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PUBLIC PARTICIPATION PROJECT MANAGEMENT

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ABSTRACT

The relevance of the topic is due to the need for improvement and further development of scientific and methodological provision of portfolio management processes within the portfolio management introduction in the field of project management of local (territorial) self-government, including projects of public participation (PP projects).

The purpose of the study is to improve and further develop the scientific and methodological provisions of portfolio formation group processes under the conditions of PP projects' implementation, which are considered as the corresponding portfolio components.

The study's objectives are as follows: 1) to establish a conceptual research foundation and to identify project management knowledge bases relevant to the research topic; 2) to analyze the interrelated scientific and methodological approaches to: structuring categories; defining criteria for evaluation, selection and prioritization; optimization of PP project combinations as those presented in portfolios; 3) to formulate and check, using the database of public projects of Kyiv city, hypotheses relating to the insignificance of differences in the combination of PP projects, separated by thematic direction, which determine the feasibility of presenting projects of thematic areas in the relevant sub-portfolios of the overall PP project portfolio; 4) to propose the model for the formation of the optimal composition of the PP project portfolio recommended for implementation.

The methods of the study The method of scientific identification was applied while forming the conceptual basis of the research; the method of comparative analysis was applied in the analysis of scientific and methodological approaches to structuring, definition of criteria (evaluation, selection, prioritization) and optimization of the PP project portfolio; to test the hypothesis of insignificance of differences in the combinations of PP projects, separated by thematic areas, the non-parametric criterion (test) of significance of Kruskal-Wallis was used; while building a model for the formation of the optimal composition of the PP project portfolio, the method of cost-benefit analysis, the time value of money concept, and an integer programming problem were applied.

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Problem statement.

As is well known, politics and projects are frequently viewed as fundamental ways of intervention into the economy at the state level and/or at the level of individual territorial communities. At the same time, being forms of intervention into economic projects act as a means of implementation of the development strategy of the country's territorial community. This determines the need to direct them towards ensuring the achievement of relevant strategic goals. Aiming to involve local residents in various facets of community life through awareness and decision-making processes realized in the form of drafting a project to address local problems in distinct residential communities, districts, cities, etc., public participation projects, also known as PP projects, are gaining increasing recognition in the territorial communities of Ukraine and the rest of the world. At the same time, based on the analysis of requests submitted for the implementation of PP projects, the latter can be divided, in terms of compliance with the established strategic objectives, at least into two groups. There are projects that clearly cannot be matched with specific strategic objectives, and may even contradict some of them, and projects that clearly meet strategic objectives, demonstrating the applicability of the existing strategy for the local community. Taking into account the significant number of requests for projects from the second group in certain areas, in the future, these areas can be identified as those that require the intervention of local governments through changes in the relevant components of policy and/or strategy.

Currently, we can observe high growth rates in the total number of PP projects and budgets allocated for their implementation. Particularly, in Kyiv, the budget for the 348 PP projects that were approved for implementation in 2021 climbed from 50 million hryvnias in 2017 to 170 million hryvnias in 2021, while the number of projects approved for implementation increased from 62 in 2017 to 393 in 2022. (It is planned to allocate 200 million hryvnias in 2022). In order to address this, project management must become more effective and efficient across all of its domains, including healthcare, education, transportation, and so on.

It is widely acknowledged that combining projects and programs into portfolios enables one to obtain a new management quality, increases the overall impact of their implementation, and gradually develops the portfolios themselves into an effective mechanism for implementing not only strategical goals but also their formation [1, 2]. The increasing importance of portfolio management in the theory and practice of project management is indirectly indicated by the fact that, since 2006, the largest professional organisation in the field of project management, the Project Management Institute, PMI, has singled out from its basic standard PMBOK Guide a project management standard, A Guide to the Project Management Body of Knowledge, which develops and communicates to project management professionals a portfolio management standard. At the same time, until now, portfolios have been considered in scientific papers and portfolio management standards mainly in the context of the implementation of strategies by individual, mostly business organizations or organizational networks.

Thus, the relevance of the scientific topic is due to the need for improvement and further development of scientific methodological provisions to support portfolio management processes in the context of the introduction of portfolio-oriented management in the field of project management of local (territorial) self-government, including projects of public participation (equivalent to the term "public projects").

Analysis of the latest research.

The PMI has offered so far four versions of portfolio management standard, which were published in 2006 [3], 2008 [4], 2013 [5] and 2017 [6], respectively. Project management is one of those concepts that has many meanings, as was stated in the initial version of this standard. It was only ever affiliated with projects for a long time. However, today, it is becoming obvious that project management also deals with portfolio and program management, focusing on the thesis of "doing the right job," as opposed to the traditional project and program management - "doing the job right" [3].

