This work relates to devising an approach to the formation of portfolios of restoration and development projects of territories. The object of research is the processes of development and restoration of territories. The subject of the study is the process of forming portfolios of development and restoration projects. The problem being solved is to devise an approach to the formation of project portfolios focused on the processes of development and restoration of territories.

The peculiarities of the organization of the processes of development and restoration of territories have been defined. It is shown that development and restoration projects are usually associated with the need to create many related products. Therefore, a multi-project approach was determined as the main one for the formation of portfolios of restoration and development projects of territories. A method to form multi-project portfolios using the cost-benefit concept has been developed. It is proposed to use the value created by the products of the sub-projects for the population of the territories as benefits.

A multi-project planning model was built, taking into account the cause-and-effect relationships between individual subprojects. A feature of the model is that the products of subprojects are the object of planning. Vector analysis was used to determine the value of individual products, which makes it possible to establish the order of their creation in accordance with the cause-and-effect relationships between them.

The approach, method, and model were practically validated within the framework of actual scenarios of infrastructure development of the Košice Self-Governing Region on 4 classes of multi-projects, which were divided into sub-projects and were successfully implemented.

The devised approach, method, and model could be used to solve the tasks necessary for the restoration of the territories in Ukraine

Keywords: territory development, product planning, project portfolio management, multi-project approach

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DEVISING A MULTI-PROJECT APPROACH TO THE FORMATION OF PORTFOLIOS FOR RESTORATION AND DEVELOPMENT OF TERRITORIES WITHIN THE CONCEPT OF STRATEGIC INVESTMENTS AND DEVELOPMENT PACKAGES OF THE STINBALEF PROJECT

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1. Introduction

There are two concepts for the implementation of life strategies both at the level of an individual and at the level of any state. The first is that it is possible to develop only by providing for one's own livelihood. The second is that life is ensured through development. The first leads to the fact that spending on science, education, and innovation in the

country is carried out according to the residual principle. What will remain after paying salaries (primarily to officials), pensions, other current needs of the state. The second ensures the progressive development of the country, through science, education, innovations, which makes it possible to spend more on ensuring its vital activities. Usually, the second concept underlies the development of rich countries. The first is for the poor.

Therefore, the question arises of how to implement the concept of development when the country is not economically strong enough, or on the example of Ukraine, when there is a war in it? It is clear that in this case development projects should be aimed at obtaining a significant profit from their implementation, and their costs should be as low as possible. Achieving this is possible, including, due to such approaches to the selection of development projects and their management, which could ensure the minimum level of costs. Due to the effective decomposition of the development strategy by projects, the formation of a rational order of their implementation in accordance with cause-and-effect relationships, the minimization of costs for changes, re-planning and processing, risks, and overpayments.

It is clear that the state's development strategy should be based on taking into account the needs and peculiarities of the economic structure of regions. After all, agricultural regions have their own needs, industrial regions have different needs. Therefore, the vision and development strategy of any country should provide for territorial development based on strategic packages, the creation and further evaluation of which is a significant challenge for subjects of territorial development, especially for local authorities. And the military activities in Ukraine require considering not only the territorial development of communities but also the issue of the restoration of territories. From this arises a scientific and applied problem, which is related to the development of an approach to the formation of strategic investment and development portfolios of projects of restoration and development of territories based on the methodology of quantitative assessment of their efficiency and effectiveness. The results of such studies are needed in practice because the war going on in Ukraine requires the creation of new practical project management tools that are more effective in terms of restoring the territories. As experience shows, specific scientific, technical, and practical developments have not yet been carried out on this path. Hence, an urgent scientific task arises, which involves the development of such an approach to the formation of project portfolios that would take into account the specificity of strategic packages for the restoration and development of territories.

2. Literature review and problem statement

The issue of restoration and development of territories is gaining more and more popularity, which is connected with the spread of natural and man-made disasters. Literary sources present the principles of overcoming disasters, which are aimed at the restoration and development of territories, taking into account economic, social, political, and environmental challenges [1, 2]. The proposed approaches do not take into account the issues of managing the restoration and development of territories. In paper [3], a project approach to the management of the processes of territory restoration is proposed, but the main emphasis in the cited work is on administrative instructions. The continuation of the work is study [4], which focuses on the formation of basic requirements for territorial restoration and development projects through the study of problems and challenges, as well as studies of success factors in order to determine which critical success factors are most influential in avoiding failures of a specific project. The analyzed studies are focused on the scale of one project or a certain number of interconnected projects – programs, and the works do not take into account the aggregate of scattered projects. This issue is partly reflected in [5]. The authors proposed a multi-project approach for companies that are geographically dispersed. The disadvantage of the cited work is that the proposed research is poorly scaled at the country level. Therefore, the question of how to manage territorial restoration and development projects, when the destructions are scattered territorially and there are many of them, is an open question. Facilitating the management of a package of such projects is the formation of a management standard for recovery and development [6] and information support for a package of projects [7]. The proposed standard [6] facilitates the management of a package of projects. But the cited work does not consider the issue of choosing a project from a set of scattered and unrelated projects – multi-projects. Paper [8] proposed a multi-objective approach to portfolio selection, which combines project interdependences and multiple objectives into a complex mathematical model. The disadvantage of the cited work is that it does not indicate how to act with projects that arise along the way, which are not related to each other, how to evaluate the multifacetedness, and structuredness of the products of these multi-projects – the benefit from the products of the projects. A different approach must be used for the professional management of a multitude of weakly interconnected projects and programs for the restoration of territories. It would be based on the standard of project management and on the formation of a strategic package of projects that will be implemented based on the assessment of benefits from the project product.

