Multidimensionality and Multilevel Values of IT Projects SMART-cities and SMART-regions

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Abstract

This study is devoted to the development of a conceptual model and a method for assessing the value of IT projects for cities and regions as part of their smart transformation. Unlike existing approaches, the model and method take into account the "adjustment" of the value, taking into account the budget and project time frame, as well as the "contribution" of the project to the achievement of multiple targets in interrelated/related areas, taking into account the priorities of areas and goals (integral value) and the significance of the project for different interrelated levels, taking into account the priorities of objects (which are affected by the project), areas and goals (hierarchical value). Together, this makes it possible to take into account the significance of the results and relationships of projects that are characterized by multidimensionality and multi-levelness. The proposed method for assessing the value is developed for three options for the conditions for considering a project: 1) the basic option - taking into account the system of target indicators and their priorities for one "object"; 2) an option that takes into account the conditions of the project's multidimensionality, when its results are significant for various areas, and the value is commensurate with the project's contribution to the achievement of multiple systems of target indicators in several interrelated/related areas, taking into account the priorities of areas and goals - integral value; 3) an option that provides for the significance of the project for various areas at various interrelated levels, taking into account the priorities of centres, areas, goals - a hierarchical value. The practical use of this method allows you to reasonably make decisions on financing or other support at the state level. An important feature of the proposed method for assessing the integral and hierarchical value is that the method is universal and can be used for projects of any nature that meet either the condition of multidimensionality, multi-levelness or both.

Keywords [1]

Value, multi-levelness, multidimensionality, SMART-cities, assessment method, IT projects

1. Introduction

Smart cities and smart regions are transforming the way IT projects are created and managed. These projects have multidimensional and multilevel values, making it important to evaluate their worth. While there are many publications on assessing project value, most focus on theoretical or practical aspects. However, it is essential to develop a method for evaluating project value based on the key characteristics of budget, time, and results. This approach must take into account the different values that IT projects can bring, such as strategic, operational, financial, and user values [1]. Furthermore, the significance of a project and its effectiveness can be linked to different levels, from local to regional, and even international. This study aims to develop a method for assessing the value of IT projects that considers their multidimensional and multilevel nature [2].

Modern project and program management methodology places great importance on the concept of "value". As a result, a significant amount of literature has been dedicated to exploring theoretical and practical approaches to evaluating the value of projects, portfolios, and programs [3]. This includes the development of appropriate methods and models to optimize portfolios and programs based on the criterion of maximum value while considering any constraints [4]. Today, "value" is a more comprehensive and significant concept compared to traditional efficiency, although in some cases,

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"value" is equivalent to "efficiency". In models that optimize portfolios and programs, efficiency is viewed as a constraint, while the primary goal and corresponding efficiency criterion remain focused on achieving maximum value.

It should be noted that “value” is one of the key categories of modern project and program management methodology, therefore a significant number of modern publications are devoted to both theoretical and practical aspects of assessing the value of projects, portfolios, programs [5], including the development of appropriate methods, and also models for the formation of portfolios and programs according to the criterion of maximum value [6], taking into account the system of restrictions. Thus, today "value" [7] is a broader and more meaningful concept than traditional efficiency, and only for some categories of projects "value" is equivalent to "efficiency". In the mentioned models of portfolios and programs, efficiency acts as a constraint, and the main goal and the corresponding efficiency criterion is precise "value".

In the works, a generalization of “value” was proposed as a correspondence to the goals (enterprises, companies, organizations) or the “degree of contribution” of the project to the achievement of the goal. At the same time, it was established in [7] that each project can contribute to various strategic goals of the enterprise.

But the question arises - the contribution of the project to the achievement of the goal (goals) can be high, but the cost of the project is also too high, and slightly less modest results in achieving the goal (goals) can be provided by a project with a much smaller budget. In addition, the duration of the project is also significant in terms of its value - if results that are not much different can be achieved using two projects with different deadlines, then, naturally, preference should be given to the project with a shorter time to get the result.

In addition, at the level of evaluation methods, such an aspect of the value of projects as multi-levelness is ignored. This is especially true for IT projects [8], infrastructure projects, projects related to the development of tourism, and environmental projects when financing is provided from budgetary funds, and the significance of the project and its effectiveness can be associated with both the local and regional levels, and, in some cases, and with the level of the country as a whole. And for some projects, which should be implemented with the support of international funds, the significance can be considered and assessed accordingly within the international community.

Thus, the purpose of this study is to develop a conceptual model and an appropriate method for assessing the value of IT projects, taking into account the multidimensionality and multilevel nature of their results [9].

"Value" is one of the key categories of modern project and program management methodology, therefore a significant number of modern publications are devoted to both theoretical and practical aspects of assessing the value of projects, portfolios, and programs, including the development of appropriate methods, as well as models formation of portfolios and programs according to the criterion of maximum value, taking into account the system of restrictions. Thus, today "value" is a broader and more meaningful concept than traditional efficiency, and only for some categories of projects "value" is equivalent to "effectiveness". In the mentioned models of portfolios and programs, efficiency acts as a constraint, and the main goal and the corresponding efficiency criterion is precise "value".

Even though a significant number of publications are devoted to "values", nevertheless, many aspects remain unexplored or not clearly defined.

Thus, the essence of the "value" of projects is determined by taking into account their specifics this is a generally accepted approach. Naturally, the value of an environmental project and the value of a project related to the development of tourism are formed taking into account their characteristics.

Multidimensionality and multilevel values of IT projects refer to the various ways in which IT projects can create value for different stakeholders at different levels within an organization. Let's look at the basic values of IT projects [10].

Strategic value: IT projects can provide strategic value by aligning with the overall business strategy and helping to achieve business goals. For example, a project that introduces new technology to improve customer experience can create strategic value by increasing customer satisfaction and loyalty.

Operational value: IT projects can also provide operational value by improving the efficiency and effectiveness of business processes [11]. For example, a project that automates a manual process can reduce errors and save time, resulting in operational efficiency gains.

Financial value: IT projects can generate financial value by reducing costs, increasing revenue, or both. For example, a project that enables online sales can increase revenue by opening up new sales channels and reducing costs by automating order processing.

User value: IT projects can create user value by improving the user experience of employees, customers, or other stakeholders. For example, a project that introduces a mobile app for employees to access company resources can improve their productivity and satisfaction.

Societal value: IT projects can also create societal value by contributing to social or environmental goals. For example, a project that reduces carbon emissions through the use of virtual meetings can contribute to environmental sustainability [12].

At each of these levels, IT projects can create value for multiple stakeholders, such as employees, customers, partners, shareholders, and society at large. The ability and agility to create value across multiple dimensions and levels are what makes IT projects such a powerful tool for driving business success and social impact [13].