In the Standard for Portfolio Management, the terms "portfolio" and "portfolio management" act as initial points of reference. Comparing the definitions of portfolio in different versions of the Standard for Portfolio Management, PMI, table 1, we can come to a conclusion, that in the first three versions [3–5] a portfolio is considered as one, that includes projects, programs. and also, other jobs, which are not included into previously mentioned components - projects and programs. At the same time, starting from the end of 2000, in the second edition of the Standard for Portfolio Management [4]

and in some other standards, PMI started to use the term "highest level portfolio", which except for projects and programs, by definition may contain lower level portfolio. During the same time period, the professional community observes that in practice, there is a tendency in any large portfolio to appear more or less stable groups of projects sporadically, and sometimes systematically. We can refer to these project groups as subunits of a single portfolio as long as they are just there to make management easier. However, when we start to allocate resources separately for a group and rank projects within such a group, we deal with singling out a portfolio of a relatively lower level within a portfolio of a relatively higher level. We can apply all the techniques and tools of traditional portfolio management to these new "units" [7]. These practices were taken into account to define a portfolio in the fourth edition of the Standard for Portfolio Management, PMI through the introduction of subsidiary portfolios as portfolio components [6].

The fourth version of the Standard for Portfolio Management, PMI explicitly defines the term "portfolio," and PMI connects the existence of a portfolio to the adoption of specific tactics and the accomplishment of specific objectives of the company or business units [6]. At the same time, a portfolio assumes the existence of both current components and those that will be added in the future. It is obvious that the presence of multiple strategies and goals can result in a single organization having more than one portfolio. New project and program initiatives are included in existing or new portfolios. In addition, relatively bigger portfolios may include subsidiary portfolios. We may observe mainly hierarchical structuring. Portfolios can exist at different organizational levels, including the organization as a whole, a department, a business unit, or a function [6]. They can also be internal or external to the organization.

Table 1. Definitions of Portfolio and Portfolio Management in the versions of The Standard for Portfolio Management published by PMI in the period from 2006 to 2017

Edition (version) of portfolio management, PMI	The term "portfolio"	The term "portfolio management"
1	2	3
The first edition, 2006 [3]	A portfolio is a collection of projects (temporary endeavors undertaken to create a unique product, service, or result) and/or programs (a group of related projects managed in a coordinated way to obtain benefits and control not available from managing them individually) and other work that are grouped together to facilitate the effective management of that work to meet strategic objectives.	Portfolio management is the centralized management of one or more portfolios, which includes identifying, prioritizing, authorizing, managing, and controlling projects, programs, and other related work, to achieve specific strategic objectives. It is an approach to achieving strategic goals by selecting, prioritizing, assessing, and managing projects, programs and other related work based upon their alignment and contribution to the organization's strategies and objectives. Portfolio management combines (a) the organization's focus of ensuring that projects selected for investment meet the portfolio strategy with (b) the project management focus of delivering projects effectively and within their planned contribution to the portfolio.

1	2	3
<p>The second edition, 2008 [4]</p>	<p>A portfolio is a collection of projects or programs and other work that are grouped together to facilitate effective management of that work to meet strategic business objectives.</p>	<p>Portfolio management is the coordinated management of portfolio components to achieve specific organizational objectives. Portfolio management is also an opportunity for a governing body to make decisions that control or influence the direction of a group of portfolio components (a sub-portfolio, program, projects, or other work) as they work to achieve specific outcomes. An organization uses the tools and techniques described in the standard for portfolio management to identify, select, prioritize, govern, monitor, and report the the contributions of the components to, and their relative alignment with, organizational objectives.</p> <p>Portfolio management is not connected with component management. Its aim is to ensure, that an organization is “doing the right job” rather than “doing the job right”.</p>
<p>The third edition, 2013 [5]</p>	<p>A portfolio is a component collection of programs, projects, or operations managed as a group to achieve strategic objectives.</p>	<p>Portfolio management is the coordinated management of one or more portfolios to achieve organizational strategies and objectives. It includes interrelated organizational processes by which an organization evaluates, selects, prioritizes, and allocates its limited internal resources to best accomplish organizational strategies consistent with its vision, mission, and values.</p> <p>Portfolio management produces valuable information to support or alter organizational strategies and investment decisions. Portfolio management provides an opportunity for a governing body to make decisions that control or influence the direction of a group of portfolio components as they work to achieve specific outcomes. An organization uses the processes, tools, and techniques described in the standard to identify, select, prioritize, govern, allocate resources, monitor, and report the contributions of the portfolio components to, and their relative alignment with, organizational objectives. Portfolio management balances conflicting demands between programs and projects, allocates resources based on organizational priorities and capacity, and manages so as to achieve the benefits identified.</p>