Thus, our review of the literature demonstrates that the research aimed at solving issues related to the restoration of territories through the initiation and implementation of many projects is promising. But there is one problem here. As the analysis of literary sources revealed, despite the obtained scientific and practical results, the issue of creating a package – multi-project approach to the formation of portfolios of restoration and development projects of territories was not sufficiently reflected in publications. The presence of an unsolved part of the problem, namely, the lack of a multi-project approach to the formation of portfolios of territorial restoration and development projects, makes the research proposed in our work necessary.

3. The aim and objectives of the study

The purpose of our study is to devise a multi-project approach to the formation of portfolios of territorial restoration and development projects. This will make it possible to compose portfolios of projects for restoration and development of territories from projects that create the highest value and are the least expensive due to the optimization of cause-and-effect relationships in the structure of sub-projects.

To achieve this goal, the following tasks must be solved:

– to justify the necessity and expediency of using a multi-project approach to form portfolios of restoration and development projects;

– to propose a method of forming portfolios of multi-projects for the restoration and development of territories using the cost-benefit concept;

– to build a multi-project planning model taking into account cause-and-effect relationships between individual sub-projects;

– to practically verify the theoretical results.

4. The study materials and methods

The object of the current research is the processes of development and restoration of territories.

The subject of the study is the process of forming portfolios of development and restoration projects.

The research hypothesis assumes that the implementation of a multi-project approach to the formation of portfolios of territorial restoration and development projects will allow rational division of projects into sub-projects interconnected by cause-and-effect relationships. This will ensure the inclusion in the portfolio of those projects that have the highest benefits and the lowest costs in the course of implementation. This is due to the fact that there is a possibility of selecting sub-projects that provide economically profitable products even before the completion of the entire project.

Within the framework of the multi-project approach, small projects that do not require division into sub-projects were not considered. Also, targeted programs, which can also be part of the project portfolio, were not considered. Although the proposed multi-project approach can also be used to manage the restoration programs of territories that contain projects. At the same time, the program itself will be considered as a multi-project, and the program project will be considered as a sub-project. In addition, forms of investment and management organization in individual territories were not considered. The work focused on methods of structuring multi-projects and obtaining numerical characteristics of the expediency of their implementation. Attention was also focused on the need to implement territorial restoration projects, which is not of practical importance for most countries of the world but is very important for Ukraine.

The assumption of the work is that the projects of restoration of the territories of Ukraine require the creation of the same regional management system as investment projects and development projects.

The peculiarity of our work is that it continues the research, the first part of which was reported in [6] and considered the creation of a portfolio management standard for territory restoration. As in work [6], the portfolios of projects for the restoration and/or development of territories are considered. These portfolios are created to facilitate the management of a strategic package of projects. Under the strategic package of projects, we shall understand a set of projects aimed at the development of regions (development package), or at making a profit (investment package), or at the restoration of territories (restoration package).

A limitation of the work is that it considers a portfolio of multi-projects, rather than projects and programs. A multi-project is a temporary effort to achieve several local goals. For example, a project to restore an energy infrastructure facility may include subprojects of dismantling a destroyed transformer substation, purchasing, and installing new equipment, restoring power lines, restoring a road, etc.

This concept is somewhat different from the concept of a program. After all, the program covers projects united by one goal. It is large-scale and aimed at achieving strategic goals. Moreover, each project is quite autonomous, with its team, resources, plans. The goal of each multi-project for the restoration and development of territories is specified by the products necessary for the population of the territories. It achieves operational rather than strategic goals. From the point of view of management, each program can be considered as a large-scale multi-project. It should be managed taking into account the entire set of projects. But a multi-project does not have the properties of a program from the point of view of management. There are no separate sub-project goals, in general there are no separate teams, sub-project plans are part of a multi-project plan, etc. Therefore, the multi-project approach is more universal, it can also be used for program management.

A strategic package is a set of multi-projects, each of which may include/change individual sub-projects in the course of execution in order to:

1. Facilitating their management due to the decomposition of the internal environment of projects.

2. Respond in a timely manner to changes in the conditions of implementation of restoration projects (additional financing, occurrence of unforeseen technical difficulties, etc.).

3. Increasing efficiency by reducing management and implementation costs by optimizing cause-and-effect relationships in the structure of sub-projects.

The provisions of the system approach were used to decompose multi-projects into sub-projects with further integration of their management processes taking into account cause and effect relationships. Strategic management methods were used to manage the configuration of strategic project packages. The project management methodology was used to structure and highlight the processes and functions of multi-project management.

The concept of cost-benefit analysis was applied to quantitatively assess the usefulness of the proposed measures that will be included in the proposed strategic project packages.

5. Results of devising a multi-project approach to the formation of portfolios of restoration and development projects of territories

5. 1. Justification of the use of a multi-project approach for the formation of portfolios of restoration and development projects of territories

In addition to the great challenges that regions face, including environmental, demographic, economic and social, it is very important to recognize the unique dynamics of territorial recovery from natural or man-made disasters, as well as wars. Unfortunately, a bitter example of this is Ukraine, which is struggling with the deep consequences of armed conflicts and the need for extensive recovery and reconstruction. Along with many regions facing environmental and demographic challenges, post-war recovery regions such as eastern Ukraine must contend with the additional task of reconstruction, reintegration, and reconciliation. These areas require individual strategies for economic renewal, social healing, and environmental restoration.

Local and regional authorities play a key role not only in addressing these specific needs of post-war reconstruction but also in achieving the larger goals identified in strategic documents developed at all administrative levels. Their participation is essential to ensuring stability, prosperity, and sustainable development, even amid the worries and challenges of recovery.

