Verbal analysis of engineering and construction contracts

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ABSTRACT

The paper aims to analyse the construction contracts provided by FIDIC (International Federation of Consulting Engineers) and to determine their effectiveness by verbal methods. Contractors of international construction projects are often faced with complicated situations working in the conditions of uncertainty in construction. One of the potential risk factors is associated with the requirements of contract conditions. A simple quantitative method for evaluating the requirements defined in specifications of the contract is presented. One of the major aspects is project or contract management. Project developers need various models of managing large and complex projects. The suggested method for evaluating contract effectiveness may be widely applied at one of the stages of project management. A case study of practical use of verbal methods is presented.

1. INTRODUCTION

In September of 2004, Lithuania joined the International Federation of Consulting Engineers (FIDIC). At present, a joint-stock company ‘Lithuanian Institute of Building Design’ represents Lithuania in this organization. The demand for engineering consultancy is constantly growing, however, this concept has not been clearly defined in Lithuania yet. The Association of Lithuanian Design Firms basing itself on FIDIC experiences will seek the recognition of engineering consultancy as business activity. The main problems to be considered are as follows:

- models of implementing investment projects in construction;
- contracts for design projects according to FIDIC;
- contracts for construction projects according to FIDIC;
- settlement of disputes according to FIDIC contract regulations;
- insurance of design and construction projects.

The problems associated with construction contracts are widely discussed in the scientific literature. In one of the papers [1] contracts describing the relationships with the providers of logistic services are analysed as insurance and dispute prevention means.

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Paper [2] considers the problem of contract interpretation by examining the Supreme Court of Virginia’s decision on the case of D.C. Mc Clain Inc. V. Arlington state. Mc Clain Inc. claims of wrongful termination and defective design, while Arlington County claims of breach of contract and implied warranties.

The paper [3] analyses the standards and conditions of contracts which are of special importance in making contracts in the construction industry in European countries. It focuses on the need for project managers to review their strategies against possible commercial developments over the expected project lifetime. The new-style ICE contract may provide flexibility, clarity, simplicity and an emphasis on good project management.

Contractors of international construction projects are often faced with the situation of uncertainty working in the field of construction [4]. The specifications of contracts and their requirements make a potential source of risk. The paper presents a simple quantitative method for evaluating technical specifications of a construction contract. This method is based on 11 attributes, including clarity, conciseness, completeness, internal and external consistency, practicality, fairness, effect on quality, cost, schedule, and safety. This procedure can also be used to assess the risk level associated with contract conditions.

The paper [5] discusses basic managed care contract terms that are frequently negotiated by the parties, such as key contract definitions, compensation, terms and termination as well as some standard clauses in contracts.

A recently published book on projects and contracts [6] is written by well-known project managers: professor Rodney Turner, Peter Bailey, Denise Baver, Peter March, Stephen Simister, Fotis Skountzos and Nigel Smith. The book deals with various aspects of projects, such as setting up and operating a project management strategy, the appointment and control of consultants and constructors responsible for technical aspects of the project, etc. It also emphasizes the need for developing and implementing the control systems, which may be the subject of a specific contract with a specialist consultant. Various forms of contract are discussed, including ‘traditional’ forms based on detailed drawings and bills of quantities, ‘design and build’, ‘turnkey’, ‘contract management’, ‘cost plus’, ‘concession’ and ‘public-private partnership.’

Now, contractual relationships are mainly based on confrontational situations [7] that reflect the level of trust (or mistrust) in the contract documents. This determines the relationships among contractors. This paper presents some of the results of a survey conducted across the Canadian and North American construction industry. It should be obvious that trust and constructing methods are related and this relationship is of vital importance to effective project management and contract administration. Trust relationship between the contracting parties provides some opportunities for developing a better risk allocation mechanism and contracting strategies, as well as for significant saving in the annual bill for construction.

The paper [8] discusses methods of determining contract price and risks. However, an algorithm for cost estimation is not provided there. An emphasis is placed on the standard requirements to cost estimation in getting the insurance policy from an insurance company.