1	2	3
The fourth edition, 2017 [6]	A portfolio is a collection of programs, projects, subsidiary portfolios, and operations managed as a group to achieve strategic objectives.	Portfolio management is the centralized management of one or more portfolios to achieve strategic objectives. It is the application of portfolio management principles to align the portfolio and its components with the organizational strategy. Portfolio management can also be viewed as a dynamic activity through which an organization invests its resources to achieve its strategic objectives by identifying, categorizing, monitoring, evaluating, integrating, selecting, prioritizing, optimizing, balancing, authorizing, transitioning, controlling, and terminating portfolio components.

In our research, we use the terms “portfolio” and “portfolio management” in correspondence with their meanings provided in the fourth edition of the Standards for Portfolio Management, table 1, unless otherwise specified.

The current study focuses on the comparison and contrast of portfolio management process visions, particularly the process set of portfolio formation, in accordance with various versions of the PMI Standard for Portfolio Management [3-6]. The process set of portfolio formation was singled out in the first version of the Standard for Portfolio Management by PMI [3]. According to this version, the processes of this group are mostly realized by an organization during the period of review of its strategic goals, plans, and budgets, as a rule, at the end of a fiscal year. Some organization have a shorter planning cycle. Furthermore, the necessity of these processes also arises when we observe sharp changes in conditions for conducting business [7]. The following processes were included in this set: identification of components; categorization of components; evaluation of components; selection of components; prioritization of components (determining the degree of priority; sometimes the term "rating" is used); portfolio balancing; and authorization (approval) of portfolio components [3].

In the second version of the Standard for Portfolio Management, PMI the set of process formation retains its previous name and cited-above list of processes. At the same time, it is mentioned that the basis of these processes is formed by the portfolio management knowledge base. Meanwhile, the following processes: portfolio risk identification, portfolio risk analysis, and development of risk management measures were added to the cited-above list of processes. It was previously believed that these processes were based on the knowledge base of portfolio risk management [4].

In the third version of the Standard for Portfolio Management, PMI, the portfolio formation set is presented as one, which includes processes aimed at management and optimization of the portfolio. The methods for categorizing, assessing and choosing, modifying and excluding portfolio components, as well as portfolio management measurements, are described in this set [5]. We can identify the following processes within this set: portfolio change management, the basis of which is a knowledge base on strategic portfolio management; portfolio optimization, the basis of which is a knowledge base on portfolio management; supply and demand management and portfolio value management-the basis of these two processes is a knowledge base on portfolio effectiveness and efficiency management; portfolio information management, the basis of which is a knowledge base on portfolio communication management; and portfolio risk management, the basis of which is a knowledge base on portfolio risk management [5]. It is important to note that the definition process set is a relatively new process set in the third version of the Standard for Portfolio Management, PMI [5] compared to the previous two versions. This set includes the following processes: development of a portfolio strategic plan; development of a portfolio charter; and defining a portfolio "road map", the basis of which is a knowledge base on portfolio strategic management; development of a plan for portfolio communication management; the basis of which is a knowledge base on portfolio communication management; development of a plan for portfolio risk management; the basis of which is a knowledge

base on portfolio risk management. As we can see, a defining process set has partially overtaken some processes, which were considered as part of a process forming set in previous versions of the Standard for Portfolio Management, PMI. At the same time, if we link processes with knowledge bases, we can notice that in both the first and the second versions of the Standard for Portfolio Management, PMI's traditional portfolio forming processes are studied with a knowledge base on portfolio management [3, 4]. In particular, it is applicable to identification, categorization, evaluation, selection, prioritization, and balancing (hereinafter, optimization).

In the fourth version of the Standard for Portfolio Management, PMI [6] portfolio management processes act as those which are grouped according to the phases of the portfolio life cycle identified in this version—as stages of the portfolio management process—initiation, planning, implementation, and optimization, as well as monitoring and control, if it is envisaged to separate this stage of the management process, which is not considered as a separate phase of the portfolio life cycle. The processes of portfolio set formation, in the interpretation of the first three versions of the Standard for Portfolio Management, PMI [3–5], and, in part, the processes of portfolio set definition, which were introduced in the third version [5], mainly correspond to the process set of initiation and planning [6]. It is worth noticing that optimization (previously called balancing) as it is interpreted in the first three cited-above versions [3–5], occurs according to the fourth version not only at the optimization stage, but also to a large extent at the planning stage, in particular, at its beginning, and is also possible at the stage of implementation [6].