Slovakia is an example of how to organize such an activity. In the context of Agenda 2030 [9], the European Union and national governments such as in Slovakia, there is an urgent need to harmonize regional efforts with the global sustainable development agenda. The vision of Slovakia's development until 2030 emphasizes the importance of territorial expansion, where strategic packages are the driving force. These packages represent a multifaceted approach to stimulating recovery, growth, and innovation.

At the heart of this approach is the project «Development of strategic investment concepts and development packages for the regions of Slovakia with a cause-and-effect relationship with the creation of a methodology for quantitative assessment of their efficiency and effectiveness» (STINBALEF).

The main goal of the STINBALEF project, launched in November 2019, is «creating concepts of strategic investment and development packages for the regions of Slovakia with a causal relationship with the creation of a methodology for quantifying their efficiency and effectiveness». This effort not only serves a national development vision but can also provide ideas and methodologies that could be adapted to post-war recovery scenarios similar to those in Ukraine. The expected results of the project, although they are aimed primarily at local and regional politicians, have a greater impact. The proposed tools can be adapted to address the complex challenges faced by regions undergoing post-war recovery. The ability to transform the current economy into an innovation-oriented, closed-loop economy is a goal that goes beyond territorial development to encompass post-war regions. In addition, the emphasis on the definition of natural territorial units based on economic, social, and demographic relations has a strong resonance for the post-war regions. After all, in them, recovery should go beyond only physical proximity and take into account complex socio-economic interdependences.

An example of cause-and-effect relationships in projects of strategic development of regions is the link between Investments in infrastructure and Economic growth of the region. Investments in infrastructure projects, such as roads, bridges, and utilities, directly lead to economic growth in the region through various interconnected pathways:

1. Modernization and expansion of infrastructure can make the region more attractive for enterprises seeking to establish or expand their activities. Access to efficient transport networks and public services such as water and electricity can significantly reduce operating costs, making it more attractive for businesses to invest in the region. As a result, more companies can set up their facilities or headquarters, which can lead to job creation and increased local tax revenue.

2. Infrastructure projects themselves require a workforce, from engineers and construction workers to project managers and support staff. These projects create immediate employment opportunities, helping increase the level of employment in the region. This not only benefits the local workforce but also increases consumer spending, spurring economic growth.

3. Upgraded infrastructure, such as modern highways and public transportation systems, can improve regional connectivity. This increased mobility can lead to increased trade and commerce as goods and services become easier to move within and across a region. It can also attract more visitors, contributing to the growth of the tourism sector.

4. Infrastructure investment often leads to the development of residential and commercial facilities in previously undeveloped or remote areas. The availability of basic services and convenient transportation can make these areas more desirable for real estate investment. This expansion of real estate can further boost the construction industry and create additional jobs.

5. Better infrastructure can improve the overall quality of life for residents. Reduced congestion, safer roads and improved public services contribute to a more attractive living environment. This can lead to population growth and attract talent, which in turn can support a dynamic and diverse economy.

6. Economic growth caused by infrastructure investment can lead to increased tax revenue for the region. As businesses expand and property values rise, local and regional governments can collect more taxes. These additional funds can be reinvested in further infrastructure development or used to support social programs and public services.

Thus, investment in infrastructure is a catalyst for economic growth in the region. Not only does it provide the basis for business development, but it also creates jobs, improves connectivity, improves general living conditions, and generates income for public services. A positive feedback loop between investment in infrastructure and economic growth contributes to the development of the region.

In order to evaluate the effectiveness of measures proposed as part of strategic investment and development packages, it is necessary to devise a comprehensive analysis of costs and benefits. In the context of post-war recovery, such an analysis can offer a means of assessing the impact of investments and policies on the recovery of regions and strengthening their resilience to new challenges. This approach not only contributes to national and regional programs but also provides valuable information for areas like eastern Ukraine, where the recovery process is ongoing and complex.

As the experience of implementing the STINBALEF territorial development strategic package shows, all the projects included in it are interconnected by cause-and-effect relationships. Moreover, such a strategic package includes both investment and development projects. If this area is expanded to the conditions of Ukraine, then it will be necessary to include territorial restoration packages in this strategic package. The peculiarity of such projects is that they are interconnected. You cannot build a railway without creating infrastructure. It is possible to move residential buildings, garages, roads, and shops. The construction of new facilities (for example, bridges, office premises, warehouses), power supply, etc. In essence, we are talking about the cause-and-effect relationship of these projects. Therefore, in terms of project management methodology, we can talk about programs (when all projects are interconnected by one goal) or about multi-projects (projects in which sub-projects are distinguished for ease of management). For example, a multi-project railroad construction consists of many interrelated sub-projects.

Usually, the program includes organizationally independent projects, which have leaders, teams, etc. And there is greater independence of management and execution. Example. In the space program. The launch vehicle preparation project is in no way related to the project of creating flight tracking stations. A multi-project is a management project that is unified, but sub-projects are distinguished in it, which, unlike a program, can already arise along the way. In terms of scale, the subproject is usually small, smaller than the projects that make up the programs. Subprojects are most often causally linked with other subprojects. Due to the fact that sub-projects can arise during the execution of a multi-project, the management model is complicated. When new sub-projects arise, it is necessary to change the plan

for managing resources, works, etc. It is this approach that is more suitable for the selection, structuring, and management of projects for the restoration and development of territories. Then, the methodology of managing projects for the restoration and development of territories, based on a multi-project approach, will be based on the following scheme:

1. Possible projects are evaluated from the point of view of benefit (benefit from products).

2. The most profitable are potential multi-projects for inclusion in a portfolio (package).

3. In each multi-project, sub-projects are distinguished. Each of which, in general, has a separate benefit. For subprojects, costs are calculated taking into account the cause-and-effect relationship. The procedure for execution and receipt of benefits. For example, the railroad can be launched before the construction of one of the two warehouses is completed.

