Enhancing public-private partnership efficiency by using life cycle contracts: a conceptual approach

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Abstract. Public-private partnership is a popular form of cooperation between the state and private operators. Thanks to this cooperation both parties can achieve their goals. The state attracts investments into capital-requiring projects while private companies get stable long-term cash flows and good rate of return in combination with law risks. However, being a form of cooperation of two parties, public-private partnership depends on the quality of organization of this cooperation.

This paper presents an overview of public-private partnership and highlights its advantages for the state, business and the end user. Further, it presents an analysis of the life cycle contract system and identifies the disadvantages of this form of interaction. The authors propose to modernize the system of life cycle contracts through the concept of total cost of ownership. The nature of this concept is explained, its advantages and shortcomings are discussed. The paper provides practical examples and research that substantiate the authors' opinion.

1. Introduction

Public-private partnership (PPP) is a very popular mechanism of business and government cooperation. This system of collaboration becomes more and more popular in Russia nowadays. The main idea of PPP consists in medium-term and long-term cooperation between public and private (commercial) organizations in order to carry out common investment. A more detailed definition can be interpreted as follows: public-private partnership is an institutional and organizational alliance between the state and the business in order to implement national and international, large-scale and local, but always socially significant projects in a wide range of activities. Normally PPP are implemented for projects where a big amount of investments is required. For example, public-private partnerships in Russia are used in the construction of sports facilities, large-scale transport systems, and airports [1, 2, 3, 4].

Economic interpretation of public-private partnership is in the redistribution of powers between the state and the business in strategic sectors that cannot be fully financed by government. These
industries include housing and utilities, social services, improvement of cityscapes, transport, cultural heritage sites, etc. [5, 6].

According to the approach related to public policy and management, public-private partnership is located on the border of relations between the state and business, being neither an institution of privatization nor an institution of nationalization, but only a form of optimizing the state's performance of its duties to society, i.e., uninterrupted provision of public goods to the population [6]. It reflects the current trend of resource-pooling on the basis of different mixtures of institutional mechanisms [7]. As other forms of resource-pooling [8], PPP reduces risks into specific assets.

The use of the public-private partnership mechanism is aimed at ensuring the ability to implement socially significant projects which are not attractive for traditional forms of private financing) in the shortest possible time. In addition, the mechanism of partnership between government and business can increase the effectiveness of projects through the participation of private business, which is usually more effective in the market than state institutions; to reduce the burden on the budget by attracting private funds and transferring part of the costs to the state users (to commercialize the provision of services), to enable the attraction of the best personnel and technologies, to improve the quality end-user services. Finally, this mechanism provides an opportunity to focus public authorities’ attention on their most characteristic administrative functions and reducing public risks by distributing them between the private partner and the government [1, 9, 10, 11].

However, PPP is an intricate mechanism that is not always easy to implement due to the divergence of government and business goals [2, 12, 13], see the table 1.

| Advantages of PPP (for all participants) | Disadvantages of PPP |
|----------------------------------------|----------------------|
| 1. The application of innovative approaches; | 1. Asymmetric information flows |
| 2. saving time during project implementation; | 2. Probability of dishonest business intentions |
| 3. reduction of expenditures from the state budget; | 3. Danger of transferring risks to the public sector |
| 4. engaging the most qualified specialists in each industry; | | |
| 5. modernization of the public sector; | | |
| 6. flexibility in engineering. | | |

For state:
1. Legal risks
2. Economic risks
3. Commercial risks
4. Risk of force majeure

For business:
1. Lack of democratic control and participation.
2. Lack of social justice
3. Excessive pressure on citizens.
4. Risk of oligopolization of supply industries

For citizens and society:
1. Asymmetric information flows
2. Probability of dishonest business intentions
3. Danger of transferring risks to the public sector
4. Legal risks
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6. Commercial risks
7. Risk of force majeure
8. Lack of democratic control and participation.
9. Lack of social justice
10. Excessive pressure on citizens.
11. Risk of oligopolization of supply industries

Public-private partnerships involve interaction on equal terms in order to obtain the desired benefits for each of the parties. In other words, the state and the business must work to maximize the overall benefit. However, using a PPP, it is quite difficult to come to an agreement between the parties, since the business seeks to increase profit from the use and recoup the investment sooner, while the state tries to minimize costs. This contradiction leads to the question posed by the authors in this article. Namely, what mechanisms will allow both sides to come to an agreement and achieve the best results
from working together? Life cycle contracts (LCC) may be considered as such mechanism [9, 14, 15, 16, 17]. The present paper gives an analysis of implementation of LCC for PPP.