It is obvious that if we try to apply portfolio-oriented management methodology to the project management of local (territorial) self-government, including PP projects, we need to adopt certain changes. In our work we do not set an aim to substantiate the necessity to single out certain processes, which may make up a set of processes for the formation of a PP project portfolio, and accordingly, to define the content of these processes as the main actions that are supposed to be taken, as well as input and output data for each process in correlation with portfolio life-cycle stages as the stages of the portfolio management process. At the same time, for any structuring of process sets of portfolio formation, it is of interest to investigate the problem of elaborating the scientific and methodological approaches considered in the relationship to: structuring of categories; definition of criteria for assessment, selection, and prioritization; and optimization of PP project sets—such as those presented in portfolios. At the same time, the research gap is identified as the absence of scientific and methodological support for the development of the above-mentioned approaches.

The purpose of the study is to improve and further develop the scientific and methodological provisions of portfolio group formation under the condition of PP project implementation, regarding the development of the concept of PP project portfolio formation.

The object of the study. Processes of formation of PP projects sets for implementation.

The subject of the study. Methods and models of projects portfolio formation.

Presentation of the main research results.

In general, the process of evaluation and selection of PP projects for implementation is as follows. Requests for PP projects must undergo a preliminary selection procedure at the relevant executive structures of the territorial community. Then, those of the requests that have successfully passed the preliminary selection are offered for consideration to the residents of the territorial community. In the latter, each voter receives a specific, predetermined amount of votes. The definition of "a resident of the territorial community" may differ.

Additionally, projects are reviewed, chosen, prioritized, and optimized in accordance with preset criteria depending on the amount of votes obtained as a distinct indicator or in a predetermined combination with other indicators. The group of projects created in this manner is then transferred for execution.

The generalized vision of the concept of public participation project portfolio formation offered by the authors is presented in fig. 1.

