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**THE IMPROVEMENT OF THE PRIVATE COMPANIES' SELECTION
PROCEDURE FOR CREATION A PUBLIC-PRIVATE PARTNERSHIPS**

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**УСОВЕРШЕНСТВОВАНИЕ ПРОЦЕДУРЫ ОТБОРА
ЧАСТНЫХ КОМПАНИЙ
ДЛЯ СОЗДАНИЯ ГОСУДАРСТВЕННО-ЧАСТНОГО ПАРТНЁРСТВА**

As a result of studying the selection procedures (request for valuation, request for proposals, auction, tender) of private companies for creating public-private partnerships, some shortcomings of their work were identified. Firstly, only one company becomes a winner as a result of the selection, and the other applicants are excluded from participation in the partnership. Secondly, only financial characteristics of the companies that are potential participants are analyzed, some important factors of the legal and professional nature are not considered. The purpose of the article is to offer a procedure for preliminary and main selection (improve the existing procedure). It should be noted that we examine the development projects of social infrastructure, so the selection of companies is specific for the field assets: land, buildings, money. The pre-selection procedure is based on the analysis of legal and professional factors. The main selection procedure is based on the quantitative data of the assets of the company and forms partnerships of the companies whose assets are complementary to each other (the arguments of such sets of assets of the companies are listed in the first part of the work). In contrast with the existing selection procedure, the public-private partnership with the participation of several private companies can be identified as a result of improved selection procedure. This procedure can also create several public-private partnerships. The construction procedure of public-private partnerships is described using graph theory – coloring of vertices and edges of a graph according to certain rules. At the end of the article, there is a remark that the proposed procedure produces a result that is no less and in some cases even more effective than the current ones.

PUBLIC-PRIVATE PARTNERSHIP; ALLIANCE; SELECTION ALGORITHM; SELECTION PROCEDURE; GRAPH THEORY.

В результате исследования процедур отбора (запрос цен, запрос предложений, аукцион, конкурс) частных компаний для создания государственно-частного партнерства были выявлены некоторые недостатки их работы. Во-первых, в результате отбора победителем становится только одна компания, а другие, подавшие заявки отстраняются от участия в партнерстве. Во-вторых, анализируются только финансовые характеристики компаний – потенциальных участников, не учитываются важные факторы правового и профессионального характера. Целью статьи является предложить процедуру предварительного и основного отбора (усовершенствовав существующую). Следует отметить, что рассматриваются проекты развития социальной инфраструктуры, поэтому отбор компаний строится с учетом специфических для этой сферы активов: земельных участков, зданий и сооружений, денежных средств. Процедура предварительного отбора основана на анализе правовых и профессиональных факторов. Процедура основного отбора опирается на количественные данные об активах компании и составляет партнерства из компаний, активы которых дополняют друг друга (рассуждения о таких наборах активов компаний приведены в первой части работы). В отличие от существующей процедуры отбора, в результате работы усовершенствованной процедуры отбора может быть выделено государственно-частное партнерство с участием нескольких частных компаний. Данная процедура позволяет также сформировать несколько государственно-частных партнерств. Процедура построения государственно-частных партнерств описана с использованием теории графов и раскраски вершин и ребер графа по определенным правилам. В конце статьи приводится замечание о том, что предлагаемая процедура даёт результат не менее эффективный, чем существующая, а в некоторых случаях, даже лучший.

ГОСУДАРСТВЕННО-ЧАСТНОЕ ПАРТНЕРСТВО; АЛЬЯНС; АЛГОРИТМ ОТБОРА; ПРОЦЕДУРА ОТБОРА; ТЕОРИЯ ГРАФОВ.

Introduction. The formation of public-private partnerships implements the idea of mutually beneficial cooperation on the basis of the interests and goals of the participants (different sectors of the economy). On the one hand, the public sector gains the opportunity for more competent management of state property, increasing the quality and quantity of services provided to the society; on the other hand, companies that are business representatives improve business reputation and receive additional funding [2]. The more public-private partnerships are created, the more socially important projects can be implemented [12, 14]. The urgent task of providing a favorable social environment focuses our attention on the projects of social infrastructure development. [4].

Electronic business platforms are one of the tools for organizing the selection of private companies for PPP creation. The city administration places a request for selecting the candidates for private-company partners in a particular project on an Internet portal. A significant drawback of the method is that only one company can become the winner as the result of the selection procedure; all other companies who applied will not take part in the partnership.

