Improving the terms of the life cycle contract for the creation of complex technical objects in high-tech industries

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Abstract. The article discusses the features of life cycle contracts (LCC) for the creation of complex technical objects as a form of public-private partnership (PPP), which is the basis for the development of industries of a modern innovative economy. These contracts are used in the design, modernization, and operation of transport infrastructure facilities, roads and road facilities, airfields, public utilities infrastructure, capital construction, state information systems, and specialized services industries. To improve contractual relations, it is proposed to use the theory of contracts of 2016 Nobel laureates Oliver Hart and Bengdt Holmström, based on the improving information management processes and applying incentive schemes that are optimal for various cases, allowing to take into account the interests of all interested parties and achieve the greatest effect from the execution of the contract. The developed recommendations and proposals are presented to ensure the validity of the cost estimates of the contract stages, stimulate the introduction of innovative technologies, and increase the effectiveness of investments at various stages of the life cycle of the implementation of projects for the creation of complex technical objects. The prospects of using innovative solutions for the use of blockchain technologies are considered.

1. Introduction
In the current diversity of innovative, research, and industrial projects, the most important task is to ensure the necessary flexibility in project management in order to achieve a given level of quality, which is the result of the integration of activities in the field of metrology, standardization, testing, accreditation, and certification, compliance with implementation deadlines and resource limits.

The existing system of concluding contracts for the implementation of design work does not have sufficient flexibility and requires improvement in order to minimize problems of violation of deadlines and to obtain results in general and individual stages of work.

The relevance of the study is determined by the fact that the better the terms of the contract are formulated, the more motives and incentives for participants to get the maximum benefit from interaction.

The aim of the study is to form more perfect contractual relationship using the basic principles of contract theory.

The theory of contracts is a direction in the development of institutional economics. It has been developing since the 1970s. The founders of the theory are rightfully considered Oliver Hart and Bengdt Holmström, who had the Nobel Prize in 2016. The theoretical tools they developed allow a deeper understanding of the specifics of real contracts and their application in various fields of activity. This is
a relatively new theory; its provisions are often discussed in various scientific works, but are still not widely applied in practice.

The theory of contracts is based on the application of incentive schemes that are optimal for each case, encouraging each participant to behave efficiently within the framework of a contract. Therefore, it is proposed to use its basic models to improve the terms of the LCC.

LCC is a new form of PPP. PPP is an up-to-date state-of-the-art implementation scheme for projects involving the state, which is a combination of the resources of the customer state and a private company on the basis of an agreement to attract private investment for federal, regional, and municipal property. At the same time, the state saves financial resources during the construction or reconstruction of the necessary complex technical facilities, and the owners of private capital receive income from their subsequent operation.

The institute of PPP is applicable in almost all sectors: transport, social facilities, utilities, government buildings and other structures, and specialized services (communications networks or military equipment). The development of sectors of the modern innovative economy today relies precisely on effective PPP.

According to the article 34, part 16 of the Federal Law № 44-FL LCC provides for the purchase of goods or work (including, if necessary, the design and construction of the object to be created as a result of the work), subsequent maintenance, repair and, if necessary, operation and (or) disposal of the goods delivered or created as a result of the work of the object.

This kind of agreement implies the obligation of the contractor (private company) to design, build, maintain, operate, and in some cases, dispose of a certain object during the entire period of its operation, and the customer has to pay for the results of the work. There are forms that provide for the design, construction, financing, operation and management of the created object, or the subsequent provision of services for the maintenance of the object.

The cases in which a LCC is concluded are determined by the Government Resolution of the Russian Federation № 1087 of November 28, 2013 "On determining the cases of concluding a LCC". These include the execution of works on the design and construction of roads and road structures, airfields, transport infrastructure, public infrastructure, design, construction and reconstruction of capital construction projects in various fields.

There is a draft resolution providing for the possibility of concluding LCC in the field of creation, development (modernization), and operation of state information systems.