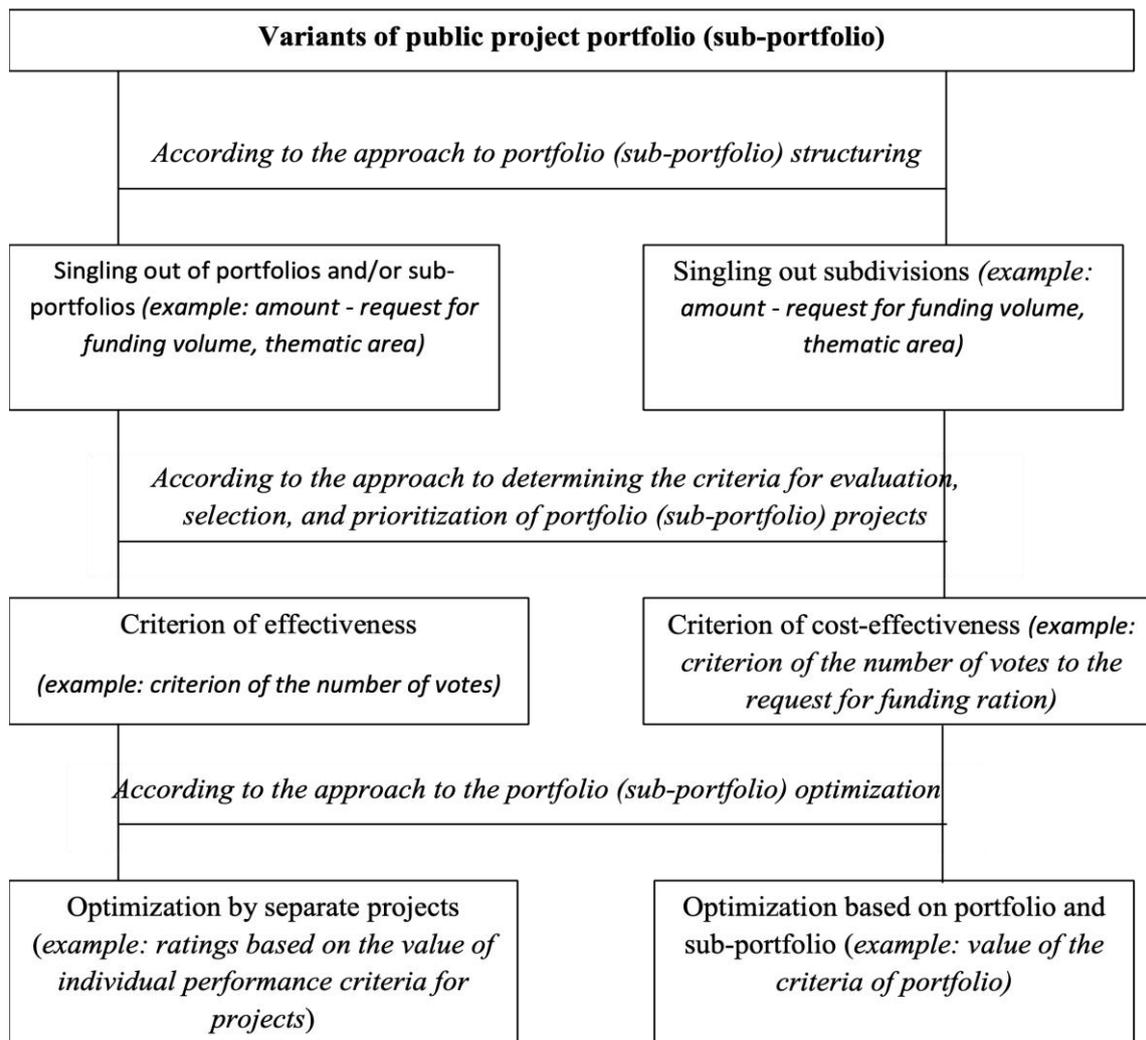


Fig. 1. The concept of public participation project formation

Let us consider in detail the interrelated scientific and methodological approaches to public participation project portfolio formation. These approaches were identified in the above concept, Fig. 1.

The analysis of existing practices regarding the forming and implementing processes of a set of PP projects, which is considered in this paper as a portfolio, gives us grounds to distinguish at least two fundamentally different approaches to structuring this portfolio. The first approach does not provide for a separate preliminary allocation (fixation) of budget regarding any component of the PP portfolio. Projects that differ in the parameters that these projects characterize, for example, by thematic focus, request for funding volume, etc., receive their rating within the general list, according to which they can later be prioritized within the thematic list, and a joint budget is allocated to them. Accordingly, following the interpretation of the portfolio or sub-portfolio provided in the review, we can only deal with the units of the portfolio, which are singled out in most cases only for ease of management. We can provide as example public projects in Kyiv, according to which it is proposed to single out the following ten topics for implementation in 2022: roads, transport; ecology; housing (utilities, energy efficiency); health; information technology (IT); culture, tourism; youth, sports; education; civil society; social security, inclusion; interthematic. In particular, for each project, the city working group on public budget, if the localization of the project is citywide, or district working group on public budget, in the case of district localization of the project, appoints a person responsible for project examination. There are other aspects of project management in Kyiv, the conditions for which depend on the thematic direction of the public project [8]. At the same, time allocation of separate budgets for each thematic area is currently not provided for.

According to the second cited-above approach to structuring the PP project portfolio, in contrast to the first, a separate rating and budgeting of projects that differ significantly in the values of certain defined and selected for categorization parameters are provided. If we deal with public projects in Kyiv for 2022, two categories are singled out: small and large projects, as it was in previous years. The group of small public projects accepted for implementation in Kyiv in 2022 includes projects with a budget (expenditure) of 100,000 to 999,900 hryvnias, and the group of large projects includes those with a budget of 1,000,000 to 3,000,000 hryvnias [8].

Thus, now, in the "language" of portfolio-oriented management, we can interpret the set of public projects in Kyiv for 2022 as a portfolio, which includes two categories: the category of small and the category of large projects as its sub-portfolios. As it was mentioned above, we can deal with the division of projects in accordance with thematic areas in the context of singling out portfolio units (sub-portfolio) for the ease of management. As criteria for evaluation, selection, and prioritization of projects for implementation using only one of the above approaches, or, as we see in the example of Kyiv, both approaches in a certain combination, there is the use of mostly two criteria as alternatives. These are the criterion "number of votes" received by the project for support (hereinafter—the criterion of the number of votes) and the criterion of the ratio of the number of votes received by the project for support to the request for funding volume for the project (hereinafter—the criterion of the ratio of the number of votes to the request for funding). Carrying out a comparative analysis of the two outlined approaches to the portfolio structuring of PP projects, we can point out that an advantage of the first approach is that, first of all, it "equalizes" in the community's vision all projects in their quest to be implemented at the expense of the PP budget (the term "public budget" is used as a synonymic term. This, to the greatest extent, corresponds to the essence of the development of the "movement" of PP projects as such. At the same time, this apparent "equality" can end up being a myth. This is partly because initiatives that match specific criteria are occasionally, a priori, comparatively more likely to receive more votes. Nevertheless, they may not necessarily have higher social or financial efficiency when viewed objectively. For example, this is observed for relatively significantly larger projects than others in the relevant list, which is reflected in the request for funding. If we stick with the previous example, large projects tend to "lose" when a different criterion for evaluation, selection, and prioritization of projects for execution is chosen—the ratio of votes to funding requests. It is important to keep in mind that by selecting this criterion, which enables us to consider cost-effectiveness, we have, in some ways, violated the concept of "equality," which is based on the number of votes received—real or imagined—by PP projects in the eyes of citizens who participate in these projects in one way or another.