Research Methodology. The main objective of the study is to offer such a selection procedure for private companies which allows to form several sustainable public-private partnerships for the development of social infrastructure projects. This object is achieved in several steps: the first is analyzing the possible government and business coalitions by taking into account the assets of potential participants; the potential participants are then divided into two parts, those that definitely will not be able to implement the project (and are excluded from consideration), and those who can implement it; after that a basic selection procedure is offered. It is shown that the result obtained by this procedure is no less effective (the number of PPPs will be no less than under the current procedure, and they will be more stable) than by the current selection procedure.

Creating public-private partnerships in view of the assets of potential participants. A lack of resources is a prerequisite to creating a public-private partnership [3, 10, 13]. In this case, private companies or city administration initiate the search for potential partners with the necessary (missing) resource. The analysis of the development of social infrastructure projects implemented through public-private partnerships reveals that

potential assets of the participants (as well as of the city administration as a representative of the state, and of private companies) can be divided into three groups: land; buildings and constructions; cash. It is convenient to use a language of binary relations to view the possible combinations of assets of private companies and the state, as well as to evaluate the possibility of establishing a PPP on their basis. [8]. If a private company has the land, but has neither money, nor buildings and structures, then it is denoted as «100», in other words, «1» means that the relevant asset is available, and «0» indicates the absence of the asset. So a set of state and business resources of the alliance can be written as a chain of six digits, where the first three show the assets of the city administration, and the last three the assets of the private company. After considering all possible chain combinations, it can be concluded which alliances will lead to the creation of PPPs, and which will not.

The number of all possible combinations is equal to the number of permutations with the repetition of 2 (two possible values: zero or one) by 6 digits in the chain, i. e., 64. However, some of the chains hold no interest for the investigation. Tab. 1 explains why these chains have been removed from the analysis.

Companies owning the asset sets described by the chains in the first four rows of the table will not be able to form PPPs. Let us determine the number of combinations excluded from consideration. The first row of the table consists of eight 6-digit chains: from «000000» to «111000», which will no longer be taken into account. The second row contains the chains from «000000» to «000111», but a chain of «000000» has been included in the first row, so it is not listed in the second row of the table which has seven new combinations. Seven and six combinations are excluded from consideration in the third and fourth rows, respectively. As a result, 36 combinations of different sets of assets needed for creating state and business alliances are identified (there are some examples of sets of assets that allow to create PPPs in Table 1; an interaction scenario is proposed in the last five rows, but this is only a fragment of the full table). Thus, we have identified the cases where government and business interests can be reconciled on the basis of the resources that each of these entities are lacking for implementing social projects. The third part of the work will offer a basic procedure for selecting the participants for creating public-private partnerships based on the selected sets of assets.

Table 1

Combinations of asset sets in the PPP

City administration assets			Private company assets			Scenario of development for the alliance
Land	Buildings and constructions	Cash	Land	Buildings and constructions	Cash	
000...111			0	0	0	It is impossible to create a PPP. The private company does not make any contribution to the Partnership, as it does not have any of the necessary assets (8 combinations)
0	0	0	000...111			It is impossible to create a PPP. The city administration does not make any contribution to the Partnership, as it does not have any of the necessary assets (7 combinations)
000...111			1	1	1	There is no need to create the PPP (the private company has all the necessary assets)
1	1	1	000...111			There is no need to create the PPP (the city administration has all the necessary assets)
1	0	0	0	0	1	Private company buys or rents land
1	0	1	0	1	0	Selling or leasing a building or construction to the city
1	0	0	0	1	1	Private company repairs (if necessary) the building and transfers it to the city as payment for land
1	0	0	1	0	0	Land is pledged to a credit institution by the private company to borrow funds
0	1	0	0	0	1	Private company repairs the building owned by the city administration and gets profits from using it together with the city administration after the building has been put into operation

Preliminary procedure for selecting participants. One of the four procedures can be currently used for selecting the participants by means of electronic business platforms: request for quotations, request for proposal, auction or tender. Regardless of the selection procedure chosen, one company that implements one project will be the winner. All other companies who do not win will be excluded from participation in PPPs. This is the first drawback of this selection: it does not account for the fact that alliances of the «private company-state» or «two private companies-state» types can be created among the companies that do not win to implement other social infrastructure projects. The second major selection drawback is that none of these four procedures take into account important factors of a qualitative nature (experience of the company, its business reputation, etc.), the selection is based solely on the quantitative characteristics related to the company's assets [6]. Subsequently, a situation

can occur when the winning company is not able to implement the project, for example, because of past trials (as these factors are not taken into account in the current selection procedure) [5]. In other words, it is impossible to analyze the stability of the company and the potential sustainability of the partnership. To avoid such situations, we propose to introduce a preliminary procedure for selecting participants that includes the parameters reflecting the quality indicators in quantitative terms. The parameters can be divided into legal and professional groups. These groups form the criteria designed to prevent outsiders (i. e., the companies which will be definitely unable to complete the project) from participating. The parameters of the first group may include having violated the rules of using urban areas and other real estate (buildings and structures) during the previous investment projects, the company's proven involvement in criminal activities in the economic sector, etc. The parameters of the second group are the

number of successfully implemented projects in the construction sector, the implementation of construction projects outside the Russian Federation, the presence of deviations from the planned timing for the previously implemented projects [7].