An increasing number of state highway agencies are using Incentive/Disincentive (I/D) bidding for highway construction. This bidding concept is designed [9] to cut the total contract time by allowing the contractor to obtain incentives for early completion and pay disincentives for late completion of a project. In this case, contractors can determine a better strategy to develop bid estimate, including construction cost and time and model of determining an optimal low bid for both linear I/D and escalating I/D type projects. A quantifying model is offered for this purpose. A functional relationship between the construction cost and time duration is developed based on the projects of the Florida Department of Transportation.
During the construction crisis, traditional contracts are inflexible, restrictive and ineffective [10]. In this case, project participants tend to opt out contract procedures prone to changes which, in turn, leads to a loss of organizational and managerial control. To avoid this problem, the main principles underlying contemporary crisis in management thinking should be embraced by traditional construction contracts. As an intermediate step, some emergency procedures are suggested which could be easily incorporated into the existing traditional forms of contract, providing temporary flexibility during a crisis and affording an element of managerial control.

The authors [11] examine why renegotiation processes can lead to opposite results regarding the commitment value of third-party contracts in the presence of asymmetric information. They think that a contract loses all strategic value if renegotiation takes place during the production stage rather than before the production begins. This result casts serious doubt on the relevance of previous findings. The analysis made also explains the differences between many of the results in the negotiation literature.

The most important problem is project and contract management. These aspects are analysed by many authors who emphasize the need for the construction industry to increase its efficiency to be competitive in the market. In this respect, the repetitive processes deserve special consideration [12]. Process modelling, database analysis and the available software help to plan and perform complex design and construction work.

Strong isomorphic forces are at work in the emerging project management profession. At the same time, competent project management practice is evolving and expanding to include soft and hard skills. Contemporary scholars consider that these different skills are founded on inherently gendered logic systems [13]. Thus, logic systems in project management become increasingly important. This primarily applies to generally accepted project management practice. Therefore, the above approach may also be fruitful for the analysis of project management in construction.

Project management embraces the development of contract to be signed by employer and one or more contractors. Economic success of both parties largely depends on the contract developed, which also determines the behaviour of managers seeking to increase profit and protect themselves from losses [14]. Taking into account the significance of contract, top managers of both parties should be involved in contract development and negotiation. However, in the literature on the problem, contract is considered to be a technical aspect of project development, which should be a responsibility of project managers and lawyers. In the paper considered, eight key criteria of contract evaluation to be analysed by top managers in developing contracts for large projects are described. Thus, top managers developing contract conditions should pay special attention to these eight criteria.

The need for various management models is increasing among project managers. Some authors believe that in developing project management methods the investigation of both project success and critical success factors should be made.

A model of project excellence based on EFQM (European Foundation for Quality Management) developed model is linking success criteria and critical success factors [15]. In this paper, the creation of project excellence model and its application to project management are described. A survey of literature on the problem is also provided and five types of projects based on project excellence model are suggested. Some recommendations to practical application of the developed model are also given.

The goal of the present paper is to analyse the main principles underpinning FIDIC contracts in construction and to determine their effectiveness by applying verbal evaluation analysis.
2. MANAGEMENT OF CONSTRUCTION PROJECTS

In analyzing project management and contracting problems risk exposure should be assessed as a factor influencing the final solution.

Most state-financed construction contracts are drawn up by state agencies or engineering consultants, while the role of contractors in determining contract conditions and exceptions is insignificant. Contract drafters are aware of the possibility to allocate risks and responsibility on contractors and insurance companies through contract exceptions and many of them do so. This practice may lead to high contract price because contractors increase it by providing for unforeseen expenses associated with risks or uncertainty.

Construction contracts are made following the standard practice of FIDIC or other international organisations. Juridical or physical persons in this country may also contract for construction projects on the same basis. Contracts made according to the standards of FIDIC or other organizations should take into account the international laws and legislation agreements of Lithuania as well as the requirements of building regulations.

The source of building legislation is a document adopted by a competent institution regulating social relations in construction. All legal construction documents make an integral system, and, when applying them, one should keep in mind their interrelation [16].

The subjects of construction contracts taking part in tendering are defined by the law. They are:
1. purchasing organization (employer) or client;
2. supplier (contractor).

Two models of investment project implementation are commonly used in Lithuania. They include the organization of bidding and making a construction contract, when the following conditions are met:
1. the client has a contractor design and detail design;
2. the client has only a detail design of a building, while the contractor or specially employed designer should provide the contractor design.