4. On the basis of costs and benefits, a decision is made on the formation of a portfolio of multi-projects (strategic package).

It is this approach that will make it possible to evaluate multi-projects in terms of their importance for the restoration of the territories of Ukraine. As well as structure them in such a way that separate products appear during the implementation of the entire multi-project and effectively manage sub-projects that form such separate products (Fig. 1).

A multi-project is a management project that is unified, but sub-projects are distinguished in it, which, unlike a program, can already arise along the way. As follows from Fig. 1, the benefit from a multi-project appears even before its end because the products of individual sub-projects begin to be used. Another advantage is that if, during the implementation of individual sub-projects, insurmountable circumstances arise that require the implementation of additional measures, then new sub-projects are initiated. In the structure of the already existing multi-project and without changes in the management organization. This advantage is very important in projects of restoration of territories when it is required to quickly implement actions to dismantle various objects. That may lead to the need to implement new measures if dismantling leads to the occurrence of unpredictable or difficult to predict consequences. Both in terms of content and duration and cost.

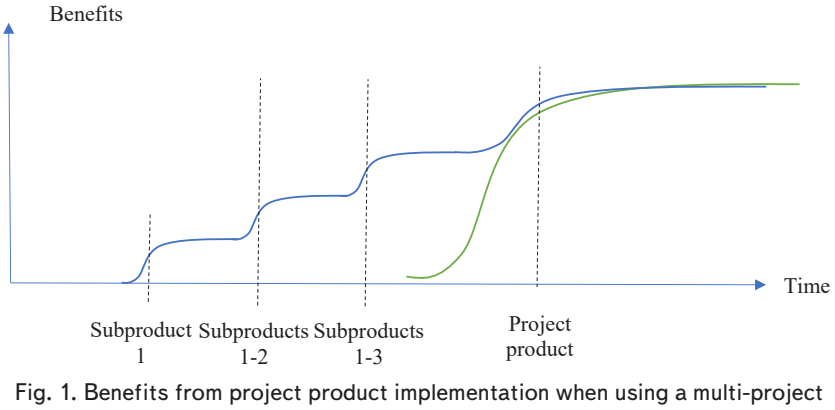

Fig. 1. Benefits from project product implementation when using a multi-project approach (blue line) compared to a project approach (green line)

The multi-project approach allows you to solve similar problems by creating a flexible scheme for tracking sub-projects based on establishing their priorities, technological, physical, or cause-and-effect relationships.

To implement a multi-project approach to the formation of portfolios of restoration and development projects of territories, two main tasks must be solved: to optimize the portfolio in terms of multi-project composition and to build a model of multi-project planning of the portfolio of projects.

5. 2. Method for forming portfolios of multi-projects for the restoration and development of territories using the cost-benefit concept

The cost-benefit concept was used to assess the expediency of implementation of development and restoration projects. When the regions are limited in terms of financing, funds should be spent on the most profitable projects. For investment projects, this benefit is usually evaluated through the financial result. But for development projects, and especially for restoration projects, the issue of benefit assessment is very difficult. Because for them the financial result is often not the main thing. The main thing is to meet the needs of the population, to create value for people living in this area.

The interpretation of the category «value» in historical and conceptual contexts has undergone a certain evolution, it is often equated with cost [10]. In the plane of the project approach, this concept is often reduced to the difference between the benefits and costs of the project, which significantly narrows its real meaning. In work [10], positive changes that occur as a result of the implementation of the project and meet the expectations of its stakeholders are used as the value of the project. This determination of the value of the project takes into account the interests of the population of the territories in development and restoration projects [10].

The following method of forming a portfolio of multi-projects for the development and restoration of the region is proposed, which is based on the use of the value of the product of the multi-project for the territories in the concept of costs and benefits as merits.

Let's consider some object W_i on the territory of a country, which is created within the framework of the multi-project R_i of development or restoration of the territory. The commissioning of this object will satisfy the needs of the population, which can be estimated by the value E_i. Multi-project costs are S_i. Moreover, costs are estimated in monetary units. In order to use the cost-benefit concept, it is necessary to reduce benefits and costs to one dimension. And usually, this dimensionality is the currency of one or another country. It is difficult to apply such a technique for multi-project restoration. It is difficult to evaluate in monetary units the restoration of highways or railroad tracks, the commissioning of a store, etc. Therefore, it is suggested to make a reverse course. Convert the loss of funds into a loss of value for the population of the territories, due to the fact that the funds spent on the multi-project did not go to social payments, financial assistance to the population, etc. Therefore, the costs of the multi-project will be equivalent to the amount of loss of value for the population of the territory:

$$S_i \sim E_i^S,$$

where

$$E_i^S = \frac{S_i}{\sum_{j=1}^{M} S_j}, \quad (1)$$

where S_i is the cost of the multi-project R_i; E_i^S – the lost value for the population of the territory equivalent to the costs of the multi-project; M is the number of potential multi-projects.

Then the feasibility of the multi-project R_i can be determined by the difference between the received and lost value:

$$\Delta_i = E_i - E_i^S, \quad (2)$$

where Δ_i is the feasibility assessment of the multi-project R_i; E_i is the estimate of the value of the multi-project R_i.