Within the given research, we have carried out an investigation, the main question of which sounded this way: "Do the requests for funding volume of public projects submitted in 2019 and those waiting for implementation in 2020 in Kyiv differ greatly in regards to singled out themes in the singled out categories?" In order to test the null (working) hypotheses about the importance of the variations between the PP projects that were submitted in the categories of small and large projects as defined by request for funding volume, this question was addressed in the study. We analyzed, accordingly, a database of projects that were the subject of voting in 2019 [9].

It is important to note that the "threshold" that distinguished between small and major projects during this time was lower, at 399,900 hryvnias. At the same time, the lower limit was not actually set, while the upper limit for the category of large projects corresponded to the existing one-3,000,000 hryvnias. The singled out thematic areas were also somewhat different: security; roads, transport; culture, tourism; ecology; education; health care; social security; sport; IT (information technology); civil society; utilities, energy saving; public space; etc.

Our research aimed to show whether a huge difference in funding volumes for projects in various areas within one category existed, and thus, we could assume, it was industry-specific. It could in its turn indicate "inequality" during their ranking together on the basis of the ration of the number of votes to the request for funding. Projects in spheres (thematic areas) with fewer requests for funding volume within a relevant category (small or large) will gain higher ratings in comparison with others, with a slight difference in the votes in favour. Thus, these spheres (thematic areas) will gain hidden preferences in the form of an increased number of projects accepted for implementation in comparison with other spheres (thematic areas).

To prove our hypotheses, we applied a nonparametric criterion, the Kruskal-Wallis test of significance, which is a multidimensional generalization of the Wilcoxon–Mann–Whitney criterion. Since this criterion is rank-based, any monotonic modifications of measurement scales have no effect on it. In accordance with alternative hypotheses, the difference between PP projects, which were submitted under small and large project categories, regarding the request for funding volume is significant. After carrying out the calculation by applying the program product IBM SPSS Statistics 22, we rejected each of the zero hypotheses with a level of significance of 0.05. It means that the difference between PP projects, which were submitted under small and large project categories in the relevant thematic areas, regarding the request for funding volume is significant.

Therefore, it is fair to rank the projects within these thematic areas inside different budgeting categories or to evaluate them based on the number of votes, where the request for financing has no bearing on how they are rated. I.e., in the second case, we deal with a portfolio (sub-portfolio).

It is obvious that if we introduce ranking by a different criteria within one common budget, it must be applicable for all units of the single portfolio. As a result, it may have a negative impact on rating results for projects of other portfolio segments, which are singled out in accordance with their spheres (thematic areas).

Our considerations bring us to a logical assumption of the necessity to single out within the public budget portfolio of Kyiv in accordance with the existing categories (sub-portfolios)—small and large—categories (sub-portfolios) of thematic areas. The latter, as we mentioned beforehand, based on their characteristics, may only be considered as sub-units created for the ease of management.

The issue of optimization of a portfolio or sub-portfolio which corresponds to the existing singled out criteria of projects is of special interest during portfolio formation of PP projects. There are many ways to approach this issue. Firstly, it is a possibility to consider the conditions of dependence between separate projects. Within the singled out categories, as well as within the sub-units of these categories, PP projects may be presented as independent or dependent. On the basis of addition or replacement, the latter can therefore be depicted as dependent. In the meantime, by creating new, integrated components that comprise dependent projects, the conditions of the components' reliance in accordance with these principles can be taken into consideration. When we examine PP projects that were completed under the category of small projects in the "Education" thematic area, we can see that there were numerous requests for funding in the same amount for projects that were similar but for different schools, and that were intended to install audio and multimedia equipment. These projects can be considered together, for instance, as a part of a program, which are complementary in cost; we can expect a positive synergy effect due to the possibility of centralized procurement, with subsequent installation and maintenance appropriate to these equipment projects. The same considerations can be applied when we observe projects for kindergartens "Music and Dances", which were implemented in the category of small projects in the thematic area "Culture" in 2019 (planning) and 2020 (implementation).