The LCC allows the state to effectively invest budgetary funds in the creation of infrastructure that meets the established functional parameters, without participating in its creation and even in further maintenance and disposal.

The relevance of the study is determined by the fact that the better formulated the terms of the contract, the more motives and incentives for participants to get the maximum benefit from the interaction.

The aim of the study is to form a better contractual relationship using the basic provisions of the theory of contracts.

The theory of contracts is the direction of development of institutional economics. It has been developing since the 70s of the last century. The founders of the theory are considered to be Oliver Hart and Bengt Holmström, who received the Nobel Prize in 2016. The theoretical tools developed by them allow to understand more deeply the specifics of real contracts and to apply them in various fields of activity. This is a relatively new theory, its provisions are often discussed in various scientific papers, but still little used in practice.

The theory of contracts is based on the use of optimal incentive schemes for each case, encouraging each participant to behave effectively within the framework of the concluded contract. Therefore, it is proposed to use its basic models to improve the conditions of the LCC.
2. Methodology

The basic methodological principles of this study are based on the provisions of the theory of contracts in relation to the formation of contractual terms of the LCC.

The modern theory of contracts is a fundamental theory of the new institutional economy, which developed in contrast to the neoclassical. As economic science developed, more meaningful and accurate models emerged. Thus, the theory of market equilibrium assumes that the main mechanism of interaction between all agents is the price mechanism, while this provision does not allow to adequately assess the economic relations of those for whom the information component plays an important role, such as for customers and contractors, owners and managers of companies [1].

At the basis of the neoclassical theory are the provisions on the choice that makes the consumer, seeking to maximize utility, and the manufacturer, focusing on maximizing their profits in a resource-limited environment. This does not always justify itself in practice, as well as such prerequisites of neoclassical theory as transparency, accessibility and symmetry of information.

Not fully considered the motives of economic actors with their behavioral opportunism, that is, the desire to distort information in the personal interest. The idea of personal enrichment is accepted by both theories, but neoclassicists do not consider that enrichment is possible due to the imperfection of the market mechanism. Adhering to the theory of complete symmetry of information, they believe that the market mechanism is ideal, with which neoinstitutionalists disagree.

Information asymmetry is considered one of the fundamental prerequisites of contract theory [2].

Oliver Hart and Bengt Holmström are not pioneers of the theory of contracts, but they proposed the use of mathematical models to expand this theory, conducting empirical studies of the activities of individual enterprises and industries and the formation of the optimal contract using the motivational mechanisms of the participants.

Bengt Holmström proposed to use in the theory of contracts "the principle of informativeness", suggesting that the principal (customer) should develop such incentive scheme that the remuneration of the agent (contractor) is determined not by the results of the further operation of the created object, and the actions of the contractor in the process of project work. With uninformative technology of formation of remuneration by the customer of the contractor, there will be a decrease in the motivation of the contractor to effectively achieve the goals.

Thus, we can say that the theory of contracts involves the use of such incentive mechanisms that consider the interests of both the contractor and the customer and improve the efficiency of contractual work.

The LCC review is based on a cascade project management methodology. For the organization of activities at the project stages, it is proposed to use models of contract theory that implement the following aspects of the management of LCC: project justification, organization, quality, risks, changes and progress.

As a result of the analysis of theoretical provisions, normative documentation and contractual practice, the following features and advantages of the LCC were identified:

- according to the terms of the LCC, the contractor receives payments not from the date of delivery of the object, but from the beginning of its operation;
- in cases where the object cannot function properly, provides for the freezing of current payments and the possibility of penalties by the customer;
- LCC involves the use of the following motivational opportunities for the contractor: acceleration of work performance for the purpose of faster receipt of payments; better construction of the object in order to save subsequent operating costs for repairs; introduction of innovative technologies for the construction of the object due to the possibility of regulating the requirements of construction norms and rules; formation of optimal conditions for users of the contract for the scheduled maintenance of the object, which avoids penalties for obstacles to its operation for the performers [3];
LCC allows to reduce expenses of the state customer on creation of object that is a basis of optimum PPP in the conditions of deficiency of budgetary investments.