If measured in monetary units, we shall get a classic formula for calculating costs and benefits. But, as it was said above, it is impossible to apply such an assessment for multi-projects of development and restoration. Therefore, an approach based on a sociological assessment of the value of costs and the value of the multi-project product for the population is proposed. And based on this assessment, those multi-projects that should be included in the portfolio of multi-projects for the development and restoration of regions will be determined.

To obtain such an estimate, it is necessary to conduct a sociological study to answer the question – what is the value of objects that are created (restored) in multi-projects of development and restoration. to this end, one can use the following survey schemes:

1. Consider all pairs of multi-project products with the choice of the more valuable one, according to the respondent.
2. Choose the most valuable of all multi-project products.
3. Rank multi-project products.

The implementation of any of these schemes will lead to the formation of some assessment, which will correspond to the priority of the product of the multi-project for the population of the territory:

$$\forall W_i \exists \mu_i,$$

where μ_i – normalized product priority W_i:

$$\sum_{i=1}^{N} \mu_i = 1.$$

It is possible to replace the sociological survey with an expert assessment, which can be conducted by the regional authorities regarding the value of the multi-project for the territory.

The value ratio of multi-project products can be determined by a number:

$$\forall W_i, W_k : \frac{E_i}{E_k} = \frac{\mu_i}{\mu_k} = \beta_{ik}, \quad (3)$$

where β_{ik} is the ratio of the values of products of multi-projects R_i and R_k.

Then the assessment of the expediency of including some multi-project in the portfolio from (2) is equal to:

$$\Delta_i = \mu_i - \frac{S_i}{\sum_{j=1}^{M} S_j}.$$

The effectiveness of spending on a multi-project of development or restoration can be obtained by determining the relative cost of a unit of value of this multi-project.

Definition 1. The relative cost of a unit of product value is the value of the loss of value for the population of the territory, which is associated with project costs, in relation to the purchased value:

$$\alpha_i = \frac{E_i^S}{\mu_i},$$

where α_i is the relative cost of a unit of product value W_i.

The portfolio must include multi-projects that have the highest value and feasibility, and the lowest relative cost. The key parameters that determine such multi-projects are the relative cost of the product value unit α_i and the multi-project feasibility assessment Δ_i. The scheme for including the most valuable multi-projects in the portfolio will include the following stages:

1. Definition of investment restrictions on the strategic package S_0.
2. Inclusion in the pool of potential multi-projects only those for which $\Delta_i > 0$.
3. If the pool of potential multi-projects is empty, the review is completed.
4. If the multi-project with the highest multi-project feasibility assessment Δ_i requires costs S_i that are higher than S_0 – work with investors to finance this multi-project. If such an investor is found, include a multi-project in the portfolio. Exclusion of a multi-project from the pool of potential multi-projects.
5. If the pool of potential multi-projects is empty, the review is completed.
6. Selection of the multi-project with the lowest relative cost of the product value unit α_i.
7. If the costs of this multi-project are higher than S_0 – exclude the multi-project from the pool of potential multi-projects. Return to point 5.
8. Inclusion of the selected multi-project in the portfolio and excluding it from the pool of potential multi-projects. Reduction of the value of S_0 by S_i.
9. Transition to item 5.

The given method makes it possible to select from the portfolio of multi-projects those that are most in demand for the region and have a low cost.

Now it is necessary to consider the issue of decomposition of such multi-projects into sub-projects in order to increase the efficiency of management (sub-projects are easier to manage than large integrated projects) and to create a plan for commissioning products of multi-projects «in parts».

5. 3. Multi-project planning model taking into account cause-and-effect relationships between individual subprojects

For the effective development and restoration of the territories of Ukraine, it is necessary not only to select multi-projects that create the highest value but also to manage multi-project portfolios in such a way that their products are obtained as quickly as possible and with the lowest costs. To this end, it is necessary to rationally divide multi-projects into sub-projects and plan their execution in such a way that the obtained products of sub-projects best contribute to the execution of other multi-projects. And for this, it is necessary to take into account the cause-and-effect relationships between individual subprojects.

In essence, we are talking about the construction of a product planning system. In traditional planning systems, relationships (finish-start, finish-finish, start-start, and sometimes start-finish) are established between jobs. Regardless

of which part of the overall product the work is aimed at. In the multi-project approach, efficiency is achieved due to faster obtaining autonomous parts of the project product in sub-projects (Fig. 1). Therefore, connections must be established between subprojects. And already within the framework of the sub-project – between works.

The basis of such cause-and-effect relationships is a technological, physical, or logical connection between the products formed in different multi-projects. For example, restoration of part of the housing stock requires, first of all, restoration of energy supply. Because without power supply, it will be impossible to connect various equipment, tools, mechanisms for performing such works. And, of course, to improve the efficiency of management, it is better to separate the restoration of power supply from the general multi-project as a sub-project, plan and provide it separately with the involvement of part of the multi-project team to work only on it. In general:

$$R_i = \left\{ r_{ij} \right\}, j = \overline{1, n_i},$$

where r_{ij} is a subproject of multi-project R_i; n_i is the number of subprojects.

We shall assume that each subproject creates some separate part of the total product (as in the example above – energy supply):

$$\forall r_{ij} \exists w_{ij} : w_{ij} = f\left(r_{ij}\right),$$

where w_{ij} is the separated part of the product W_i of the multi-project R_i, which is created in the sub-project r_{ij}.