2. Literature review

Strategic value is one of the key ways in which IT projects can create value for an organization. In the context of IT projects, strategic value refers to the extent to which the project aligns with the overall business strategy and helps to achieve business goals [14].

IT projects can provide strategic value in several ways.

Supporting business objectives: IT projects can help to support the achievement of business objectives by providing tools and systems that enable employees to work more efficiently, provide better customer service, or develop new products and services.

Improving competitiveness: IT projects can help to improve the competitiveness of a company by providing new capabilities that differentiate it from competitors, such as new products, services, or business models.

Enhancing customer experience: IT projects can help to enhance the customer experience by providing better access to information, improving communication channels, or simplifying the buying process.

Enabling innovation: IT projects can enable innovation by providing tools and systems that support research and development, or by providing new ways to analyze data and generate insights.

Supporting decision-making: IT projects can support decision-making by providing access to real-time data and analytics, enabling better forecasting and risk management, and improving collaboration and communication across departments.

IT projects can provide strategic value by supporting business objectives, improving competitiveness, enhancing customer experience, enabling innovation, and supporting decision-making. By aligning with the overall business strategy and helping to achieve business goals, IT projects can help organizations to stay competitive, grow, and succeed [15].

Operational value is another way in which IT projects can create value for organizations. In the context of IT projects, operational value refers to the extent to which the project improves the efficiency and effectiveness of business processes [16].

IT projects can provide operational value in several ways.

Automating manual processes: IT projects can automate manual processes, such as data entry, inventory management, or scheduling, reducing errors and saving time.

Streamlining workflows: IT projects can streamline workflows by providing tools and systems that enable employees to work more efficiently, reducing the time required to complete tasks.

Improving communication: IT projects can improve communication across departments and with customers, suppliers, or partners, reducing the time required to resolve issues and make decisions.

Enhancing data analysis: IT projects can enhance data analysis by providing tools and systems that enable better analysis of data, improving forecasting and decision-making.

Reducing costs: IT projects can reduce costs by eliminating manual processes, reducing errors, and improving efficiency, resulting in cost savings.

IT projects can provide operational value by automating manual processes, streamlining workflows, improving communication, enhancing data analysis, and reducing costs. By improving the efficiency and effectiveness of business processes, IT projects can help organizations to reduce costs, increase productivity, and achieve better results.

IT projects can create financial value for organizations by reducing costs, increasing revenue, or both. In the context of IT projects, financial value refers to the extent to which the project generates financial benefits for the organization.

IT projects can provide financial value in several ways.

Reducing costs: IT projects can reduce costs by automating manual processes, improving efficiency, and reducing errors, resulting in cost savings.

Increasing revenue: IT projects can increase revenue by providing new capabilities that enable the organization to develop new products, services, or business models, or by providing new ways to reach customers and increase sales.

Improving cash flow: IT projects can improve cash flow by providing tools and systems that enable faster payment processing, better inventory management, or more accurate forecasting.

Reducing risk: IT projects can reduce risk by providing tools and systems that enable better risk management, such as fraud detection or compliance monitoring.

Enabling cost avoidance: IT projects can enable cost avoidance by providing tools and systems that enable the organization to avoid costs that would otherwise be incurred, such as by preventing errors or reducing downtime.

IT projects can create financial value by reducing costs, increasing revenue, improving cash flow, reducing risk, and enabling cost avoidance. By generating financial benefits for the organization, IT projects can help to improve the financial performance of the organization and support its long-term sustainability.

Societal value is an important way in which IT projects can create value beyond the organization itself. In the context of IT projects, societal value refers to the extent to which the project contributes to the well-being of society as a whole, including its impact on social, environmental, and ethical factors [17].

IT projects can provide societal value in several ways.

Improving access to information: IT projects can improve access to information, enabling people to make more informed decisions and increasing transparency and accountability.

Enabling innovation: IT projects can enable innovation by providing new tools and systems that enable new products, services, or business models, stimulating economic growth and creating new opportunities.

Reducing environmental impact: IT projects can reduce environmental impact by providing tools and systems that enable more efficient use of resources, reducing waste, and promoting sustainable practices.

Enhancing social inclusion: IT projects can enhance social inclusion by providing tools and systems that enable marginalized or disadvantaged communities to access information, services, or job opportunities.

Promoting ethical behaviour: IT projects can promote ethical behaviour by providing tools and systems that promote transparency, accountability, and ethical decision-making.

IT projects can create societal value by improving access to information, enabling innovation, reducing environmental impact, enhancing social inclusion, and promoting ethical behaviour. By contributing to the well-being of society as a whole, IT projects can help to address some of the most pressing social, environmental, and ethical challenges of our time [18].

IT projects are often multidimensional, meaning they involve multiple dimensions or aspects that contribute to their overall success or value. The multidimensionality of IT projects can be thought of in terms of several different dimensions.

Technical dimension: This dimension involves the technical aspects of the project, such as the hardware, software, and infrastructure required to implement the project successfully.

Process dimension: This dimension involves the processes and procedures required to support the project, such as project management methodologies, change management processes, and quality control processes.

People dimension: This dimension involves the people involved in the project, such as project team members, stakeholders, end-users, and customers.

Organizational dimension: This dimension involves the organizational context in which the project is being implemented, such as the culture, structure, and strategic priorities of the organization.

Financial dimension: This dimension involves the financial aspects of the project, such as the budget, return on investment, and cost-benefit analysis.

Time dimension: This dimension involves the timeline or schedule for the project, including deadlines, milestones, and critical path analysis.

Strategic dimension: This dimension involves the alignment of the project with the overall strategic goals and objectives of the organization.

By considering each of these dimensions, IT project managers can gain a more comprehensive understanding of the project and its various components, as well as the factors that contribute to its

success or failure. Managing the multidimensionality of IT projects requires careful planning, coordination, and communication across all dimensions, and a focus on integrating the various aspects of the project to ensure that they work together effectively. Multilevel in the context of IT projects refers to the different levels or layers of the project, which may be nested or interconnected. These levels can be thought of as a hierarchy, with each level building on the one below it and contributing to the overall success of the project.

The multilevel nature of IT projects can be viewed in terms of several different levels.

Strategic level: This level involves the overall strategic direction of the organization and how the project fits into that strategy. At this level, decisions are made regarding the project's scope, goals, and objectives.

Tactical level: This level involves the planning and execution of the project, including the development of project plans, timelines, and resource allocation.

Operational level: This level involves the day-to-day management of the project, including monitoring progress, tracking budgets, and identifying and addressing issues and risks.

Technical level: This level involves the technical aspects of the project, including the development and deployment of hardware and software systems, as well as the management of data and information.