The investor seeking to get profit from his investment should:
1. select the best model of project management and implementation;
2. professionally organize bidding for carrying out the construction work at a high professional level;
3. prepare a well-thought out and detail construction contract.

The system of construction project selection based on FIDIC models of construction investment projects and the role of the client and contractor in this process are illustrated in Table 1.

3. THE ANALYSIS OF CONSTRUCTION CONTRACTS

Based on the analysis of the available engineering contracts and practical experience, key criteria for economic evaluation of a business deal may be identified. These are the parameters to be clearly defined in contract. They should reflect the main conditions of the contract (e.g. technical specifications and warranties, cost, schedule of payment, etc.) and define general obligations and responsibilities of the parties involved (securities, damage claims and liability limits, etc.).

A brief description of each set of evaluation criteria is presented in Table 2. The key issues to be included in the contract are defined in this table. Then, every set of criteria will be described in detail. Risk assessment should include eight evaluation criteria for major projects exposed to higher risks. Highly risky projects should be considered more carefully. Risky projects may be classified (through risk identification and evaluation), depending on the
relevant criteria.

*Contract definitions:*
- specifications;
- project price (quality of cost estimates);
- work schedule;
- terms and conditions of payment;
- performance guarantees (for defects);
- warranties;
- liability limits;
- securities.

**Table 1 – FIDIC models of investment construction projects and the input of employer and contractor in their design.**

<table>
<thead>
<tr>
<th>№</th>
<th>Implementation model</th>
<th>Basis of tender</th>
<th>Employer’s input at the tender stage</th>
<th>Contractor’s input at the tender stage</th>
<th>The criteria of contract evaluation and award</th>
<th>Projects designed by contractor or specially employed designer</th>
<th>Contract provisions according to FIDIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Construction</td>
<td>Detail and contractor design</td>
<td>To prepare tender documentation including detail and contractor design as well as technical specifications and bills of quantities</td>
<td>To offer the construction price according to bills of quantities as well as detail and contractor design</td>
<td>The lowest bid</td>
<td>Technological construction project</td>
<td>Red Book published in 1999</td>
</tr>
<tr>
<td>2</td>
<td>Construction</td>
<td>Detail design</td>
<td>To prepare tender documentation including detail and contractor design as well as technical specifications and preliminary bills of quantities</td>
<td>To offer the construction price according to preliminary bills of quantities and technological project</td>
<td>The lowest bid</td>
<td>Detail design and technological construction project</td>
<td>Red Book published in 1999</td>
</tr>
<tr>
<td>3</td>
<td>Design and construction</td>
<td>Project concept and contractor’s technical specification</td>
<td>To prepare tender documentation including project concept as well as maintenance and other requirements (technical specifications)</td>
<td>To provide a draft (preliminary) project and the construction cost</td>
<td>The most economically and financially beneficial project</td>
<td>Detail and contractor design as well as technological construction project</td>
<td>Yellow Book published in 1999</td>
</tr>
<tr>
<td>4</td>
<td>Design, construction, management and taking over (‘turn-key’ project)</td>
<td>Draft project or project concept and contractor’s technical specification</td>
<td>To prepare tender documentation including draft project or project concept and major maintenance requirements (a brief technical specification)</td>
<td>To provide a draft (preliminary) project and to offer the cost of design, construction, management, maintenance and taking over</td>
<td>The most economically and financially beneficial project</td>
<td>Detail design, technological construction project</td>
<td>Silver Book published in 1999</td>
</tr>
<tr>
<td>5</td>
<td>Design, construction, management and taking over (‘turn-key’ project)</td>
<td>Draft requirements to project usage and the required capacities</td>
<td>To prepare tender documentation including major maintenance and usage requirements (a brief technical specification) with desired capacities and unit cost</td>
<td>To offer a project concept and product unit cost</td>
<td>The lowest product unit cost</td>
<td>Detail design, technological construction project</td>
<td>Silver Book published in 1999</td>
</tr>
</tbody>
</table>
Table 2 – Major contract provisions and their effect on contract management.