After the companies which are definitely not going to complete the project have been excluded, there remain several companies that are potential participants of the public-private partnership. The assets of the city administration and private companies should be analyzed by how they complement each other in order to identify one or more of the PPP companies that passed the preliminary selection procedure. [11, 15].

The main selection procedure. The basic selection procedure focuses on the assets of private companies and the city administration. We offer to use the language of graph theory to simulate the process of forming public-private partnerships of companies that have passed the pre-selection procedure. Let us construct an undirected graph $G = \langle V, E \rangle$, where V is the set of vertices and E is the set of arcs. If n companies pass the pre-selection procedure than V will consist of $2n$ vertices. Each node is either a private company or a city administration. The maximum number of PPPs formed of n private companies is n , therefore n vertices will correspond to the city administration (as the city administration should participate in every PPP, so the appointment of one peak to the city administration is not enough). Let us use a classical technique of graph theory and apply edge coloring [1]: the red edge will mean that the participants characterized by the connected peaks enter the PPP, the black edge will mean that the participants do not form the PPP. Graph G will be a complete bipartite graph, so the set of nodes can be divided into two disjoint sets A and B , while the edges connect the vertices only if one of them belongs to the set A , and the other to set B , each vertex of the set A is associated with each vertex of the set B [8]. A is the set of vertices corresponding to the public sector of the economy, B is the set of vertices corresponding to the private sector of the economy. This is done for two reasons. Firstly, it is to exclude from consideration the «private company – private company» type of alliances since they are beyond the scope of our analysis

and «city administration – city administration» unions formally possible with a full graph that is not bipartite. As a result, there will be only the coalitions reflecting the essence of the PPP, i. e., «private company – city administration,» or «private company – city administration – private company». Secondly, it is to consider all possible combinations of the interactions between private companies and the city administration.

Each selected participant and the city administration has one or more assets, which belong to one of the groups: land; buildings and structures; cash. For taking these assets into account in the formation of a PPP, each vertex of the graph corresponds to an information structure presented in Tab. 2. For example, if the city administration owns 10,000 square meters of land, «10000» is written in the field «available assets» at the vertices of the set A . If a private company needs 4000 square meters for the construction project, then «4000» will be recorded in the «Requirements» of the corresponding vertex of the set B . It is important to note that all vertices of A have the same information structures, as they show the assets of one city administration.

Table 2

Example of the information structure

	Available assets	Requirements
Land	0	4000
Buildings and constructions	0	0
Cash	1000000	0

The main selection procedure is based on the breadth-first search algorithm of graph traversal. Checks specific for the creation of the PPP are added during the traversal. The bipartite graph is built by the beginning of the main procedure, and each of its vertices is provided with an information structure with six number fields.

Following the classical breadth-first search algorithm of graph traversal, the vertices of the graph are colored by white, gray or black for keeping track of the main procedure. Initially, all the vertices are white; when a vertex is opened (discovered) during the search process, it is colored gray or black [9]. Gray means that the company corresponding to the vertex was

regarded as a candidate for participating in the PPP but did not pass the selection because its asset set is insufficient. The company with a set of assets that allows it to implement the project on the basis of the PPP has a black vertex.

The main selection procedure works as follows:

1) The vertex of the set A is chosen.

2) The «Available assets» field of its information structure is considered.

3) The chains with the set of assets corresponding to the «Available assets» field are selected from the available options. For example, if the vertex of the set A is represented by the information structure in Table 2, the chains with the first three digits «001» will be selected (the city administration has the money). At the same time the city administration does not have the land for the project (see «Requirements»), therefore, the last three digits in the chain will be «100», «101» or «110» (private companies entering into the PPP must own land lots). Consequently, after analyzing the information structure of the vertices, the chains of asset sets of the city administration and private companies which guarantee that the created PPP will be stable (i. e., the interests of the state and the business can be reconciled on the basis of the assets that each of them are lacking) can be selected.

4) We pass all the vertices connected to the vertex of the step 1, until we find the vertex of the set B corresponding to the desired set of assets (comparing the selected chains from step 3 to the information structures of vertices in B).