In general, different multi-projects can have the same subprojects. In the given example, energy supply can be used in the implementation of other multi-projects. For example, restoration of street lighting. If both multi-projects fall into the portfolio, then in one of them the need to implement a sub-project – restoration of energy supply – disappears. But on the other hand, the multi-project, in which the power supply will be restored, will be implemented earlier. This will determine the cause-and-effect relationship between multi-projects. In addition, sub-projects that provide a more valuable product for the territory should be completed earlier (Fig. 1).

Taking into account these two parameters – the value of the product of the sub-project and the use of this product in other sub-projects, we shall determine the priority of the products of the sub-projects. And hence, the order of execution of the multi-projects themselves. That will be the structural basis of the plan for the development or restoration of territories.

Let's introduce the concept of the integrated value of the subproject.

Definition 2. By the integrated value of the subproject, we shall understand the vector whose starting point has coordinates (0, 0, 0), and the coordinates of the end point will correspond to:

1. Values of the multi-project, which includes this subproject.

2. Sums of values of multi-projects, which also contain the product of this sub-project.

3. The sums of the values of multi-projects, the implementation of which requires the creation of the product of this sub-project:

$$\overrightarrow{\varphi_{ij}}\left(E_i, \sum_{w_{ij}=w_{kd}, i\neq k} E_k, \sum_{w_{ij}\to w_{ty}} E_t \right),$$

where φ_{ij} is a vector corresponding to the value of the separated part of the product w_{ij} of the subproject r_{ij}; w_{kl} is a separate part of the product W_k of the multi-project R_k; w_{ty} is a separate part of the product W_t of the multi-project R_t, which is created in the subproject r_{ty}, which requires the separate part of the product w_{ij} to be executed; E_k – estimation of the value of the multi-project R_k; E_t – estimation of the value of the multi-project R_t.

The length of the vector φ_{ij} will determine the priority of the r_{ij} subproject:

$$l_{ij} = \left|\overrightarrow{\varphi_{ij}}\right| = \sqrt{E_i^2} + \left(\sum\nolimits_{w_{ij}=w_{kl}, i\neq k} E_k\right)^2 + \left(\sum\nolimits_{w_{ij}\longrightarrow w_{ty}} E_t\right)^2, \qquad (4)$$

where l_{ij} is the priority of subproject r_{ij}.

Thus, the multi-project portfolio implementation plan should be drawn up in such a way that the sub-projects with the highest priority are implemented first. And this is possible only under the condition that the order of implementation of multi-projects that form products used in other multi-projects will correspond to priority (4):

$$L_i = \sum_j l_{ij},$$

where L_i is the priority of multi-project R_i.

Then the multi-project portfolio planning scheme will be as follows:

1. Selection of the multi-project with the highest priority.

2. If there are sub-projects, the implementation of which must precede this one - planning the implementation of these sub-projects. Calculation of the remaining resources for the remaining multi-projects.

3. Planning of the selected multi-project.

4. Calculation of the remaining resources for the remaining multi-projects.

5. Exclusion of the selected multi-project from consideration.

6. If all multi-projects have been considered – completion of planning.

7. Return to point 1.

The planning itself can be carried out in a traditional way – with the use of software tools that will be determined by the multi-project portfolio management team and business processes described in [11].

5. 4. Practical verification of the obtained theoretical results

The use of the developed approach to the formation of portfolios of multi-projects for the restoration and development of territories was carried out on the example of the STINBALEF project. Application of the research results in practice also included cooperation with key participants, in particular the Košice Autonomous Region and the European Association of Territorial Cooperation Via Carpatia. These participants are important subjects of territorial development and have the authority to make decisions and allocate financial resources for the development of their territories.

The implementation of the multi-project approach to the formation of portfolios of restoration and development of territories in the STINBALEF project was a complex and structured process that integrated the concept of «cost-benefit» and the multi-project planning model. The goal was to devise a methodology that would take into account not only individual subprojects but also their interdependence,

cause-and-effect relationships between them, and synergies between their results, which affect the effectiveness of investments. This reflects the fact that the evaluation of the effects of the development projects supported by the European Regional Development Fund (EFRD) shows an unexpectedly low efficiency of the projects in terms of their contribution to the achievement of the main goal of the EFRD – the reduction of regional disparities. A detailed look at the project structure shows, on the one hand, the relevance of a specific project, on the other hand, the lack of their integration with other projects that include additional innovations as prerequisites for achieving the proper effect [12]. The integration of specific projects into project packages guarantees not only synergy, which supports the effectiveness of a set of project activities in relation to their results, but also contributes to the effectiveness of project management. Carrying out this review involved several key steps. Firstly, it involved the identification of a diverse range of sub-projects aimed at the recovery and development of the Kosice region in Slovakia, covering activities ranging from infrastructure development to social initiatives. Each sub-project underwent a thorough cost-benefit analysis to assess its potential impact on the region's economic, social, and environmental viability. And this influence was expertly given a numerical measure ranging from 0 (no influence at all) to 1 (maximum positive impact assessment). The value of the sub-projects was determined based on an assessment of their potential to obtain significant benefits, taking into account cause and effect relationships. Thus, this approach also differed from others in assessing cause-and-effect relationships between individual sub-projects, recognizing how the success or failure of one can affect others, thus ensuring strategic alignment with broader regional development goals. The resulting project portfolio was strategically and systemically coherent to maximize its impact on the region.

At the stage «A3.2. The development of a modular platform for the creation of concepts of strategic investment and development packages» of the STINBALEF project, which was successfully implemented in 2023, the practical verification of the obtained theoretical results was a relevant and integral component of the project. This stage involved the application of the proposed approach to real scenarios of the development of transport, communication, and energy infrastructure and the rational use of natural resources and the protection of nature and ecosystems of the Košice Autonomous Region. This validation was aimed at ensuring that previously devised theoretical concepts and methodologies become practically applicable and effective in practice in real-world settings.