User level: This level involves the end-users of the project, including employees, customers, and partners, and their needs and requirements.

Social level: This level involves the broader social and ethical implications of the project, including its impact on society, privacy, and security.

By considering each of these levels, IT project managers can gain a more comprehensive understanding of the project and its various components, as well as the factors that contribute to its success or failure. Managing the multilevel nature of IT projects requires careful coordination and communication across all levels and a focus on integrating the various aspects of the project to ensure that they work together effectively.

In the works [7], a generalization of “value” was proposed as the correspondence to the goals (enterprises, companies, organizations) or the “degree of contribution” of the project to the achievement of the goal. At the same time, in [9] it is established that each project can contribute to various strategic goals of the enterprise and, using the example of projects and technical development programs, a method for assessing value is presented, taking into account the fuzziness of information about the results of projects. This approach can be considered universal, it takes into account the multidimensionality of project results, and the unequal goals (using appropriate weights), and to take into account the specifics of projects, it is required to determine the essence of the goals and results of project implementation.

But the question arises - the contribution of the project to the achievement of the goal (goals) can be high, but the cost of the project is also too high, and slightly less modest results in achieving the goal (goals) can be provided by a project with a much smaller budget. In addition, the duration of the project is also significant in terms of its value - if results that are not much different can be achieved using two projects with different deadlines, then, naturally, preference should be given to the project with a shorter time to get the result.

In the models of portfolios and program formation proposed in [9], time and expenses (budget) are used as constraints, which ensures the adequacy of the proposed process of portfolios and program formation to the real situation and selection conditions.

But in practice, there are many situations when it is necessary to compare projects or rank them for subsequent selection processes, and in such cases, only compliance with the goals somewhat narrows the real assessment of the project, which leads to the need to develop a method for assessing the value of projects, taking into account their key characteristics - "result", "budget" and "time".

In addition, at the level of evaluation methods, such an aspect of the value of projects as multi-levelness remains unattended. This is especially true for infrastructure projects, tourism development, and environmental projects when financing is provided from budgetary funds, and the significance of the project and its effectiveness can be associated both with the local, and regional level and with the level of the country as a whole. And for some projects, which should be implemented with the support of international funds, the significance can be considered and assessed accordingly within the international community.

So, in [10] hierarchies of levels of consideration of infrastructure projects and projects of technical development of ports were built, which is a good example of the "multilevel" results of the project, and therefore its value.

So, to sum it up:

- the value of the project is a multidimensional concept, which is taken into account in the existing evaluation methods as the contribution of the project to the achievement of various goals of the enterprise/organization, thus, the results of the project, which are different, and the set of goals of the enterprise/organization are compared;
- the value of the project should take into account the diversity of results (where appropriate), that is, their significance from the point of view of a particular locality, region, or country, which, for example, is the case for infrastructure projects, tourism development projects, and environmental projects. In addition, if the project is planned as an element of an appropriate program, this should also be taken into account;
- the value of the project should take into account its multidimensional nature (where appropriate, such as for transport and logistics projects for tourist centres);
- the value of the project is determined not only by the results but also by their "intensity" and cost, that is, the assessment of the value of the project should take into account its duration, the period until the results are obtained, the duration of the results, as well as the budget, which leads to a comparison of "results" - "costs".
- This approach forms the basis of the method for evaluating the value of projects, which is based on existing evaluation methods as their development, taking into account the foregoing.

3. Basic concept and method of estimating the value

Basic concept and method of estimating value. As mentioned above, IT projects that are implemented at the level of cities or regions as part of their SMART transformation can be social, as well as affect the transport sector, as well as tourism. Thus, the projects under consideration are connected with the intersection of many areas (Fig. 1), which are also interconnected.

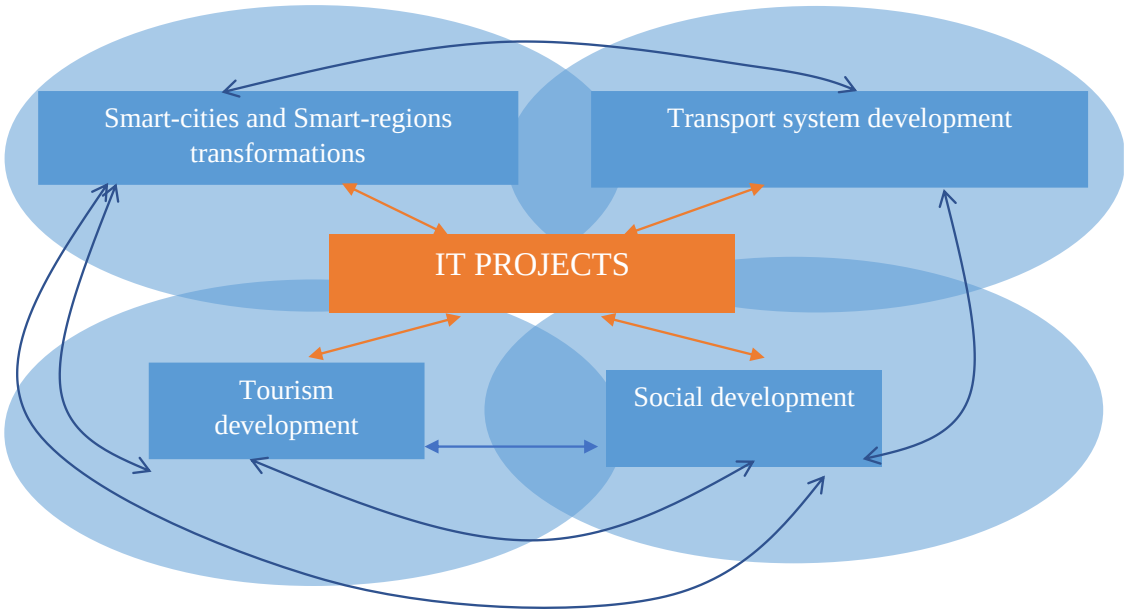

Figure 1: The intersection of different areas for IT projects related to the SMART transformation of cities and regions

In addition, the multidimensionality of the results of the implementation of such projects can be manifested at various levels - at the level of a separate district of the city, at the level of the city or at the region as a whole.

Thus, the method for evaluating the value of an IT project should take into account these two properties - multidimensionality and multi-levelness. In addition, the value of the project is determined not only by its results but also by its "intensity" and costs, that is, the assessment of the value of the project must take into account its duration, the period until the results are obtained, the duration of the results, as well as the budget, which leads to a comparison of "results" - "expenses". This approach forms the basis of the proposed method for evaluating the value of projects, which is based on existing evaluation methods as their development, taking into account the foregoing. Thus, the conceptual model

of the formation of the value of the project and its corresponding assessment, taking into account the positions formulated above, can be represented as follows (Fig. 2).