2. Materials and methods
The paper is mostly conceptual and is based on the analysis of the present literature. However, we will analyze a case of implementation of LCC.

Speaking about the LCC, first of all, it should be noted that it is an alternative form of public procurement. Its peculiarity is that the state enters into one contract with one private company, which will fulfill the obligations to implement a full range of services - starting from the implementation and construction of the object, to its long-term operation and disposal [16, 17]. So our research will be organized as follows:
- First, we will consider in more detail the tasks of each of the parties and their financial goals;
- Next we will discuss the advantages of PPP for key stakeholders;
- After that we will propose our view of how LLC can be used to enhance PPP efficiency;
- Last, we will give a detailed analysis of a case of LCC use.

3. Results and Discussion
State’s tasks:
- Formulate requirements for the object of the agreement.
- Conduct a competitive selection among applicants and select one winner who will be engaged in the implementation of the project.
- Make payments according to the agreement.
Performer’s tasks:
- Project implementation at all stages.
- Provides project financing from its own or borrowed funds.
- Responsible for the quality of the project, compliance with the requirements specified in the contract.
- Transfers the object to the ownership of the state (the customer) and receives payments.

From the point of view of financial management, all the work is taken over by the private company. Business must pay for the project implementation and all operating costs at his own expense. However, it does not have the right to charge a fee for using its service. This is done by the state (if charging for the service is provided at all). Also, the state, in accordance with the contract, pays the business amounts of money for its activities. In fact, the state's LCC is the same as outsourcing for any company. In other words, the state transfers responsibilities for performing a certain list of jobs, and receives income from them (this income can be expressed in money or in the satisfaction of citizens with a certain service). And the outsourcer company also receives income (contractual payments from the state) [16, 17].

Next, we will consider the advantages and disadvantages of using LCC.
Advantages for state:
- Getting a better quality object.
- Reducing the risk of opportunistic behavior of the performer.
- Easier budget planning.
- Ability to choose a supplier based on the price-quality ratio which is important for the total efficiency of the project [18].
• Reducing management costs.

Improving the quality of the resulting infrastructure is achieved through the practice of shifting risks. According to this rule, the risk should be managed by the entity that has more opportunities (resources) for this. Obviously, the design firm has much more qualified employees in the field of design. Therefore, the state only develops the requirements for the project (unified and maximum throughput, for example), and the designers, in turn, perform the necessary actions to achieve these requirements.

Easier budget planning is explained by the fact that the allocation of a large enough amount of money for the implementation of the project greatly increases the budget burden and distributing the same amount over time provides load mitigation and facilitates the budget planning process itself.

The ability to choose a supplier based on the price-quality ratio is an advantage of all forms of public procurement, however, using a LCC only one supplier is selected for the entire stage of project implementation, which leads to savings on competitive selection [16].

Advantages for business:
• Revenue does not depend on demand;
• Term financing form state;
• Strengthening the company's market position; applying new management and technological solutions.

The independence of the firm's income from demand means that for the firm, insufficient demand does not affect cash flows, which are defined in advance and represent government payments. Also, by fulfilling a government contract, the supplier company saves money on marketing research, which is necessary to bring a new product to the market.

Speaking about the application of new management and technological solutions, it should be noted that the operation of the facility will not be aimed at obtaining maximum profit (as in the case of ordinary businesses), but at its most convenient use for the implementation of state goals. Of course, such decisions show the essence of management from different perspectives [19].

Advantages for consumers (final users):
• Access to quality public goods.
• Maximum availability of this good.

Both of these advantages are derived from the theory of the FGC itself, since the supplier is interested in providing a quality service to avoid penalties.

As shown in the work above, LCC has a number of advantages. However, like any mechanism, it has its drawbacks. Therefore, later in the work, the authors will identify the disadvantages of LCC and offer a conception that can optimize them.

Problems of CVC:
• Limited resources and capacities of the supplier.
• Risk of non-payment.
• Wrong definition of cost of the project.
• An ill-conceived system of financial interaction between the supplier and the state.
• A poorly calculated economic model with an incorrect definition of income flow.

Since projects implemented with the help of LCC are always complex and long-playing, it is quite difficult to find a suitable supplier. To ensure the implementation of such projects, the supplier must have a strong, multi-disciplinary and technical base. Moreover, in order for this transaction to be a
public procurement, there must be two or more supplier firms in order to organize a competition [16, 20].