<table>
<thead>
<tr>
<th>Key criteria</th>
<th>The effect of contract form on management</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Positive</td>
<td>Negative</td>
</tr>
<tr>
<td>Specifications</td>
<td>Concentrated on key criteria</td>
<td>Too detailed</td>
</tr>
<tr>
<td>Price</td>
<td>Reasonable</td>
<td>Not beneficial for contractor</td>
</tr>
<tr>
<td>Terms of payment</td>
<td>Favourable for contractor</td>
<td>Unfavourable for contractor</td>
</tr>
<tr>
<td>Schedule</td>
<td>Rational delay time</td>
<td>High coverage of losses</td>
</tr>
<tr>
<td>Performance guarantees</td>
<td>Concentrated on key criteria</td>
<td>Too detailed</td>
</tr>
<tr>
<td>Warranties</td>
<td>Rather limited</td>
<td>All including</td>
</tr>
<tr>
<td>Liability</td>
<td>Not high with respect to contract price</td>
<td>High with respect to contract price</td>
</tr>
<tr>
<td>Securities</td>
<td>Not broad with respect to contract price</td>
<td>Broad with respect to contract price</td>
</tr>
</tbody>
</table>

The present investigation is based on Jarillo’s concepts of ‘classic market’ and ‘strategic network’ of partners. The latter, however, requires the continuous collaboration and relationships. Usually, projects do not meet these conditions because the collaboration is over when the project is completed and is not likely to be continued in the future.

Jarillo and Stinchcombe and Heimer further developed Williamson’s theory of transaction costs by considering varying requirements (i.e. of the clients or regulations), instability of expenses (i.e. cost factors or technical defects) and the control problems of contract execution. To solve these problems, the authors suggest that some ‘hierarchical’ elements, relating to a key management structure, dispute settlements and standard management procedures, incentives, etc. be included in contracts.

It can be shown that well-known procedures and methods improve the standards, dispute settlements and management of contracts. However, the evaluation criteria may differ, depending on a particular project.

The experience of the authors of the present research shows that a set of properly selected project evaluation criteria can help avoid strong negative effects of the most critical factors in 80 % of cases. If some actions or procedures do not satisfy the above-mentioned criteria, it may greatly affect project execution which, in this case, can hardly be successful. However, if some other requirements are not satisfied, the project is not likely to fail. Therefore, it may be recommended to managers to pay special attention to the described issues.

3.1. Description of the economic impact of the key levers on the contract business deal

General conditions include adequate and complete description of work when technical and commercial aspects are balanced. The client defines the work to be done under project which actually determines its long-term profit.

Price (cost estimates) embraces such issues as price stability and the assessment of expenses.

In fact, price should be in agreement with the standards required by technical specifications, including the stability of expenses. The client should avoid offering the lowest bid in all cases.

Terms of payment define a schedule of partial pay determining how ready cash obtained by the contractor covers the expenses in the course of project execution.

Schedule fixes the dates of feasible work completion (especially in the middle and the end of the process), which should not be altered. The influence of the expenses caused by delays on the levels of liquidated damages is also described.

Guarantees of project execution refer to satisfying the requirements to plant
performance according to specified technological parameters. The conditions of satisfying these technological requirements and those for the levels of liquidated damages in the case of deviation from the specified parameters are defined.

Warranties (warranty period) define payments for defect remedying or replacement of faulty equipment. Compensation for unsatisfactory services may also be provided.

Liability limit defines the highest limit of contractor’s liability. Is it clearly defined in the contract? Are incidental or accidental damages excluded? Liquidated damages levels and warranties protect the employer, while contract liability limit protects the contractor.

Insurance (deposits, securities, bonds, etc.) determines how the contractor guarantees project execution to the employer and how the employer ensures payment for the contractor’s work.

Six key levers (evaluation criteria) make a basis for performing these procedures. The contract defines the behaviour of the contracting parties because, first, the project does not provide for continuous relationships which could discipline people. Second, the turnover of employees is a common practice. Therefore, the contract defines the scope of work as well as standards of behaviour and trust in others as well as project execution. The validity, realism, completeness and coherence of a business venture are the main features evoking confidence and contributing to success of the project.