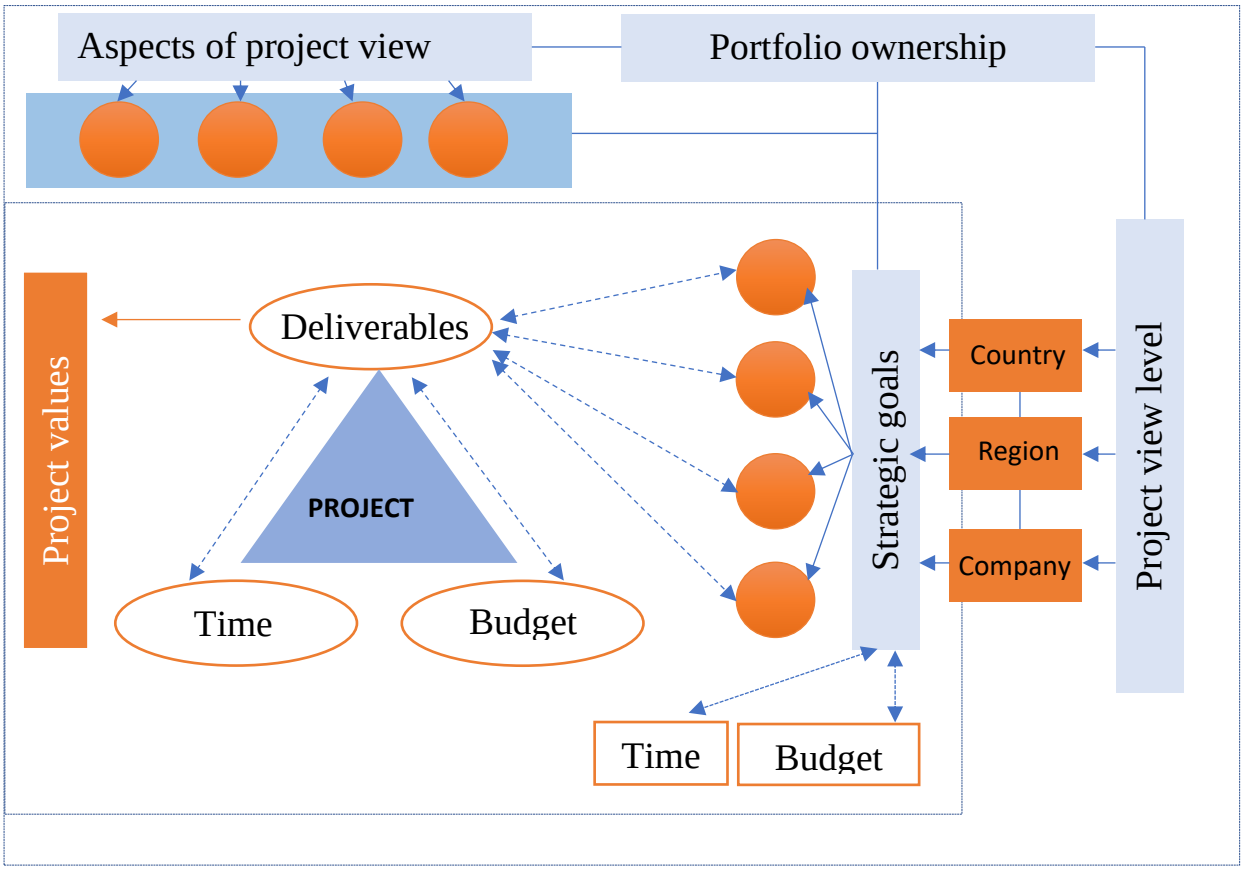

Figure 2: Conceptual model for the formation of the value of the project in terms of multi-level and multi-aspect

Since not all conditions (Figure 1) are formed comprehensively for each project, the value assessment method is offered in various versions, depending on what exactly should be taken into account.

The first option is the simplest case when the project must comply with one (or several) strategic goals without taking into account multi-level and multi-dimensionality, that is, taking into account factors - budget and time, which were not previously considered in the proposed approaches to value formation.

Let us introduce the notation:

$j = \overline{1,m}$ serial number of the project, m - the total number of projects under consideration;

$S_i, i = \overline{1,n}$ criterion assessment of the *i*-th goal, *n* - the total number of goals of the considered level (company, region of the country) that can be compared with the project under consideration;

$\alpha_i, i = \overline{1,n}$ goal weight (priority), as a rule, $\sum_{i=1}^{n} \alpha_i = 1$ the condition is set;

$S_i^j, i = \overline{1,n},\ j = \overline{1,m}$ characteristics of the results of the implementation of the *j*-th project from the position of the *i*-th goal, that is, the assessment is comparable to S_i^j , respectively S_i, has the same dimension;

$R^j,\ j = \overline{1,m}$ project budget;

- $T^j,\ j = \overline{1,m}$ project implementation period/time to receive the project product.

As an assessment of the value of projects $0 \le V^j \le 1,\ j = \overline{1,m}$, the following is proposed:

$$V^j = 1 - \frac{T^j}{T^*} \cdot \frac{R^j}{R^*} \cdot \sum_{i=1}^{n} \alpha_i \frac{(S_i^j - S_i)^2}{S_i^2} \quad (1)$$

where T^*, R^* - respectively, the budget and the deadline for achieving the goal are taken as the base. Note that it is logical to consider only projects for which:

$$R^j \le R^*, T^j \le T^*, \; j = \overline{1, m}. \quad (2)$$

Thus, $\frac{(S_i^j - S_i)^2}{S_i^2}$ it compares the "distance" of the results from the target indicator and $\frac{T^j}{T^*} \cdot \frac{R^j}{R^*}$ corrects it by an amount equal to the ratio of the time and budget of the project with some basic values. The less time and money the project needs, the smaller this correction factor, the smaller the value $\frac{T^j}{T^*} \cdot \frac{R^j}{R^*} \cdot \sum_{i=1}^{n} \alpha_i \frac{(S_i^j - S_i)^2}{S_i^2}$, and the larger the value (1). The reverse is also true. Thus, of two projects with almost the same results, the one with a smaller budget and a faster implementation time will be more valuable.

The closer the characteristics of the project are to the “ideal values”, that is, with the maximum achievement of the goal in a shorter time and with a smaller budget than for the base values, the closer the value is to 1, and, accordingly, vice versa.