4a) If the vertex of the set B is not found, the main selection process ends.

4b) If the vertex of the set B is found, then the numerical values of the fields of the information structure are compared. If the assets are sufficient for the project, then the vertex of the set B and the vertex of the set A are colored black, the edge connecting them turns red, proceed to step 5. If the assets are not enough, then the vertex of the set B turns gray, proceed to step 4.

5) All the information fields of the vertices of A are edited: assets are adjusted (reduced by the amount used in the newly formed PPP).

6) Proceed to step 1.

After all of the «state – private company» couples have been considered, the possibility of creating the «private company – the state –

private company» alliances should be checked. In order to check the remaining gray vertices (companies not involved in any PPP), the original graph is rebuilt: the vertices of B are combined by two (the values of the information structure for the assets of the new vertices of B are calculated as the sum of the values of the fields of initial vertices), vertices of the set A do not change. The algorithm is repeated again for a new graph.

At the end of the algorithm the number of formed public-private partnerships will be equal to the number of vertices in the set A connected with at least one edge.

We claim that the described basic procedure offering the option of forming public-private partnerships is no less effective than the existing selection procedure; it is effective in the sense that the number of PPPs formed with the help of our proposed procedure will be at least not less than the number of PPPs formed with the help of the existing selection procedure. At the same time, the PPPs will be more stable due to the use of the pre-selection procedure analyzing the legal and professional aspects of the companies willing to participate in PPPs.

Proof. Let us consider two cases when the existing selection procedure did not reveal the winner (the assets of any company are not sufficient for implementing the project), and when one winner was selected.

In the first case, the result of the existing procedure will be 0 public-private partnerships. The proposed procedure tests the graph for the presence of the «state – private company» partnerships (and does not find any alliances as the assets of any company are not enough for implementing the project). However, then the original graph will be rebuilt and the search for the «private company – state – private company» alliances will be continued. Perhaps there will be companies among the new vertices that will be able to implement the project together with the city administration. In other words, the main result of the selection procedure will not be worse than the current.

If the current selection procedure identifies a winner, the main selection procedure will also reveal it (by analysis of the assets of private companies using the information structures). In addition, a few PPP can be found while searching



for the «state – private company» pairs. Additional partnerships may appear after searching for a PPP with three participants. Thus, the proposed selection procedure will be no less efficient than the present, and an additional pre-selection procedure allows to avoid the situations described in the second part of the study, so the partnerships formed will be more resistant.

Results and conclusions of the study. The analysis of the existing selection procedure for forming public-private partnerships has revealed some of its weaknesses. The study proposed to eliminate them by improving the selection procedure. The mechanism allowing to form a more stable partnership between the state and

the business with the help of two procedures of preliminary and basic selection is described. The first of them takes into account factors of legal and professional nature which are not taken into account in the current selection procedure. The second, based on the analysis of the assets of private companies and the city administration, selects alliances in which the participants can reconcile their interests by taking into account the missing assets and form a stable PPP.

We see a promising direction of future research in testing these procedures on specific examples of social infrastructure development projects, gathering the statistics about their stability, feasibility and the amount of formed partnerships.

