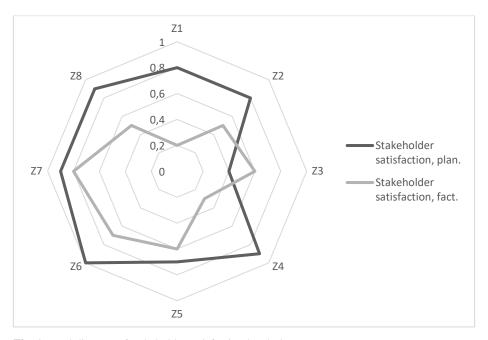


Fig. 1. Petal diagram of stakeholder satisfaction level [Own source]

By analyzing the data of the IT project stakeholders' satisfaction table and the petal diagram, the project management team identifies stakeholders whose satisfaction levels do not change during the project implementation process. Significant deviations between the planned and actual indicators of the priority stakeholders lead to the loss of homeostasis in the IT project.

Conclusions

- A mathematical model was developed describing the IT project stakeholders and the values that should be provided as a result of the IT project. Indicators of the satisfaction level of stakeholders and the provision of their values have been determined.
- 2. A mathematical model describing the artifacts of the project is constructed. Indicators describing IT project artifacts have been identified and their importance in meeting IT project stakeholders' values.
- 3. A method for assessing the satisfaction level of stakeholders has been developed. Analyzing the level of stakeholder value assurance by the results of artifacts exchange, we determine the satisfaction level of IT project stakeholders. The results of the stakeholder satisfaction analysis allow us to predict the occurrence of conflicts in the IT project and to avoid their negative consequences.

References

- 1. A Guide to the Project Management Body of Knowledge, Ed. 5, p. 590. Project Management Institute (2013).
- 2. The Standard for Program Management, Ed. 1. p. 123. Project Management Institute (2006).
- 3. P2M «Program & Project Management for Enterprise Innovation», \www/URL: http://www.pmaj.or.jp/ENG/p2m/p2m_guide/p2m_guide.html.
- Bushuev, S., Bushueva, N.: Mechanisms of value formation in the activities of projectdriven organizations. East European Journal of Advanced Technology 1 (2 (43)), 4-9 (2012). DOI: http://dx.doi.org/10.15587/1729-4061.2010.2494.
- Oshurkov, V., Makashova, V.: Mechanisms for optimizing the management of the program of IT projects. Collection of scientific papers SWORLD 11, 66-75 (2014).
- 6. Nazarova, O.B., Davletkireeva, L.Z., Malakhova, I.V.: Audit the company's information infrastructure and develop an IT strategy. International Journal of Experimental Education (11), 86-87 (2012).
- 7. Medvedeva, O.: Fuzzy cognitive modeling for solving the problems of managing the interaction of stakeholders in projects. East European Journal of Advanced Technology 5 (4 (59)), 44-49 (2012).
- Medvedeva O.: The conceptual basis of value-oriented management interaction in innovation activity. Project Management and production development: Assoc. 3 (47), 75-87 (2013).
- Molokanova V.M.: Research of project-oriented development evolutionary theory of values. Project Management and production development, Assoc 2(42), 11-17 (2012).
- 10. Molokanova V.M.: Value-oriented analysis of decision making in project management. Management of complex systems development, 25, pp. 32-39 (2016).
- 11. Chernov, S.K., Savina, O.Yu.: Method of formation of value-oriented portfolio management of high-tech enterprises projects. Management of Development of Complex Systems 34, 78–84 (2018).
- 12. Oberemok, I., Oberemok, N.: Decision-making model. Technology Audit and Production Reserves 1 (2 (33)), 13-18, (2017).
- 13. Pasichnyk, V., Kunanets, N.: IT education and IT business in Ukraine: Responses to the modern challenges. Proceedings of the International Conference on Computer Sciences and Information Technologies, 7325428, pp. 48-51. (2015)
- Romanenkov, Y., Pasichnyk, V., Veretennikova, N., Nazaruk, M., Leheza, A.: Information and technological support for the processes of prognostic modeling of regional labor markets. CEUR Workshop Proceedings, 2386, pp. 24-34 (2019).
- Shestakevych, T., Pasichnyk, V., Kunanets, N., Medykovskyy, M., Antonyuk, N.: The content web-accessibility of information and technology support in a complex system of educational and social inclusion. In: proceedings of 13th International Scientific and Technical Conference on Computer Sciences and Information Technologies, CSIT 2018, 1,8526691, pp. 27-31. (2018)
- Veretennikova, N., Pasichnyk, V., Kunanets, N., Gats, B.: E-Science: New paradigms, system integration and scientific research organization. Proceedings of the International Conference on Computer Sciences and Information Technologies, 7325436, pp. 76-81. (2015).

17. Bomba, A., Kunanets, N., Nazaruk, M., Pasichnyk, V., Veretennikova, N.: Information technologies of modeling processes for preparation of professionals in smart cities. Advances in Intelligent Systems and Computing, 754, 702-712 (2019).