4. Method for evaluating the value of projects, taking into account multidimensionality and multi-levelness

The second option for considering the value of projects is for multidimensional conditions, when the project affects, for example, various areas of development at the city/region/country level. That is, the product of the project and its results are of "value" for various areas. It was determined above that for projects of transport and logistics support for tourist centres, it is characteristic that their products belong to the areas of tourism, transport and transport infrastructure, and the social sphere, and can also be associated with the smart transformation of modern cities and regions. For such projects, the valuation should be carried out following the one presented in Fig. 3 detail approach.

Let us introduce the notation:

$k = \overline{1, K}$ the serial number of the area associated with the project, K - the total number of areas under consideration;

$\beta^k, k = \overline{1, K}$ priority of the k-th sphere at the considered level, $\sum_{k=1}^{K} \beta_k = 1$;

$S_i^k, k = \overline{1, K}, i = \overline{1, n_k}$ criterion assessment of the i-th goal of the *k*-th sphere, n_k - the total number of goals of the considered sphere that can be compared with the project under consideration;

$\alpha_i^k, k = \overline{1, K}, i = \overline{1, n_k}$ priority of the goal of the sphere under consideration $\sum_{i=1}^{n_k} \alpha_i^k = 1, k = \overline{1, K}$;

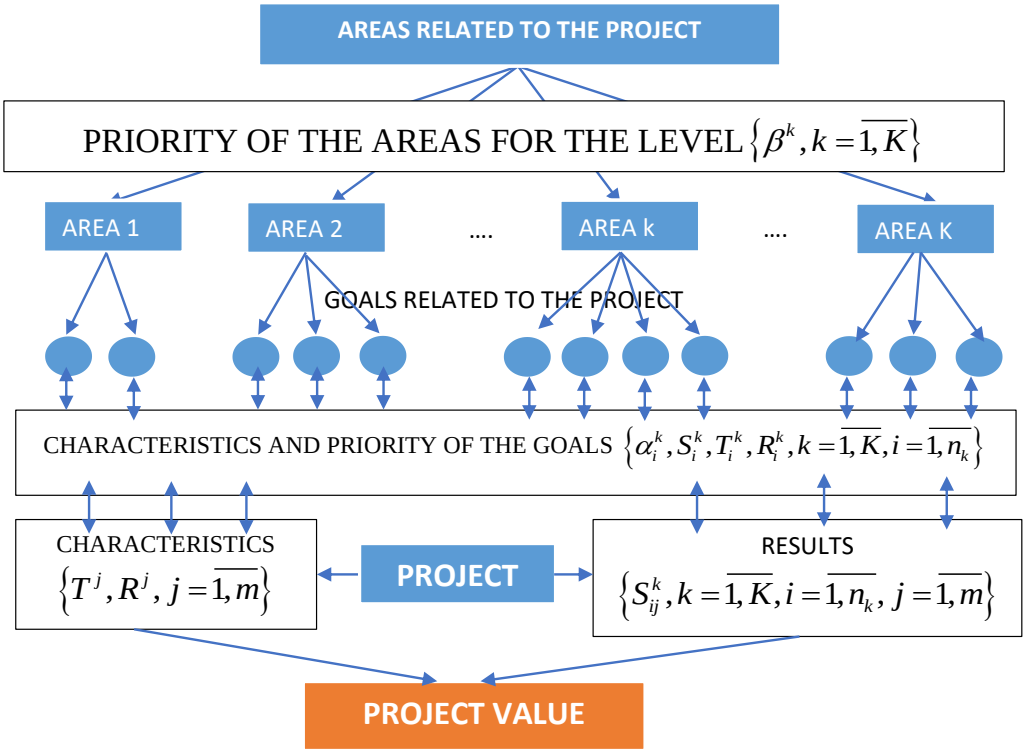

Figure 3: Taking into account multidimensionality when evaluating the value of the project

$S_{ij}^k, k=\overline{1,K}, i=\overline{1,n_k}, j=\overline{1,m}$ characteristics of the results of the implementation of the *j*-th project from the position of the *i*-th goal of the *k*-th sphere, S_{ij}^k that is, the assessment is comparable to S_i^k, respectively, has the same dimension;

$R_i^k, k=\overline{1,K}, i=\overline{1,n_k}$ budget of the *i*-th goal of the *k*-th sphere;

$T_i^k, k=\overline{1,K}, i=\overline{1,n_k}$ the term for achieving the *i*-th goal of the *k*-th sphere.

As an assessment of the value of projects $0 \le V_a^j \le 1,\ j=\overline{1,m}$ for the condition of multidimensionality, the following is proposed:

$$V_a^j = 1 - \sum_{k=1}^{K} \beta^k \left[\sum_{i=1}^{n_k} \alpha_i^k \frac{(S_{ij}^k - S_i^k)^2}{(S_i^k)^2} \cdot \frac{T^j}{T_i^k} \cdot \frac{R^j}{R_i^k} \right]. \qquad (3)$$

This value is integral, as it takes into account all related areas and goals. Following (3), the assessment of the degree of achievement of goals for each area, taking into account the priority of both areas and goals, is "adjusted" in time and budget based on the reasoning that was outlined above. According to the approach adopted above, projects are considered for which the conditions for budget and time are met:

$$R^j \le R_i^k, k=\overline{1,K}, i=\overline{1,n_k},$$
$$T^j \le T_i^k, k=\overline{1,K}, i=\overline{1,n_k}, \qquad (4)$$

Note that components (3) have an independent meaning:

$$V_k^j = 1 - \beta^k \left[\sum_{i=1}^{n_k} \alpha_i^k \frac{(S_{ij}^k - S_i^k)^2}{(S_i^k)^2} \cdot \frac{T^j}{T_i^k} \cdot \frac{R^j}{R_i^k} \right], k = \overline{1, K} \quad (5)$$

- the value of the project for the k-th sphere;

$$V_{ik}^j = 1 - \alpha_i^k \frac{(S_{ij}^k - S_i^k)^2}{(S_i^k)^2} \cdot \frac{T^j}{T_i^k} \cdot \frac{R^j}{R_i^k}, k = \overline{1, K}, i = \overline{1, n_k} \quad (6)$$

- the value of the project from the position of the *i*-th goal of the *k*-th sphere.

This allows a more detailed study of the value of the project from various points of view - from a single goal to an aggregate assessment of value in general.

An illustration of the operation of formula (3) is presented in the calculation example below (Fig. 4-6).

Note that this example assumes one goal for each area. The column "Value" presents the results of calculating the value (integral) according to formula (3), as well as the value of the project for each area following formula 4. Characteristics of the results and the corresponding goals are presented in arbitrary units, time - in months, and budget - in conditional monetary units. In the presented data fragment, the duration of the project varies from 10 to 23 months. In the process of research, the budget and results were also subject to variation. Priority (weight) of spheres, respectively, 0.2; 0.5; 0.3.