3.2. Evaluation criteria and contract form selection

Let us consider how three main types of contract including fixed price, cost reimbursable and mixed contracts may be evaluated by the suggested criteria. The results of this analysis are presented in Table 3. According to LSTK (Lump sum turn key), all objectives may be incorporated in a single contract with the highest risk and liabilities allocation and minimized number of interfaces.

All EPCM contracts are complicated, with the risk of subcontractor not defined. Due to irregular supply, some technological lines cannot be installed. Only highly experienced contractors can avoid these problems. Since the risks of subcontractor are not defined in EPCM contract, the value of some LSTK contracts is decreased by about 20 – 30 %. EPCM contract becomes very complicated when signed directly by. Besides, multiple interfaces may cause misunderstandings. Due to irregular supply, some technological lines cannot be installed. Only highly experienced contractors can avoid these problems.

LSTK contracts are not so complex because of a smaller number of interfaces. This allows for parallel consideration, negotiations and decision-making. The limits of the project under LSTK contract are clearly defined. When the project is very substantial, multilateral contracts are unavoidable.

Some additional hierarchical contract issues include:

- contract efficiency factors. These are regulatory and financial conditions ensuring project finance when the work is commenced by the contractor;
- taking over a building on completion of construction. The conditions of taking over the responsibility for the completed project by the employer and dismissal of the contractor;
- insurance. This concerns the external risks and liability of the 3rd party;
- the right of the 3rd party for intellectual property. It is a definition of risks associated with 3rd party patents and their violation;
- events of force majeure. Liabilities in the case of events beyond a party’s control, i.e. war, disasters, natural calamities, etc. are described;
- duration of work. Cost reimbursement after the completion of project suitable for the client;
- taxes. Allocation of tax and legislative risks;
• applicable law. Knowledge of legislative aspects of contract coming into force;
dispute resolution/arbitration. Dispute settlement by various mechanisms including
more drastic measures (after a certain period of time).

Table 3 – General conditions and objectives of various types of contracts in construction.

<table>
<thead>
<tr>
<th>Major types and forms of contract</th>
<th>General conditions</th>
<th>Price, cost estimates</th>
<th>Terms of payment</th>
<th>Performance guarantees</th>
<th>Warranties</th>
<th>Liability limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lump sum Fixed Price Contracts</td>
<td>The priority of contract documents should be established before making an agreement</td>
<td>Costs should be well estimated to avoid higher risks for supplier and conflicts</td>
<td>Contractor can raise the price if payment is delayed</td>
<td>A certain percentage of contract value is intended for ensuring competence, etc.</td>
<td>Warranties valid for 12-24 months after the installation</td>
<td>Liability is limited to certain percentage of the contract price</td>
</tr>
<tr>
<td>Incentive contracts (sharing within targets). These are mixed contracts presenting some features of fixed-price and cost reimbursable contracts</td>
<td>Costs should be well estimated because their increase decreases the incentive</td>
<td>Costs should be well estimated</td>
<td>Terms of payment should match the current demand for cash because of employer’s involvement in contract control</td>
<td>These should be lower than LSTK guarantees</td>
<td>The amount of incentive determines the warranties. No single party is usually responsible</td>
<td>Lower liability level than in LSTK because of lower contractor risks</td>
</tr>
<tr>
<td>Engineering, Procurement, Construction, Management EPCM – cost reimbursable contracts</td>
<td>Not properly defined projects may lead to extended specification in project execution causing the increase of costs and risks to calendar schedule</td>
<td>If costs are not well estimated, the risk will increase considerably</td>
<td>Terms of payment should match the actual demand for cash</td>
<td>Usually unavailable, except for those provided by designers according to contract conditions</td>
<td>Warranties are provided by suppliers of equipment and are valid for particular structures and services</td>
<td>Very low and limited to a certain sum</td>
</tr>
</tbody>
</table>

3.3. Economic effect of key evaluation criteria on complicated commercial venture

Let us demonstrate the economic effect of key evaluation criteria on business venture concerning flow of money in implementing the investment project under LSTK contract by a case study with ‘typical’ statistical data. The contract price of this project reaching 50 million dollars is fixed and all inclusive. The sum is paid in two installments until mechanical completion over 24 months. When the payment is over, 50 % of the steady state annual cash flow is earned during the first year. The discount rate is 10 %. Let us consider three cases with the total project life of 5, 20 and 30 years, respectively. In all cases, IRR (Internal Rate of Return) is 16.22 %, while NPV (Net Present Value) has 10 % discount rate.