In various industries LCC is already used, involving the partnership of state customers and industrial enterprises in the development and operation of complex technical facilities.

At the same time, the most important feature of industrial facilities, which are technically complex products, is the implementation and maintenance of individual stages of the life cycle of various enterprises that are co-executors. Interaction of participants of performance of works is carried out according to the state contracts defining terms, volumes of delivery, and also an order of payment.

The study and generalization of practice of work has led to the conclusion that the most important criteria of decision-making about the implementation and funding in the different stages of the life cycle from the state and private business are an adequate distribution of work among different subcontractors, the reasonableness of the costs in the framework of implementation of agreements, monitoring of receiving guaranteed results and insurance of risks of non-achievement of results [4].

The variety of life cycle processes and the need to effectively solve the problems of cost savings while improving the quality of the results of design work require active informational interaction between the principal and the project executing agent and the use of modern information technologies based on the concept of a single information space. This concept of continuous information support of the product life cycle is a combination of principles, management, and information technologies used in the implementation of the life cycle stages and processes occurring at these stages: Continuous CALS technologies, the implementation of which in Russia is still at the initial stage [5].

Now we are going to consider the models of the theory of contracts, which are the basis of the developed recommendations for improving the LCC for the creation of complex technical objects.

In the theory of contracts, the formulation of the problem of forming an optimal mutually beneficial contract with the discrepancy between the interests of the customer and the contractor and the presence of information asymmetry takes the form of a "principal-agent task", while the principal's goal is to achieve the specified results, and the cost of the work is assumed by the agent. The agent has information that is unknown to the principal (data on the "type" of the agent). The agent's activities in this case are not directly observable by the principal, and the agent's actions cannot be judged by the end result. This statement of the problem is solved using the model of asymmetric information.

The important point in this model is the identification of the necessary information about the "type" of an agent and the formation of such a contract, which creates incentives for the agent to improve the efficiency of execution of works despite the fact that the level of effort of the agent is not observable. In the theory of contracts there is a block of models of such formation, called the theory of "agency relations".

The development of asymmetric information model is the model of informative signals. In this case, the agent (contractor) before the conclusion of the contract can inform the principal of some information about his "type", that is, to give a "signal" and make their actions observable. But in order for this signal to be as informative as possible and allow for a more effective contract for the principal, it is necessary to offer the agent some conditions that have a stimulating effect that can increase the effectiveness of the work for himself.

Another model is the model of opportunistic behavior. It differs in that at the conclusion of the contract there is no asymmetry of information, it appears later. There may be a conflict of interest in the active or passive form, the agent (contractor) ceases to be interested in the effective performance of its obligations, seeks to get rid of possible risk, begins to pursue its interests, sometimes even to the detriment of the principal (customer). At the same time, the level of efforts made by the contractor to achieve the project goals is not optimal for the customer. In such cases, the customer needs to develop and offer incentives to the contractor within the framework of the contract, encouraging them to make efforts at the required level.

Another area of contract theory is the model of incomplete contracts. It involves consideration of options for joint implementation of the project, and its effectiveness and potential revenues are not known in advance and will depend on a large number of factors. A serious problem of incomplete
contracts is not only the uncertainty of the exact conditions of performance of work, but also the inability to fix these conditions in the contract. The basic premise of the theory of incomplete contracts is that it is not possible to draw up a contract that considers all possible situations in the future, but it is possible to offer incentives to the parties to act more effectively.

This theory provides for the possibility of renegotiating contracts. Participants determine the conditions and situations under which they will have the right to make decisions to resolve conflict situations, and new contracts may be concluded [6].

The theory of incomplete contracts is also used in the theory of determining the optimal size of the firm. The main provisions can be applied to the implementation of the stages of the life cycle of complex technical objects.