Figure 4 shows the components of the final (integral) value for each area following formula (4). This representation allows you to visually characterize the value of the project for each area. In this case, the greatest value of the project is in terms of area 1 and area 3.

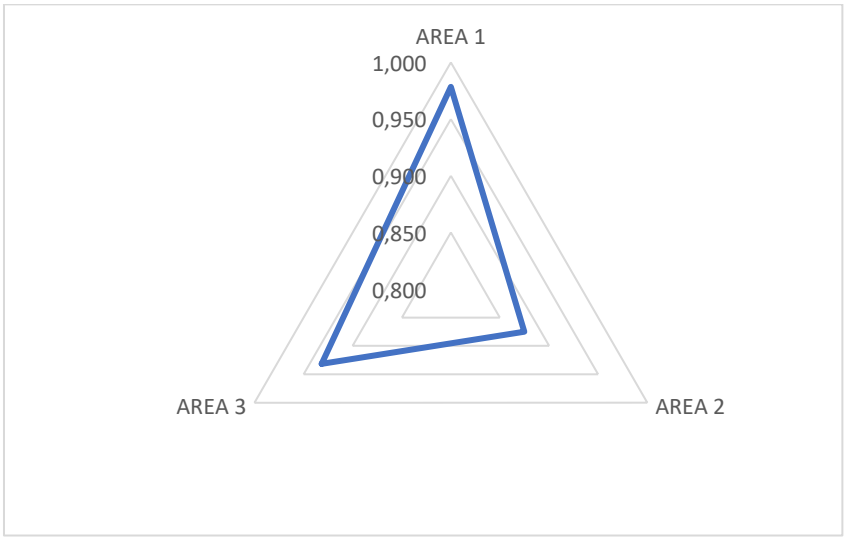

Figure 4: Values of the project from the position of each sphere

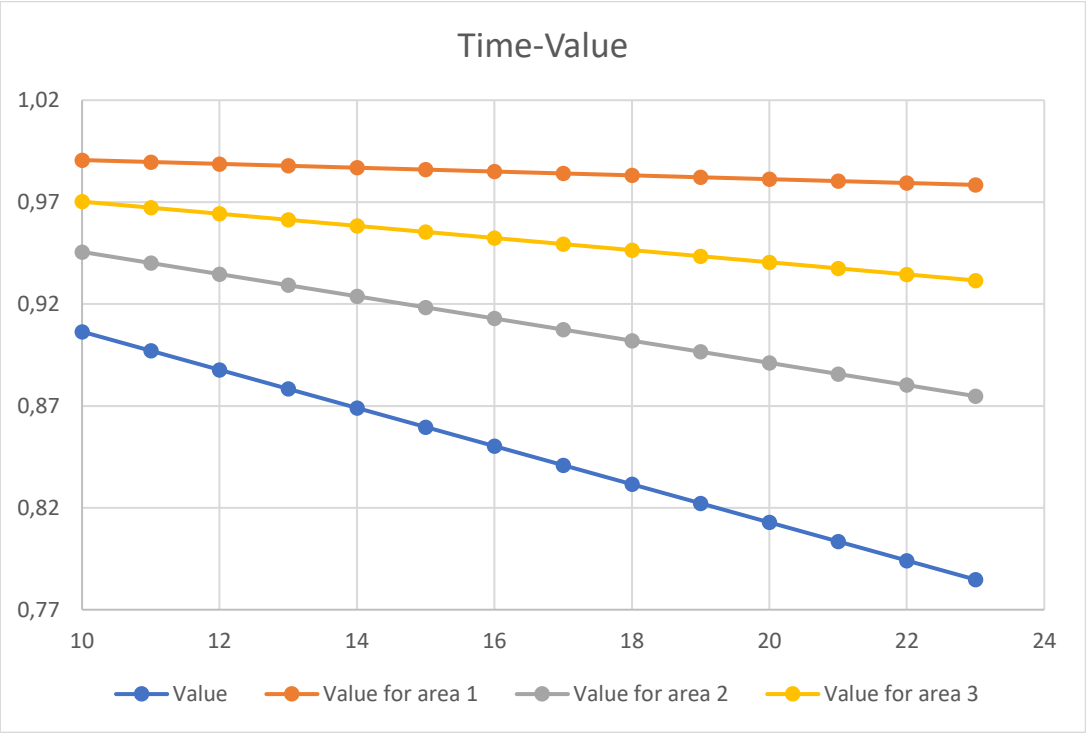

Figure 5: Dependence of the integral value of the project and the value by spheres for different values of the project implementation time

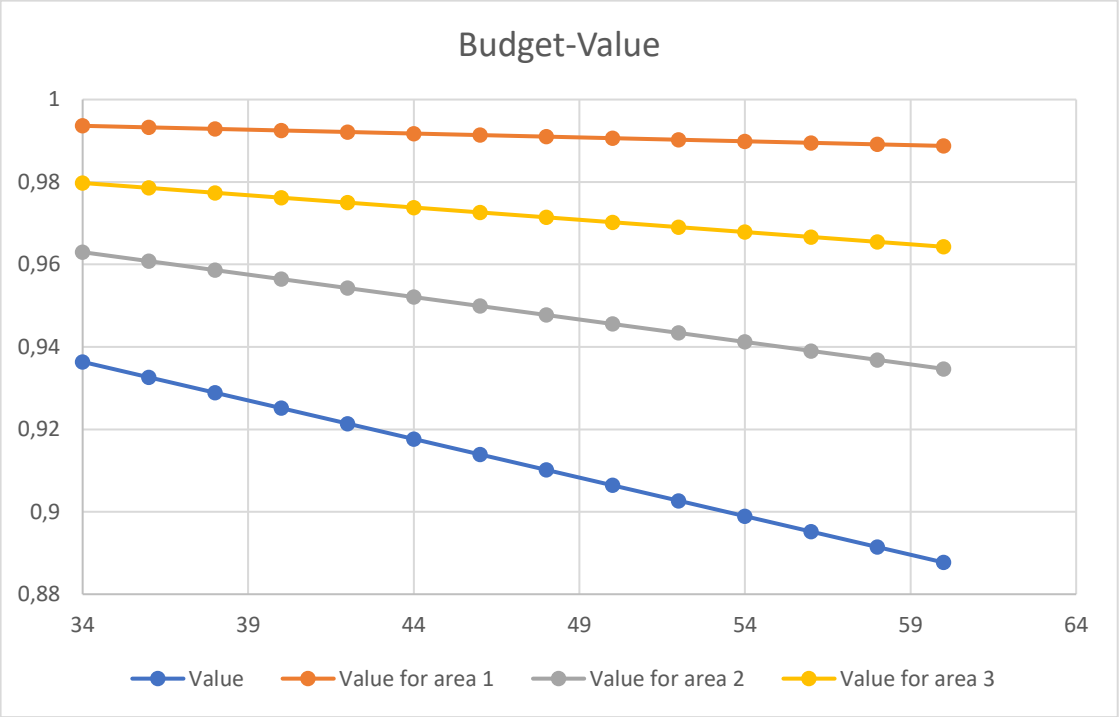

Figure 6: Dependence of the integral value of the project and the value by spheres for different values of the project budget