However, if you still manage to make a competition and the right company is selected, the state and the supplier will face 4 problems listed above. The system of payments under the contract is imperfect nowadays. It means state pays the supplier via annuity payments. But annuity payments are essentially the same. This means that the amount remains unchanged throughout the whole contract. This leads us to the fact that it would be good to make a competent calculation of operating costs, that is, to present more correct economic model. However, it is quite difficult to present a correct model for complex and long-term projects.

In order to improve the economic model of life cycle contracts and more accurately determine the cost of a project, scholars suggest using the concept of total cost of ownership (TCO). So, TCO is one of the approaches to managing the life cycle of an object, which is based on the idea of reducing operating costs by increasing the initial funding to the object in order to purchase the most high-quality, energy-efficient or long-serving equipment. Today, the concept of TCO is used all over the world and in Russia in particular. The scientific papers describe the plan for the use of TCO in completely different industries. For example, TCO the concept applies to information and analytical systems, computer systems, economy class housing, conveyor belts [21, 22, 23, 24, 25]. TCO is used in various industries, as it is focused on a qualitative analysis of the economic model of a long-term project that is why it is very well superimposed on the LCC.

The goal of the concept is to manage the total cost of the object, improving the efficiency of investments, reducing the risk of unrecorded and unplanned costs that affect the return on investment and project payback. According to the APPA 1000-1 standard-Total Cost of Ownership for Facilities Asset the total cost is calculated using the following formula:

$$\text{TCO} = \text{Ca} + \text{Co} + \text{Cm} + \text{Cu} + \text{Cr} + \text{Cd},$$

where

- $\text{Ca}$ – capital expenditures (design, QMS, installation of equipment).
- $\text{Co}$ – co-operating costs (maintenance of the facility and territory, overhead costs).
- $\text{Cm}$ – maintenance and repair costs (planned and preventive repairs and upgrades).
- $\text{Cu}$ – utility costs (electricity, gas, water, heat).
- $\text{Cr}$ – costs for modernization (equipment upgrade, overhaul).
- $\text{Cd}$ – liquidation costs (demolition, dismantling, disposal).

In the classic project management model, there are 5 parts: project initiation, project planning, project implementation, monitoring and control of project goals, and project completion. In the context of the LCC, the project initiator is the state, but it also formulates the requirements for the project, i.e. it fulfills part of the second stage. Then the supplier enters into force, which, in accordance with the requirements put forward by the customer, develops technical specifications and proceeds to the stage of project implementation. During its implementation it is necessary to carry out control in order to ensure maximum compliance with the state task. Project completion in this case is the contractual end date of the contract between the business and the state.

The fact is that projects implemented with LCC are expensive and require large initial investment. Businesses often decide to save money at the preparation and construction stages. They reach their goal, CAPEX decreases. However, reducing CAPEX in the long run is not a good solution. The purchase of cheaper and consequently less high-quality and less efficient equipment leads to earlier obsolescence of the object before the expiration of the contract. Accordingly, the supplier will need to take measures to maintain the infrastructure in working order, that is, to replace or upgrade equipment,
attract additional staff to ensure its smooth operation. These actions increase operating costs, which leads to an increase in the total cost of ownership [26, 27].

Usually, the initial cost is taken into account when estimating project implementation costs, which according to ISO 15686-5:2008 "Buildings and constructed assets" is only 20% of the total cost of the object. In other words, 4/5 of all investments are spent on repair, replacement and restoration of equipment. Concept of total cost of ownership helps to reduce this indicator.

Therefore, from the point of view of investing money, the life cycle of an object can be divided into two phases: the phase of capital expenditures and the phase of operating expenses (CAPEX and OPEX). These costs are borne by the contractor during the investment and return on investment phases, respectively. At the design stage, it is necessary to work out the feasibility study of the project, estimate the costs necessary at the stage of investment. These activities will help you to develop a correct technical task and organize the purchase of necessary materials. Also, at this stage, attention should be paid to the analysis of existing experience in the field in which the project is being implemented. During the construction phase, it is also necessary to control and monitor the risks that arise during the procurement and delivery of materials and equipment. After commissioning, the investment return phase begins. As a rule, at this stage of the life cycle, it is necessary to develop correctly a management package that will combine strategic management of personnel, strategic management of the property complex and optimization of the resulting operating costs. Then, after the expiration of a certain period, the facility will need to air major repairs, it is worth analyzing how long this object will have to be in operation and make decisions based on this.

So, let's formulate the advantages that each of the parties will receive from the application of TCO and LCC together

Benefits for the state:
1. The best quality of services for citizens.
2. Minimizing the risk of poor project execution.
3. The most accurate payment calculation system.
4. Involvement of the population in the use of public services.