We could provide some examples of mutually exclusive projects. For example, in the thematic area "Education" or "Sport". Some requests for funding equipment for playgrounds and sports grounds, which are located so close to each other based on "target audience" as a number of residents who will potentially use these sites, can be considered mutually exclusive. The provided conditions of dependence can be partially taken into account during the preliminary examination and, finally, taken into consideration after the rating vote and the optimization process. It is also appropriate to consider the conditions of dependence in the optimization process, based on the definition of the optimization process [3-6], according to the selected categories, on which the corresponding portfolios are based. This is if the preliminary examination can be effective and efficient in selecting projects for evaluation (voting), evaluation itself, and, possibly, rating—both within individual categories and within subdivisions of these categories.

The second sensible factor to consider when dealing with the optimization of the PP portfolio, in our opinion, is the selection of the optimization conditions (sub-portfolio). Firstly, we are to decide whether optimization will be applied exclusively based on individual ranking, gained by projects according to chosen criteria as a result of voting, or whether optimization will concern portfolios (sub-portfolios) as a whole.

We constantly face an obvious dilemma while forming a list of PP projects for implementation. On the one hand, it is an individual ranking that a project gets based on set criteria, and on the other

hand, we deal with the conditions for effective use of taxpayers' money within allocated budgets. And as we noticed earlier, there might be certain contradictions. By the way, it is worth noticing that the practice of using individual rankings in many cases, including those in accordance with normative acts regulating the public budget in Kyiv, indicates that these ratings are of a pure recommendation nature.

If we deal with the conditions for PP projects optimization in accordance with a set category, we can apply an Integer Programming Method to solve the problem of portfolio content optimization in the appropriate setting. The objective function is built on the number of votes given to support separate projects, and it obviously requires maximization. The budget allocated for a certain project category, which under these conditions is considered a project portfolio, serves as a restriction.

According to the above-mentioned statement, we can write:

$$\sum_{i=1}^I V_i x_i \rightarrow \max, \tag{1}$$

with the restrictions:

$$\sum_{i=1}^I C_{K_i} x_i \leq C_{K_p}, \tag{2}$$

$$x_i = 0, 1, i = \overline{1, I}, \tag{3}$$

where V_i – the number of votes, given to support i -th PP project, $i = \overline{1, I}$;

C_{K_i} – capital expenditure for i -th PP projects, $i = \overline{1, I}$;

C_{K_p} – the maximum value of the capital expenditure that can be allocated for the financing of PP projects within the given category (portfolio or sub-portfolio);

I – the total number of the projects in the category (portfolio or sub-portfolio).

The restrictions mentioned by this model for project portfolio optimization, expressions (1)–(3), in accordance with accepted practice, do not always take into account the current expenses, which are linked with the operation and maintenance of the projects in the future. These costs can be accounted for in different ways. In particular, these costs may be defined as a total sum for a certain period of project operation, for example, 5 years, and can be accounted for as a restriction at the preliminary selection stage. It is also possible to include these running costs—as modified operational costs—as a restriction of objective function (1) in the following form:

$$\sum_{i=1}^I \sum_{t_e=1}^{T_e} \frac{C_{\Pi_i t_e}}{\prod_{j=1}^{t_e} (1 + k_{ij})} x_i \leq c_{\Pi_p}, \tag{4}$$

where $C_{\Pi_i t_e}$ – the current expenditure for the i -th PP project in the time period t_e , $t_e = \overline{1, T_e}$, $i = \overline{1, I}$;

k_{ij} – cost of capital for i -th PP project in the time period j , $j = \overline{1, t_e}$, $t_e = \overline{1, T_e}$, $i = \overline{1, I}$;

c_{Π_p} – the maximum value of the current expenditure that can occur within the given category (portfolio or sub-portfolio);

T_e – an economic term of life, that is accepted by the PP projects.

The objective function can be supplemented with a restriction on current costs in the form of:

$$\sum_{i=1}^I C_{\pi_i t_e} x_i \leq C_{\pi t_e p}, t_e = \overline{1, T_e}, \quad (5)$$

where $C_{\pi t_e p}$ is the maximum value of the amount of current expenses that can occur by the category (portfolio) in the time period $i \in t_e, t_e = \overline{1, T_e}$.