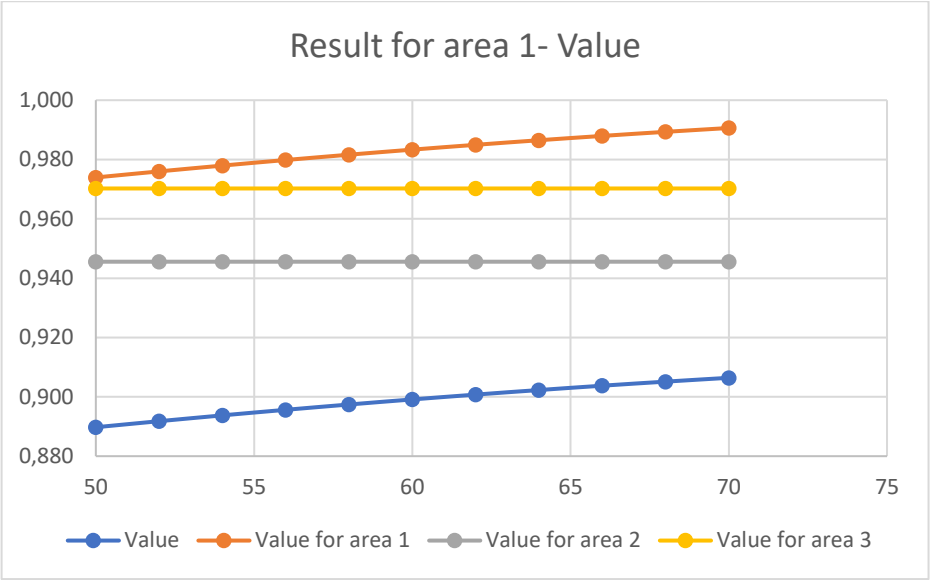

Figure 7: Dependence of the integral value of the project and the value by spheres for different values of the results of the project implementation for the first sphere

As you can see, the dynamics of value logically correspond to the dynamics of budget, time and results - the higher the budget and time, the lower the value; the higher the result in one of the areas, the higher the integral value and the value of the project from the position of the corresponding area (in this example, the first one). This confirms the compliance of the proposed formulas (3), (4) with the logic of the value concept of the project.

The next, and the last of the situations under consideration, is when the project is connected not only with different areas but also with different levels. This means that the implementation of the project produces results at various levels and in various aspects. For example, the implementation of a project related to the development of transport and logistics infrastructure for a tourist centre of the second level will have a positive impact on the tourist flow in several geographically interconnected centres at the first, second and third levels, thus the value of this project is manifested in other centres and levels. This fact should be taken into account when assessing the value of this project.

Thus, multidimensionality forms "integrality", and a multi-level - "hierarchy" (from the position of the hierarchy of tourist centres). Therefore, the value of the project, which takes into account the multidimensionality, we will define as "integral value", and the value that takes into account the multi-levelness, we will define as "hierarchical value".

Let us introduce the notation:

$y \in \Omega$ - index of the "object" (city, district, region, company), which is affected by the implementation of the project;

λ_y - the weight of the priority of the object, which is affected by the implementation of the project;

$S_{ikj}^{y}, y \in \Omega, j = \overline{1,m}, i = \overline{1,n_k}, k = \overline{1,K}$ - the result of the impact of the implementation of the *j*-th project, the achievement of the *i*-th target indicator of the *k*-th aspect on the object $y \in \Omega$;

$S_{ik}^{y}, k = \overline{1,K}, i = \overline{1,n_k}, y \in \Omega$ - assessment of the *i*-th target indicator of the *k*-th aspect of the object $y \in \Omega$, the target indicator has the same dimension as S_{ikj}^{y}, which makes it possible to compare them;

$R_{ik}^{y}, k = \overline{1,K}, i = \overline{1,n_k}, y \in \Omega$ - budget of the *i*-th goal of the *k*-th sphere *y*;

$T_{ik}^{y}, k = \overline{1,K}, i = \overline{1,n_k}, y \in \Omega$ - the term for achieving the *i*-th goal of the k-th sphere *y*.

As an assessment of the value of projects $0 \le V_h^j \le 1, j = \overline{1,m}$ for the condition of hierarchy and multidimensionality, the following is proposed:

$$V_h^j = 1 - \sum_{y \in \Omega} \lambda_y \sum_{k=1}^{K} \beta_k^y \left[\sum_{i=1}^{n_k} \alpha_{ik}^y \frac{(S_{ikj}^y - S_{ik}^y)^2}{(S_{ik}^y)^2} \cdot \frac{T^j}{T_{ik}^y} \cdot \frac{R^j}{R_{ik}^y} \right], j = \overline{1,m} \quad (7)$$

Note that in this case it is assumed that the number of considered areas/aspects related to the project is the same for each level, regardless of the level.

As in the case of valuation under multidimensional conditions, (7) contains components that have independent value:

$$V_h^{jy} = 1 - \sum_{k=1}^{K} \beta_k^y \left[\sum_{i=1}^{n_k} \alpha_{ik}^y \frac{(S_{ikj}^y - S_{ik}^y)^2}{(S_{ik}^y)^2} \cdot \frac{T^j}{T_{ik}^y} \cdot \frac{R^j}{R_{ik}^y} \right], y \in \Omega, j = \overline{1,m} \quad (8)$$

- the value of the *j*-th project for $y \in \Omega$;

$$V_h^{jk} = 1 - \sum_{y \in \Omega} \lambda_y \left[\sum_{i=1}^{n_k} \alpha_{ik}^y \frac{(S_{ikj}^y - S_{ik}^y)^2}{(S_{ik}^y)^2} \cdot \frac{T^j}{T_{ik}^y} \cdot \frac{R^j}{R_{ik}^y} \right], k = \overline{1,K}, j = \overline{1,m} \quad (9)$$

- the value of the project for the *k*-th sphere.

The system of indicators of value (6)-(9) allows you to perform an in-depth analysis of the value of the project for a specific area, the objects under consideration as a whole, taking into account all aspects and manifestations of the impact of the results of the project. We will demonstrate the work of the proposed formulas for assessing the value of a specific example. The impact of the project implementation on three objects, and two spheres for each, is considered. Priority of areas for each centre and priority of goals in Table 3.3, project results in terms of each goal for each area and centre in Table 1, and targets in Table 2.