The results obtained as a result of the research are checked on the following multi-projects of the development of the Košice Autonomous Region:

1. Multi-project: development of tourism in the mountainous region.

Subproject 1. Recreational areas and infrastructure. The sub-project includes development and modernization of recreational areas, equipment of mountain routes, etc.

Subproject 2. Promotion of tourism. As part of the sub-project, marketing and advertising activities are implemented, tourist programs are developed, and information centers are created.

Subproject 3. Assistance to local enterprises. This sub-project provides financing for the development of hotels, restaurants and other local businesses serving tourists.

2. A group of multi-projects in the regions of the area: development of rural areas and the agricultural sector.

Subproject 1. Modernization of rural infrastructure. The sub-project implements the improvement of roads, water supply, sewerage, and electricity networks, etc.

Subproject 2. Development of the agricultural sector. The subproject implements measures to support farmers through the provision of subsidies, training, and development of new agricultural projects.

3. Group of multi-projects for industrial cities of the region: expansion of industrial infrastructure.

Subproject 1. Reconstruction of industrial zones. The subproject includes the tasks of improving the condition and infrastructure of industrial zones.

Subproject 2. Development of transport infrastructure. The expansion and modernization of highways and railroads is being implemented.

4. Group of multi-projects for the cities of the region: increasing the social development of the city.

Subproject 1. Improvement of medical infrastructure. This sub-project involves reconstruction of hospitals and creation of medical centers.

Subproject 2. Support of youth and cultural initiatives. Youth activities and cultural events are organized in the sub-project.

With the classical approach to the formation of a portfolio of projects for the restoration and development of territories, the listed sub-projects would not have been selected in it. In this case, the processes of formation of products important for the Košice self-governing region would remain behind the management horizon at the level of the project portfolio. Such as recreational areas, separate mountain routes, information centers, power grids, medical centers, etc. If sub-projects are brought to the portfolio level as separate projects, then the integrity of the management of groups of such projects, within which there is a cause-and-effect relationship, is lost. And the management of which should be carried out holistically, in connection with the results of other projects. As can be seen from this example, the multi-project approach to the formation of a portfolio of projects has a significant advantage over the traditional one in strategic packages for the restoration and development of territories.

Also, a new methodology, based on a multi-project approach, was successfully implemented in the process of devising programs for the socio-economic development of self-governing regions in Slovakia, which frames the strategic new program period 2021/2027.

Thus, the STINBALEF project not only contributed to theoretical knowledge but also provided practical solutions for the recovery and development of Slovakia's regions, promoting sustainability and growth.

6. Discussion of results of devising a multi-project approach to the formation of portfolios of restoration and development projects of territories

The issue of territorial development is a question of the strategy of existence of any country in the world. The development of territories is the foundation of the economic and social prosperity of both the population and the country itself. This issue is even more urgent for Ukraine. After all, thousands of objects have already been destroyed and damaged, thousands of hectares of land have been mined.

Therefore, we can talk about the development of the territories of Ukraine only in the context of the strategic package of development and restoration of everything damaged by the war. Restoration is needed not just in the form it was before. It is necessary to restore the territories through development in a larger and modern form.

Therefore, projects of development and restoration of territories, which are very complex in their totality, require new approaches, methods, and models of management. They would take into account the connectivity of the projects of development and restoration of territories. As well as the close connection of works on dismantling objects, demining territories, restoring infrastructure, creating new residential, socio-cultural, and industrial objects.

To construct effective management systems of strategic packages, it is suggested to implement a multi-project approach. Such an approach, like no other, while preserving the integrity and system of project management, makes it possible to single out individual components and products in the structure of projects. The implementation of it ensures multifaceted, structured, connected processes aimed at creating many products within the same project. And while the management of investment projects and programs is well researched, the issue of multi-project management of strategic packages of development and restoration of territories requires the construction of new scientific and practical tools.

A distinctive feature of the multi-project approach is the focus on creating a set of products that are created by sub-projects that are linked into a single system of development and restoration of territories. A feature of this approach is the three-level structure of management of strategic packages: portfolio of multi-projects, multi-projects, sub-projects. This makes it possible to implement a flexible management methodology through the planning of products of sub-projects, to achieve the strategic goals of development and restoration of territories. Traditional approaches use the general rules prescribed in the project portfolio management standard [13], which does not allow operating individual finished components of project products as the essence of plans for the development and restoration of territories.

The proposed approach has made it possible to build a product portfolio management system, which, as follows from Fig. 1, makes it possible to receive new value during the implementation of multi-projects, and not only after their completion (Fig. 1).

Based on the given feature, the multi-project approach to the formation of portfolios of restoration and development projects of territories is supplemented by the method. As well as the model of formation and planning of a multi-project portfolio – formulas (1) to (7). The basis of this method and model is the concept of value for the population of the territories from the products of multi-projects (definition 2).

The above results – justification of the feasibility of using the multi-project approach, the method of forming multi-project portfolios and the multi-project planning model made it possible to achieve the goal of the research – to devise a multi-project approach to the formation of portfolios of restoration and development projects of territories. This approach makes it possible to solve the scientific and practical task of building the methodological foundations of multi-project management of portfolios of projects of development and restoration of territories. The proposed approach to the formation of portfolios of restoration and development projects of territories is aimed at:

– increasing the efficiency and effectiveness of measures for the development and restoration of territories due to the distribution in time and space of the components of multi-project products and their coordinated and prompt commissioning;

– creation of a unified standard for the implementation of portfolio management processes of multi-project development and restoration of territories.