A large number of problems arise due to the fact that the work at different stages of the life cycle are performed by different performers. There are difficulties of interaction and a separate sequential operation. The solution in this case can be a LCC concluded with one contractor. The contractual framework of interaction is determined by the provisions of the contract, which reflect the different forms of cooperation.

The classical scheme of the LCC includes the following stages:

- **Design.** It can include works on engineering surveys, survey and measurement works, development of design and working documentation, coordination of project documentation with the operating (interested) organizations.
- **Production.** Includes works on installation, construction, creation of the object.
- **Commissioning.** This can be start-up and adjustment work, general check of the facility operability, comparison of the work results with the planned indicators.
- **Technical assistance.** Can include the following types of works: maintenance of the plant, commissioning process of the facility, maintaining the facility, scheduled and unscheduled repairs.
- **Utilization.** It is decommissioning, demolition with the possible provision of possible use of the obtained materials.

When implementing this classical scheme, the customer (the state party to the contract) establishes requirements for the functional characteristics of the object, selects the contractor on a competitive basis, makes payments to the contractor (the private party to the contract) when the specified conditions are reached. The contractor shall finance the implementation phase of the contract, perform work under the contract and ensure that the results of the work specified functional characteristics of the object. From the moment of commissioning the object is transferred to the property of the customer, the contractor carries out further technical support, if it is provided by the concluded LCC. Changing the terms of the contract, its duration and terms of performance of obligations throughout its implementation is not allowed [7].

Incentives for performance of work by the contractor under the LCC are: penalties (for violation of deadlines) and fines (for improper performance of obligations under the contract). At each stage of the contract there is a possibility of collecting a penalty or a fine. And if the violation of the terms due to the fault of the contractor is quite clear, the fact of improper performance of obligations should be recorded by an external expert commission, which entails a halt in the execution of the contract. In this regard, customers rarely resort to the imposition of penalties, trying to settle relations with the contractor peacefully [8], of the theory of contracts to improve the conditions of the LCC and the relevance of the development of practical recommendations and proposals.

### 3. Results and discussion
There are developed recommendations on the use of contract theory to improve the LCC for the creation of complex technical objects:
• Possibility to renegotiate the contract. It is based on the provisions of the incomplete contract model and is necessary to recalculate the work performed under the contract due to changes in their volume and complexity. This will make it possible to specify the provisions of the contract at different stages, since the parties cannot foresee all the details before the start of the work.

• Quality expertise of work at each stage. This recommendation is based on the model of asymmetric information and implies the existence of conditions for the transition to the next stage of work only after receiving a positive examination of the results of the previous stage. This will be an incentive to improve the quality of work and will avoid additional costs for overfulfilling the work of subsequent stages due to the lack of quality of previous ones.

• Incentives for the use of better materials in the performance of work by the contractor. The present recommendation is based on the model of opportunistic behavior (financial incentives). The measures should be taken to encourage performers to use better materials. This will reduce the costs for the contractor and the cost of the future contract for the customer at the stage of technical support.

• Possibility of division the stages of work under the contract into additional sub-stages. The recommendation is based on the model of opportunistic behavior (strengthening of control over the fulfillment of obligations). This will ensure the uniform execution of work. In the case of the longest stages of work, the performer may have the impression that there is more than enough time to perform them and he will not hurry to start the stage (opportunistic behavior). In order to avoid such a problem, it is proposed to divide the stage into several sub-stages, each of which is closed by a separate act with subsequent payment.

• The formation of a bonus fund, from which you can deduct fines for poor performance of work. The recommendation is based on the model of opportunistic behavior using elements of the model of informative signals (financial and reputational incentives) and involves changing the terms of payment for the work performed as follows: the contract is on the base cost, part of which is the premium fund. All poorly executed works are recorded and a fine is calculated on them. After the successful completion of the last stage, the contractor is paid a bonus minus the fixed fines. At the same time, the customer does not need to stop the progress of work and hire external experts to fix violations on the part of the contractor.