For the contractor a 50-million project often means about 5 % of the contract value for contingencies and 5 % profit adding to $5 million. These figures show ‘the room for manoeuvre’ of the contractor within his/her liability limit needed to meet the employer’s requirements.

The effect of key levers on NPV and IRR changes only if cost overruns or schedule delays increase significantly beyond a 10 % variance.

Projects performed according to these scenarios are very sensitive to changes. This emphasizes the importance of performance guarantees. Now, risks are usually lower because modern technological operations ensure that premature termination is a rare case. Even in a short project lifetime of five years, the operational performance has a stronger economic impact than limited variations in project’s costs and schedule.

If key plant performance falls short by 10 % due to design errors, the cash flow impact on the client is in the area of 10 – 14 % of the contract value. Therefore, typically observed liquidated damages levels of 10 % of the contract value appear to be reasonable.
However, normal levels of liquidated damages are not sufficient in the case of large unexpected variation of plant performance. Within 15% of liability limit assumed in a simple model, the client experiences losses of €50 million, getting €7.5 million from the contractor’s liability. Hence, in the best scenario, the employer may get from €9 million (the potential profit in 5 years) to €26 million (in 30 years), while experiencing €42.5 million losses in the worst case. For contractor, the upper and the lower limits make €2.5 million. Thus, the client’s profit is 3.6-10.4 times that of the contractor, while his losses are 17 times those of the contractor in the worst scenario. To provide for such risks, the highest and the lowest limits of risk allocation should be balanced in the contract.

The second most important variable is price of the project. The 10% price reduction justifies moderate three-month delay (i.e. 12% of the schedule) in project performance. The problem arises who will be responsible and take risk in the case of contingencies. According to LSTK contracts, the contractor should take risks in such cases, while the client 'owns' contingencies in cost reimbursable projects. Skills and knowledge should help to make the proper decision on risk allocation.

The model of analysis has shown that schedule is a key factor for projects of short-term economic life. For projects of 20-year economic life, 10% contract price seems to be a reasonable precaution. Timely completion is important, since it ensures the cash flow needed to serve the debt in time, thereby allowing the contractor to offer a lower price [23].

Terms of payment are not so important for client but they are of great importance for contractor. The latter can increase profit by 10%, if the client offers him attractive payment terms. Such issues as liability limit and securities do not play an important role in the model considered. Therefore, they will not be discussed here. The problems associated with these issues will be considered in further studies. The model presented in the research shows that good performance of the contractor may be also beneficial for the client. The latter should be willing to pay the bonus, not only for early completion but for above-design plant performance as well. Unfortunately, such arrangements are rarely seen in the engineering and construction industries.

4. VERBAL ANALYSIS OF CONTRACT CONDITIONS

Strategic economic and political decision-making and research planning are referred to non-structured problems. Since the essential characteristics of such problems are qualitative, they can hardly be used in the analysis. On the other hand, the quantitative models are not sufficiently reliable.

Non-structured problems have the following common characteristics. They are unique decision-making problems, i.e. every time a decision-maker is faced with an unknown problem or the one having new features compared with the previously considered case. These problems are associated with the uncertainty of the alternatives to be evaluated, caused by the lack of information for making a decision. The evaluation of the alternatives is of qualitative nature, being usually expressed verbally (in statements).

Very often, experts cannot measure qualitative variables against an absolute scale where the level of quality does not depend on the alternatives. When the uncertainty is high, experts can only compare the alternatives qualitatively, based on particular criteria. Experts first use the extended verbal evaluation, making then the comparisons in terms of ‘better-worse’; ‘nearly equal’.

The following aspects of behaviour are evaluated by verbal methods of decision-making [24 – 26]:

- Qualitative measurements allow for an adequate description of an unstructured problem.
- Formulation of final decision making rules according to data processing principles of
humans and allow for explaining the methods psychologically.

- The procedures used to screen the conflicting data ensure the reliability of the information obtained, allowing a DM to formulate the final rules.