Advantages for the supplier (business):
1. Reducing OPEX.
2. More accurate calculation of the economic model.
3. Reducing the risk of interruptions in the operation of the facility.
4. Ensuring proper asset management.
5. Formation of the company's image.
6. Ability to master new methods of managing the property complex.

Advantages for the end user:
1. High quality of the service received.
2. Interrupted provision of this service.

Here are some examples and research of LCC and TCO applications.

Consider the study by the National Institute of Standards and Technology (NIST). It shows the distribution of TCO on the example of a heating and ventilation system (table 2). As shown in the table, purchasing and installing hardware only accounts for 43% of the cost of ownership. Maintaining air conditioning and heating equipment in working order accounts for only 7% of the total cost of ownership. At the same time, providing the equipment with electricity is 50% of the total cost. Thus,
to reduce OPEX, it will be more appropriate to initially purchase more expensive, but energy-efficient equipment, which will lead to significant savings during operation and, accordingly, reduce the TCO.

Table 2. Distribution of TCO Heating and ventilation system costs.

| Energy costs                                      | 50% |
|--------------------------------------------------|-----|
| Purchase and installation of equipment          | 43% |
| Maintenance and repair                          | 5%  |
| Works on replacement of equipment               | 2%  |

Next, we will consider the application of the concept of total cost of ownership on the example of the business center "Gallery" in SKOLKOVO, Moscow. During the implementation of this project, it was decided to pass LEED certification for green construction. After that, two models were created: the first one shows the costs of passing LEED certification, and the second one shows the costs of the traditional approach to construction (table 3)

Table 3. The use of LEED certification.

| Budget item                      | The costs for LEED-certifications, $ | Costs for traditional approach, $ |
|----------------------------------|--------------------------------------|----------------------------------|
| Single-chamber double-glazed     | 1 215 330                            |                                  |
| Windows                          |                                      |                                  |
| Double-glazed Windows            | 1 579 929                            |                                  |
| Electric heating of glass        | 354 003                              |                                  |
| Sun reflecting coating           | 60 767                               |                                  |
| Radiators                        | 248 640                              |                                  |
| Water Underfloor heating         | 130 000                              |                                  |
| Ventilation at 60 thousand cubic | 1 083 333                            |                                  |
| meters                           |                                      |                                  |
| Displacement ventilation by 30   | 758 333                              |                                  |
| thousand cubic meters            |                                      |                                  |
| Total expenses                   | 2 529 029                            | 2 901 306                        |
| CAPEX savings                    | 372 277                              | -                                |
| OPEX savings (for one year)      | 253 483                              | -                                |

Based on the data in the table, these two approaches involve the purchase of different technical characteristics of equipment. So, with the traditional approach, it was proposed to buy standard single-chamber double-glazed Windows, but they also needed to buy a system of electric heating of glass, which costs extra money, and also increases the consumption of electricity. Also, the designers had a choice between installing traditional radiators for heating rooms or using a floor heating system. After modeling both options, it became obvious that due to the design features of this business center, the purchase and installation of a more complex floor heating system would cost less than the purchase of classic heating radiators.

The cost of the project of the business center "Gallery" is $135 million, while the area of the object is 78,000 m². Only the use of LEED certification would save 372 277. Moreover, the more energy-efficient mechanisms used in the first approach also allow you to save $253,483 annually based on the results of energy modeling. Thus, the purchase and operation of energy-efficient equipment is not only cheaper, but also helps to save OPEX (for the first 20 years, operating costs will be reduced by
$2,000,000). This example clearly shows why the concept of total cost of ownership is appropriate for infrastructure projects.

4. Summary
The key problem of long-term projects is the compromise between present and future costs. Cutting costs now (for example, by using low-quality materials and less skilled work force) may lead to higher expenses in the future. These future expenses can destroy all economies obtained in the initial stage of the project.

So in case of such long term projects incentives should be created to increase investments at the initial stage in order to reduce future operating costs.

The concept of total cost of ownership analyzed in the present paper helps to find this compromise and to create these incentives. This concept does not analyze investments and operating costs separately. Instead, it is based on the idea of the total cost of ownership, that is, on all costs related to the whole life cycle of a project. TCO analysis is not aimed at the separate reduction of investments or operating costs. It helps to reduce the total cost of ownership.

We can recommend to implement the TCO concept for public-private partnerships. This concept will reduce the total state expenses and create incentives for development of high-quality infrastructure.

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