When developing a portfolio optimization model, taking into account the idea of money value over time by using discount processes, poses the question of the degree of risk. Project risk refers to risks relating to particular projects included in the portfolio. Structural risk refers to risks relating to the processes used to construct the portfolio and potential conflicts between its components. "Global risks" refer to risks that are bigger than the sum of all other risks [3–6]. As a rule, we take into account the risks of separate projects in their budgets by increasing the latter by up to 20%. Meanwhile, considering the existence of structural risks and maybe partially global risks by the totality of projects in a certain thematic area allows us to present these totalities as a portfolio (sub-portfolio).

In this research, we examine, as an example, requests for funding, which were submitted in the small and large project category within the thematic area "Culture" in 2019 [9]. The projects were implemented in 2020. To define the optimal content of the project set of this thematic area as a portfolio (sub-portfolio), we applied the Integer Programming Method, using the add-in program Solver in Microsoft Office Excel 2010. We took into consideration the following indicators for each project: the number of received votes in favour, the request for funding volume, criterion significance for evaluation, and ranking. 50 requests in total were selected for competitive selection. 28 projects received the status "implemented" under the conditions of applying the current approach to selecting projects for implementation, the total number of votes in support of these projects amounted to 10,659 votes. The total budget was 3,985,659 hryvnias. In accordance with the proposed approach to optimization, 27 projects received the status "implemented" (26 of which had this status before). We recommended changing the status of 2 projects to "participated" and vice versa, we recommended adding one project to the list of projects that could be implemented. The total number of votes in support of these projects amounted to 10,713 votes. The total budget was 3,985,959 hryvnias. Under the condition of using the current approach to optimization, the number of votes assigned to 1,000 hryvnias of funding for this project set was 2.67, and in accordance to the offered one, 2.69. At the same time, we considered the restriction for funding the projects in this area as a budget, based on the funding volume allocated for implementation of accepted projects, which amounted to 4,000,000 hryvnias.

We need to set a separate budget for this category in order to single out the PP project category and refer to it as a portfolio in the future. For instance, in accordance with the parameters of the public budget of Kyiv for 2022, it is foreseen that 40% of it will be used to implement small projects and 60% to implement large projects. If we introduce separate budgets for thematic areas, we can hypothetically use different variants to allocate budgets for small and large projects within this area. For example, this distribution can be used in proportion to the number of submitted requests or to the number of votes already received based on the results of voting by thematic areas. Other variants are also possible.

If we consider a project as a means of realization and, under certain conditions, a way to form a strategy for a territorial community, we can apply the level of a weighting coefficient as one which stimulates the development of certain thematic areas. At the same time, it can be either "strengthening" the recognition of strategic areas of development that are important for the territorial community, or strengthening strategic areas that "don't get" funds due to the deficit in the "normal" budget, or searching for new promising areas of strategic development. The latter scenario gives PP projects an experimental feel. We need to deal separately with the issue of the hierarchical structure of PP projects portfolio: categories of small and large projects must be divided into thematic areas, or vice versa, thematic areas must be divided into small and large categories. However, this issue is beyond the scope of this research.

Hypothetically, there may be complaints about the "non-transparency" of PP project selection if we use a portfolio optimization approach. First of all, due to the fact that the portfolio optimization process is not as clear as the rating. Although we would like to note that the rating as it is mentioned in various normative rulings of territorial communities has the character of a recommendation rather than a final

decision. At the same time, the correspondent program software used in the proposed approach is an open-source product, which is adopted for maximum ease of use for anyone who is eager to check whether this optimization is carried out properly. Such services are offered worldwide, and in particular in Ukraine for various areas of social life and in the context of solving a wide range of issues.

Conclusions from the conducted research and perspectives for further investigations in this area.

We have elaborated a concept of portfolio formation for PP projects, which is based on research of scientific and methodological approaches considered in the relationship to: structuring of categories; definition of criteria for assessment, selection, and prioritization; and optimization of PP project sets—such as those presented in portfolios. We have formulated and verified, using a database of public projects in Kyiv, hypotheses regarding the insignificance of differences in requests for funding volume in the sets of PP projects singled out by thematic areas, which determine the necessity to present projects of thematic areas as part of the corresponding sub-portfolios of the general portfolio of PP projects. Additionally, it has been determined that this difference is significant using the Kruskal-Wallis significance test. We have suggested a model, based on Integer Programming, for the formation of the optimal composition of the PP project portfolio, which is recommended for implementation.

The results can be viewed as offering a chance for improvement and further development of the scientific and methodological foundations for the formation processes of the portfolio sets under the circumstances of the execution of the PP projects, which are regarded as components of the respective portfolios.

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