REFERENCE

1. **Anderson D.** Diskretnaia matematika i kombinatorika. M.: Izd. dom «Vil'iams», 2004. 960 s. (rus)
2. **Babkin I.A., Zherebov E.D.** The mechanism of interaction between government and business on the basis of state-private partnership. *St. Petersburg State Polytechnical University Journal. Economics*, 2015, no. 4(223). pp. 99–107. DOI: 10.5862/JE.223.9 (rus)
3. **Varnavskii V.G., Klimentko A.V., Korolev V.A.** Gosudarstvenno-chastnoe partnerstvo, teoriia i praktika: ucheb. posobie. M.: Vyssh. shk. ekon., 2010. 228 s. (rus)
4. **Glukhov V.V., Safonov M.M.** Partnerstvo gosudarstva i biznesa. Modeli, organizatsii, otsenka. SPb.: Izd-vo Politekhn. un-ta, 2012. 161 c. (rus)
5. **Drozdov I.K.** K pravovoi prirode kontsessionnogo soglasheniia. *Khozjaistvo i pravo*. 2006. № 6. S. 49. (rus)
6. **Il'in I.V., Naidenyshcheva E.G.** Stages of the formation of public-private partnership for the social infrastructure development. *St. Petersburg State Polytechnical University Journal. Economics*, 2015, no. 4(223). pp. 91–98. DOI: 10.5862/JE.223.9. DOI: 10.5862/JE.223.8 (rus)
7. **Il'in I.V., Overchuk D.S., Naidenyshcheva E.G.** Teoretiko-igrovye modeli soglasovaniia interesov v proektakh razvitiia sotsial'noi infrastruktury. *Ekonomika i upravlenie*. 2014. № 2(100). S. 63–66. (rus)
8. **Kormen T., Leizeron Ch., Rivest R., Shtain K.** Algoritmy: postroenie i analiz. 2-e izd. M.: Izd. dom «Vil'iams», 2005. 1296 s. (rus)
9. **Romanovskii I.V.** Diskretnyi analiz. SPb.: Nevskii Dialekt; BKhV-Peterburg, 2003. 320 s. (rus)
10. **Austin J.** Strategic collaboration between nonprofits and businesses. *Nonprofit and Voluntary Sector Quarterly*, 2000, vol. 29(1), pp. 69–97.
11. **Brock H.** A Game Theoretical Account of Social Justice. *Theory and Decision*, 1979, vol. 11, pp. 239–265.
12. **Dawes R.M., Thaler R.** Cooperation. *Journal of Economic Perspectives*, 1988, vol. 2, pp. 187–197.
13. **De Clerck D., Demeulemeester E., Herroelen W.** Public private partnerships: look before you leap into marriage. *Review of Business and Economic Literature*, 2012, vol. 57, pp. 249–261.
14. **Delmon J.** Private Sector Investment in Infrastructure: Project Finance, PPP Projects and Risk. *The World Bank and Kluwer Law International*, 2009, vol. 2, pp. 7–11.
15. **Kay G., Paul J. W., Shilpa, P.** The formation of public-public partnerships. *The International Journal of Public Sector Management*, 2008, vol. 21(3), pp. 305–317.

СПИСОК ЛИТЕРАТУРЫ

1. **Андерсон Д.** Дискретная математика и комбинаторика. М.: Изд. дом «Вильямс», 2004. 960 с.
2. **Бабкин И.А., Жеребов Е.Д.** Механизм взаимодействия государства и бизнеса на основе государственно-частного партнерства // Научно-технические ведомости Санкт-Петербургского государственного политехнического университета. Экономические науки. 2015. № 4(223). С. 99–107. DOI: 10.5862/JE.223.9
3. **Варнавский В.Г., Клименко А.В., Королев В.А.** Государственно-частное партнерство, теория и практика: учеб. пособие. М.: Высш. шк. экон., 2010. 228 с.
4. **Глухов В.В., Сафонов М.М.** Партнерство государства и бизнеса. Модели, организации, оценка. СПб.: Изд-во Политехн. ун-та, 2012. 161 с.

5. **Дроздов И.К.** К правовой природе концессионного соглашения // *Хозяйство и право*. 2006. № 6. С. 49.
6. **Ильин И.В., Найденышева Е.Г.** Этапы формирования государственно-частного партнерства для развития социальной инфраструктуры // *Научно-технические ведомости Санкт-Петербургского государственного политехнического университета. Экономические науки*. 2015. № 4(223). С. 91–98. DOI: 10.5862/JE.223.8
7. **Ильин И.В., Оверчук Д.С., Найденышева Е.Г.** Теоретико-игровые модели согласования интересов в проектах развития социальной инфраструктуры // *Экономика и управление*. 2014. № 2(100). С. 63–66.
8. **Кормен Т., Лейзерсон Ч., Ривест Р., Штайн К.** Алгоритмы: построение и анализ. 2-е изд. М.: Изд. дом «Вильямс», 2005. 1296 с.
9. **Романовский И.В.** Дискретный анализ. СПб.: Невский Диалект; БХВ-Петербург, 2003. 320 с.
10. **Austin J.** Strategic collaboration between nonprofits and businesses // *Nonprofit and Voluntary Sector Quarterly*, 2000, vol. 29(1), pp. 69–97.
11. **Brock H.** A Game Theoretical Account of Social Justice // *Theory and Decision*, 1979, vol. 11, pp. 239–265.
12. **Dawes R.M., Thaler R.** Cooperation // *Journal of Economic Perspectives*, 1988, vol. 2, pp. 187–197.
13. **De Clerck D., Demeulemeester E., Herroelen W.** Public private partnerships: look before you leap into marriage // *Review of Business and Economic Literature*, 2012, vol. 57, pp. 249–261.
14. **Delmon J.** Private Sector Investment in Infrastructure: Project Finance, PPP Projects and Risk // *The World Bank and Kluwer Law International*, 2009, vol. 2, pp. 7–11.
15. **Kay G., Paul J. W., Shilpa, P.** The formation of public-public partnerships // *The International Journal of Public Sector Management*, 2008, vol. 21(3), pp. 305–317.

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