The limitations inherent in this study are related to the assumption that the projects of development and restoration of territories are essentially multi-projects in which sub-projects can be distinguished. The shortcoming of this work is that it does not fully develop the methods of structuring multi-projects (correct allocation of sub-projects), and there is also no clear answer on how to determine the values of the products of sub-projects based on estimates of the population of the territories.

The importance of the post-war reconstruction of Ukraine requires the search for new portfolio management tools. And this task is solved in this study. But just as in work [6], the task of devising a methodology for managing portfolios of projects that have a complex structure is not fully resolved. This is the aim of future research.

7. Conclusions

1. The necessity and expediency of using a multi-project approach for the formation of portfolios of territorial restoration and development projects has been substantiated. A feature of the approach is the selection of many products in the structure of restoration and development projects, which are interrelated cause-and-effect relationships. Based on this, within the framework of the multi-project approach, there is an opportunity to:

a) if necessary, flexibly change the configuration of the multi-project in order to form new products, the need for which arises in the course of its implementation. This is done by configuring one more subproject;

b) the sequence of formation of products of sub-projects makes it possible to obtain new values that satisfy the needs of the population of the territories even before the end of the entire multi-project.

These advantages are very important in land restoration projects, in which the dismantling of damaged objects, the construction of auxiliary or main buildings, the arrangement of territories, the laying of roads, energy or heat networks, etc. are implemented in one project. The creation of these products is very conveniently, from the perspective of project management, divided by subprojects. There is a specific person responsible for each of them.

In addition, the selection of structural parts (subprojects) in the project, which allow one to concentrate on autonomous parts of the overall product, makes it possible to create a product-oriented planning system. When work on such subprojects is not performed in parallel and is completed at the end of the entire project. And sequentially, in accordance with the cause-and-effect relationships between the products of the subprojects.

This makes it possible to create a clear scheme for tracking sub-projects based on establishing the importance (priorities) of their products. In the restoration and development of territories, there is always a cause-and-effect relationship between the products of different portfolio projects, as well as between sub-projects of the same project. The construction of such

a scheme for tracking subprojects is the key to more effective management not only of individual multi-projects but also of the entire portfolio of multi-projects. Thanks to this, a multi-project approach was used as a methodological basis for managing the development and restoration of territories.

2. A method of forming portfolios of multi-projects for the restoration and development of territories using the cost-benefit concept has been proposed. The peculiarity of the method is the use of not the financial indicators of the projects as benefits but the use of the category of value for the population of the territories of those products that will be created within the framework of multi-projects. This approach is based on the fact that development and restoration projects are not commercial, investment, aimed at obtaining some financial benefit. These projects are aimed at improving living conditions for the population of the territories. Even if the project is unprofitable but creates a positive worldview among the population of the territory, it should be implemented. It is by comparing the value created for the population of the territory, and the value lost due to the fact that the funds are directed to the project and not to social programs, that multi-projects are determined, which must be included in the portfolio of multi-projects. The proposed method includes 7 formulas for calculating the numerical values of project product values and contains 9 steps for determining the multi-project territory that is appropriate for the population.

3. A multi-project planning model was built, taking into account cause-and-effect relationships between individual sub-projects.

A feature of the model is that multi-project planning is carried out at the macro level – at the level of products of individual sub-projects. Such a planning model can be called a product model since the time of work on individual subprojects is established on the basis of cause-and-effect relationships between the products of subprojects.

The cause-and-effect relationship reflects the technological, physical, or logical connections between the products formed in different multi-projects. A new scientific result in this model is that it is based on the introduced new concept – the integrated value of the subproject (definition 2). The peculiarity of this approach is that the value is determined by some vector. The coordinates of the vector reflect the values of the multiproject itself, which includes this subproject; the sum of the values of multi-projects, which also contain the product of this sub-project; the sum of the values of multi-projects, the implementation of which requires the creation of the product of this sub-project. The integrated value more accurately reflects the importance of these sub-projects for the territory, which means the priority of their implementation, which formed the basis of the planning of portfolios of multi-projects for the development and restoration of territories.

4. A practical check of the obtained theoretical results was carried out, namely: a multi-project approach to the formation of portfolios of territorial restoration and development projects; the method of forming multi-project portfolios; multi-project planning models. The verification was carried out in the project «Development of concepts of strategic investments and development packages for the regions of Slovakia with a cause-and-effect relationship with the creation of a methodology for quantitative assessment of their efficiency and effectiveness». The peculiarity of the check was that it was carried out within the framework of real scenarios of the development of transport, communication, and energy infrastructure and the rational use of natural resources and the protection of nature and ecosystems of the Košice Self-Governing Region. As the experience of implementing this project showed, the devised approach, method, and model provided practical solutions for the recovery and development of Slovakia's regions, contributing to sustainability and growth. This experience testifies to the possibility of using the created tools for the post-war reconstruction of Ukraine.

These results indicate the achievement of the goal and confirmation of the research hypothesis. The devised multi-project approach to the formation of portfolios of territorial restoration and development projects has shown its effectiveness in practical implementation.

Conflicts of interest

The authors declare that they have no conflicts of interest in relation to the current study, including financial, personal, authorship, or any other, that could affect the study and the results reported in this paper.

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Data availability

All data are available in the main text of the manuscript.

Use of artificial intelligence

The authors confirm that they did not use artificial intelligence technologies when creating the presented work.

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