Implementation of the proposed recommendations in the Russian Federation is impossible without amendments to the existing legislation in the field of LCC. Therefore, we will formulate proposals for amendments to the relevant regulations:

• article 94 "Peculiarities of contract performance" §7 chapter 3 of the law 44-FL:
  o “If the Contract provides for several stages of work, each subsequent stage cannot be started without a positive examination of the result of work in the previous stage”;
  o “The use of materials, the characteristics of which exceed the features of the those provided by the customer in the design and estimate documentation, may be the basis for the payment of the premium”;
  o “According to the Customer's decision, a separate stage of the Contract execution can be divided into several sub-stages. Each sub-stage is closed by the act of the performed works with the subsequent payment. At the end of the work on all sub-stages, the final act of work and the final payment are performed”;

• article 94 “Amendment and termination of the contract” §7 chapter 3 of the law 44-FL:
  o “In case of circumstances requiring changes in the material terms of the contract, the parties may come to an agreement on the termination of such contract (in case of payment of actually performed works) and the conclusion of a new contract subject to changes in the material conditions”;

• article 22 “The initial (maximum) price of the contract, the price of the contract concluded with a single supplier (subcontractor, contractor)” chapter 2 of the law 44-FL:
The customer has the right to form a bonus fund of the total cost of work for each stage. The amount of the fund cannot be more than 15% of the cost of work on the stage. The amount of the premium paid to the contractor is calculated as the value of the bonus fund minus the fixed fines during the execution of works on the stage”.

The Ministry of transport of the Russian Federation developed and published in April 2019 the Draft Resolution of the Government “About Rules of the conclusion of LCC and about modification of Resolutions of the Government of the Russian Federation for the purpose of improvement of providing mechanism of the state and municipal needs by the conclusion of LCC” [9].

The Project proposes new rules for the conclusion of the LCC, expands the list of cases of application and proposes measures to improve the mechanism of public procurement within the framework of the LCC. It is assumed that it is possible to conclude the LCC for the performance of certain types of work or a set of work stages within one contract.

If the Project is adopted, it will solve some issues in the field of road construction, but in other sectors the LCC will continue to be high-risk for investors. In addition, the Project does not solve the problems of effective stimulation of performers.

There are no recommendations proposed in the article and ways to solve the problems under consideration in the Project.

Further development of contract theory can go the way of using innovative solutions for the use of blockchain technologies.

Decision-making on the conditions for concluding a LCC is based on the formation and processing of databases on the work executives, conditions for the performance of work, prerequisites for possible situations in the future, stimulating provisions, and possibilities for achieving the goal.

Blockchain is a continuous sequential chain of blocks containing information built according to certain rules. Information on the sides is connected, arranged in a strict chronological sequence, independently stored, which complicates the introduction of changes to the information included in the blocks. All blocks are connected by a cryptographic signature. This increases the reliability and security of the necessary databases. Blockchain can be called an innovative tool for the transfer and storage of information.

Blockchain technology can be used to store project data, automate the process of verifying the fulfillment of contract conditions, and monitor the supply chain at the stages of the life cycle.

4. Conclusions
As a result of the study of the characteristics and practice of the application of LCC for the creation of complex technical objects we identified an objective need of improving treaty relations.

To this end, it is proposed to use the basic provisions and basic models of contract theory: the models of asymmetric information, of informative signals, of opportunistic behavior in its various interpretations and of incomplete contracts. Within the framework of each model, incentive schemes for contract participants are formed, which increase the efficiency of their interaction.

The results of the study and the recommendations developed can be used to solve the urgent task of improving contractual relations to ensure the validity of cost estimates of the stages of the contract, differentiating risks, stimulating adherence to deadlines, achieving the quality of work results, introducing innovative technologies, and increasing the effectiveness of investments in implementing projects to create complex technical objects in high technology industries.

In order to implement the proposed recommendations, in the Russian Federation there are proposals for amendments to the normative acts in the field of LCC.

The proposed practical recommendations can be used to improve the terms of the LCC for the creation of complex technical objects in the process of implementing high-tech projects.

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