The suggested method is needed to arrange a number of alternatives according to the DM preferences. First, the preferences are stated based on qualitative parameters and then a logical scheme for comparing the alternatives is developed. The criteria are considered against the scales with the estimates expressed verbally by statements. A survey may be conducted to elicit the DM preferences and to eliminate the dependence of the criteria. Some special procedures are suggested to identify and eliminate the criteria dependence, which makes the use of the obtained information more effective.

The essential principles of verbal analysis used to assess the profitability of investment in construction project may be briefly described in the following way:

1. Problem description used by decision-maker and his environment should not be altered at any stage of analysis.
2. According to psychological research findings, methods of obtaining the information from people should comply with the human data processing system.
3. Logical operations on verbal variables (i.e. alternative evaluation based on various criteria) should be mathematically correct.
4. The information obtained from decision maker should not contain conflicting data.

Verbal analysis helps to reduce the gap between the demand for effective decision-making methods and the capacity of human data processing system.

First, the suggested method takes advantage of computer technology which is used to make pairwise comparison of the alternatives according to the specified rules aimed to identify their common and diverse features without the participation of decision makers. A survey made by decision maker is also computer-aided, allowing larger numbers of alternatives to be analysed.

Second, some quantitative criteria (i.e. values) may also be expressed verbally in evaluating the alternatives and stating their priorities. Thus, the suggested method allows us to operate with both qualitative and quantitative criteria to describe the alternatives. In this way, the described technique extends the possibilities of the available verbal analysis systems.

5. DETERMINING THE EFFECTIVENESS OF CONSTRUCTION CONTRACTS

To evaluate the effectiveness of construction contracts, a classification consisting of evaluation criteria and final decisions should be developed. For this purpose, the data from Table 3 (i.e. major goals of a business deal and their influence on the forms of contract) are applied to the model of the first FIDIC construction investment project, Table 1. A verbal decision support system [27] is taken from the Internet http://iva.isa.ru.

In determining the effectiveness of construction contracts, the following factors are taken into consideration:

- technical specifications;
- costs;
- terms of payment;
- performance guarantees;
- insurance costs;
- liability limit.
Every criterion is assigned an estimate, e.g. large, average, small, etc. Entering the estimates, a matrix (3*6) is constructed and the evaluation table (Figure 1) is obtained. When all the criteria are entered, the contracts of three various forms will be evaluated:

1. fixed price contract;
2. incentive contract;
3. cost reimbursable contract.

The comparison (Figure 2) is made in the following way: the program provides an estimate of each criterion and their combinations. An expert gives his/her preferences for each combination. The program allows for four evaluation variants to be considered. When the DM decides which estimate is more significant, the program chooses the estimates of two criteria and alternatives and makes their combinations (Figure 3).

To achieve more objective evaluation of construction contract effectiveness, the program provides the DM with two alternatives and three criteria for determining which criteria are more significant (Figure 4).

![Figure 1 – Evaluation table.](image1)

![Figure 2 – Making a query for comparative assessment of criteria.](image2)

![Figure 3 – Comparative evaluation of the estimates of two criteria.](image3)
Figure 4 – Comparative assessment of three criteria.

A comparison of construction contracts of three forms by a verbal method yielded the results (Figure 5) according to which the second form of contract (incentive contract) was found to be better than the first form (fixed price contract), while the alternative № 3 (reimbursable contract) was rated third.

Figure 5 – Results of comparative assessment of alternatives.

6. CONCLUSIONS

Ample literature on project management has been reviewed. However, scarce data on the key issues to be incorporated in the contracts of major engineering projects have been found. Six key criteria for contract evaluation have been developed based on the analysis of engineering projects performed by the largest international enterprises. They include technical specifications, price (precise cost estimates), terms of payment, performance guarantees, insurance costs and liability limits. The logic clarity and fairness of these factors help to determine project performance, providing the basis for a well-managed project.

The analysis has shown that LSTK (Lump sum turn key) concept gives the priority to responsibility and the reduced number of interfaces. Therefore, according to the suggested evaluation criteria, this type of contract is most suitable in the construction industry.
7. REFERENCES


Decision support system. [http://iva.isa.ru](http://iva.isa.ru) [a revised edition 2004 12 12].