Table 1

Priorities of areas β_k^y and goals α_{ik}^y

Priority	y=1	y=2	y= 3
Area 1	0,4	0,1	0,2
Goal 1	0,8	0,7	0,4
Goal 2	0,2	0,3	0,6
Area 2	0,6	0,7	0,5
Goal 1	0,7	0,6	0,8
Goal 2	0,3	0,4	0,2

Table 2

Results of the project in terms of objectives S_{ikj}^y

y=1				y=2				y= 3			
Area 1		Area 2		Area 1		Area 2		Area 1		Area 2	
Goal 1	Goal 2	Goal 1	Goal 2	Goal 1	Goal 2	Goal 1	Goal 2	Goal 1	Goal 2	Goal 1	Goal 2
5	5	30	30	8	20	20	20	30	30	100	10

Table 3

Targets S_{ik}^{y}

Priority	y=1	y=2	y= 3
Area 1			
Goal 1	30	50	100
Goal 2	20	80	70
Area 2			
Goal 1	50	40	170
Goal 2	70	70	100

Note that in the example, the data is conditional to demonstrate the operation of the method. As a result of the calculations, the values of the project values for each centre and the total value (taking into account the multidimensionality and multi-levelness) for various values of the project implementation time and its budget were obtained. Calculations show that the value of the project both at the level of a specific object of consideration and in general in all areas (hierarchical value) logically decreases as the project budget and time of its implementation increase. Figures 8 and 9 show the dependence of project value on budget and time.

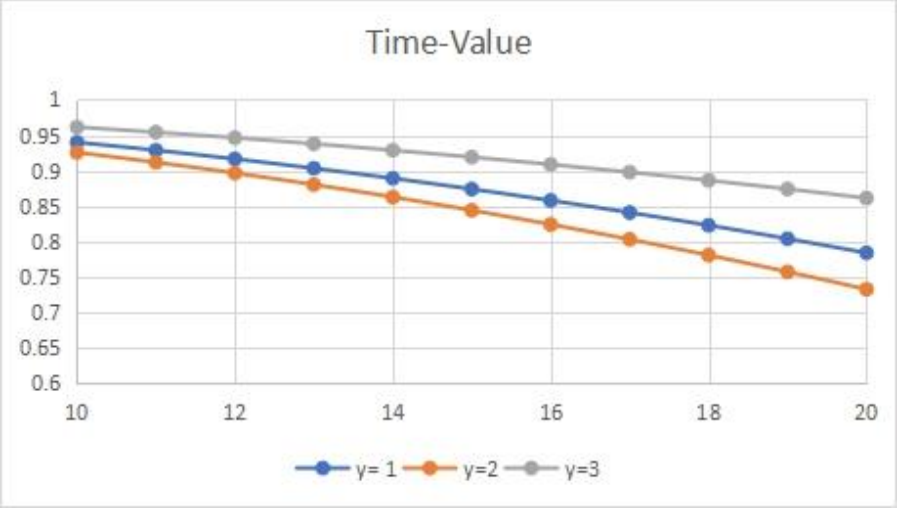

Figure 8: Change in the value of the project at the level of the centre depending on the budget

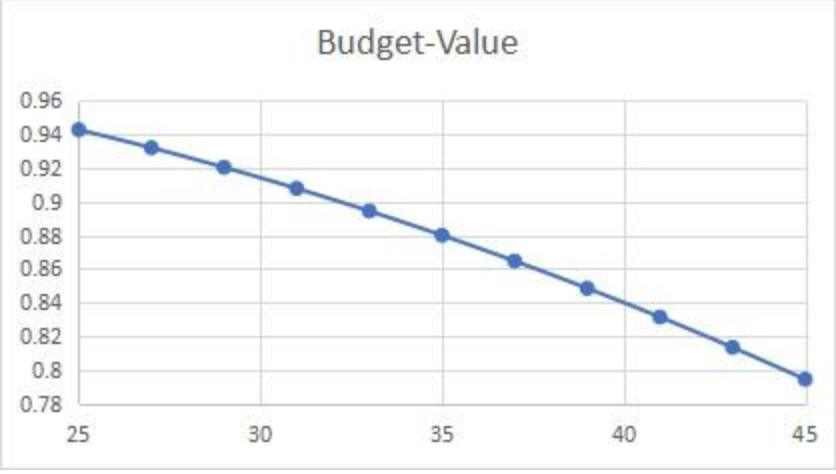

Figure 9: Change in the hierarchical value of the project from the budget

Figure 10 shows the dynamics of the project value depending on the budget for a different distribution of priorities of "objects". So, for example, with an increase in priority y=2 from 0.1 to 0.8, the value of the project decreases, which decreases much more under the influence of an increase in the project budget. This is because the contribution of the project to achieving the goals is relatively small, therefore, with an increase in the priority of this object, the value of the project naturally decreases.

Figure 10: Change in the value of the project depending on the budget with different distributions of centre priorities

Thus, the experimental calculations confirmed the validity of the proposed formula for assessing the value, since the research results are consistent with the logic of the value methodology.

5. Conclusion

This study is devoted to the development of a conceptual model and a method of assessing the value of IT projects for cities and regions as part of their smart transformation. In contrast to existing approaches, the model and method take into account the "correction" of the value taking into account the budget and the project implementation period, as well as the "contribution" of the project to the achievement of multiple target indicators in interrelated/related areas, taking into account the priorities of areas and goals (integral value) and the importance of the project for different interconnected levels, taking into account the priorities of objects (which are affected by the project), spheres and goals (hierarchical value). This together allows us to more fully take into account the significance of the results and connections of projects, which are characterized by multifacetedness and multi-levelness. We note that the proposed value estimation method is developed for three variants of the project consideration conditions:

- basic variant – accounting of the system of target indicators and their priorities for one "object";
- an option that takes into account the conditions of the project's multifacetedness, when its results are significant for various spheres, and the value is commensurate with the project's contribution to the achievement of multiple systems of target indicators in several interconnected/related spheres, taking into account the priorities of spheres and goals - integral value;
- the option providing for the significance of the project for various spheres at various interrelated levels taking into account the priorities of centres, spheres, goals - hierarchical value.

The practical use of this method allows you to reasonably make decisions on financing or other support at the state level. An important feature of the proposed method of assessing integral and hierarchical value is that the method is universal and can be used for projects of any nature that meet either the condition of multifacetedness, multi-levelness, or both. This method is applicable both for the evaluation of projects of individual companies and projects at the regional/national level.

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