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The Evaluation of the Contractor's Risk in Implementing the Investment Projects in Construction by Using the Verbal Analysis Methods

Galina Shevchenko [1], Leonas Ustinovichius [2] and Dariusz Walasek [3,*]

[1] Department of Finance Engineering, Faculty of Business Management, Vilnius Gediminas Technical University, Sauletekio ave.11, LT-10223 Vilnius, Lithuania; galina.sevcenko@vgtu.lt

[2] Department of Construction Management and Real Estate, Faculty of Civil Engineering, Vilnius Gediminas Technical University, Sauletekio ave.11, LT-10223 Vilnius, Lithuania; leonas.ustinovicius@vgtu.lt or leonas959@gmail.com

[3] Institute of Building Engineering, Faculty of Civil Engineering, Warsaw Technical University, Armii Ludowej 16, 00-637 Warsaw, Poland

* Correspondence: dariusz.walasek@pw.edu.pl; Tel.: +48-608-498-979

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Abstract: The growth of the company's investment potential is closely associated with the evaluation of the attendant risks of the process, various influencing factors, and the expected results. Therefore, the analysis of a number of qualitative and quantitative criteria of the projects and risks, as well as the potential profit-making opportunities in the investment decision making is required. This paper analyzes a decision-making strategy based on qualitative estimates obtained by investigating the risks posed, the management methods used, and the application of the proposed methods for assessing the contractor's risk in construction companies.

Keywords: building investment project; risk; assessment; verbal analysis

1. Introduction

Risk is a relevant part of the life of a business and society. Furthermore, it forms an integral part of a business, as risk is attached to every choice between various alternatives and final decisions. Almost every important economic decision involves some risk and uncertainty [1].

A great number of scientists and practitioners have been analyzing the company's investment objectives from various perspectives [2]. Profitable activities of the company (productive investments) are possible only if they are based on clearly defined investment decisions and the weighed and controlled risk, as well as targeted and supervised investment.

The problems of risk assessment and management have been discussed in the scientific literature [3–21] for a long time, but they are still acute. However, the attitudes towards these problems have been changing over time. It can be argued that the existing theories and the applied methods do not meet the changing requirements.

The need for assessing the importance of the construction investment decision-making and risk assessment under uncertainty particularly increased in the crisis and post-crisis periods in 2007, when the competition for funding a project at all stages of corporate investment project's implementation greatly increased. To gain competitive advantages, companies should continually invest in developing risk assessment methodologies, which could not only help to ensure the expected profit, but would also create capital gains for the investors. There is no doubt that effective risk assessment, as the most important risk management stage, should also become one of the most significant steps in the company's investment decision-making.

Decision–making problems in construction management often involve a complex decision-making process, where multiple requirements and conditions have to be taken into consideration simultaneously [22]. Thus, quantitative and qualitative evaluation is often required to deal with uncertainty, as well as subjective and imprecise data [23].

The construction industry is exposed to higher risks than other industries [24,25]. Construction projects are exposed to various risks. Contractors cope with this problem, while the owners pay for it. The problem of the contractor's selection is very important in developing the construction projects. This process involves the employment of people with different skills and interests. Construction projects are also influenced by a number of uncontrollable external factors.

Risks in developing construction projects have been identified [26–33] and analyzed in References [25,27–38].

The authors show that the process of risk assessment and management in construction projects has many deficiencies which decrease the effectiveness of the project management and its performance [13].

The paper considers the problem of risk assessment in making investment decisions (under risk and uncertainty conditions), whose solution would make a long-term positive effect on the company's capital investment policies in implementing the investment projects in construction and would ensure its development. The paper describes the performed empirical studies and the proposed solutions concerning risk assessment and risk management in making investment decisions (contractor selection) under the uncertainty conditions, using a verbal analysis method.

2. Verbal Analysis and Its Potentialities

Verbal analysis methods (VAM) are based on the principles presented in Figure 1. All the above-mentioned principles state that the methods of verbal analysis have mathematical and psychological backgrounds [30,39–42].

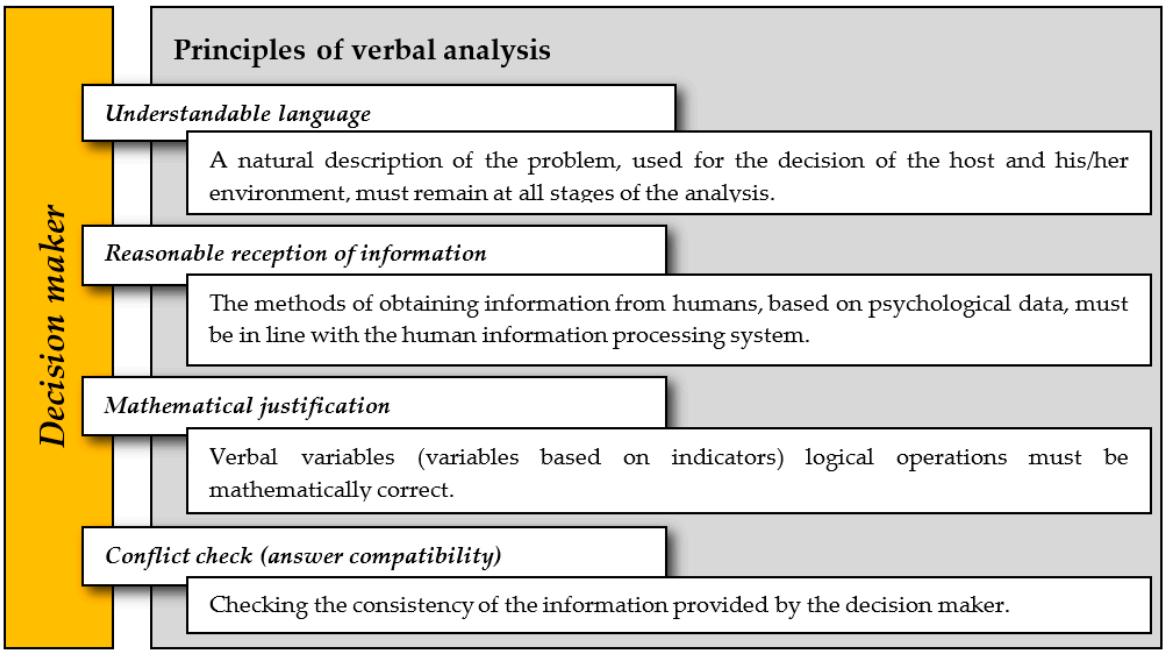

Figure 1. The major principles of verbal analysis methods [37–39,43–46].

These methods (Figure 1) give the possibility to reduce the gap between the demands for the available decision-making methods and human system's abilities to process the data [42–45].

There are three major decision-making problems as follows:

Ranking of alternatives: While solving particular problems, attention is paid to the ranking of alternatives. For example, the investors rank the possible investments, their benefits, etc., according to

expedience/profitability. In general, the ranking of alternatives (i.e., their classification/attribution to particular classes) demands the establishment of every alternative's value. There is a method called ZAPROS, which was created for the solution of this problem [46]. While using this method, there is one major rule, according to which there is a possibility to rank the alternatives described by many various criteria by evaluating the decision maker's (DM) needs. The rule's formation requires the selection of the set of criteria, describing the analyzed area, and their scales. The major rule allows for comparing two main alternatives described by the selected criteria.

The alternative's attribution to solution classes. These types of tasks are usually solved in everyday life. For example, people who want to buy a house or to evaluate the available alternatives, divide them into two groups as follows: The ones that interest them and the ones that do not interest them (those, which do not meet their major requirements and those that are not worth their attention and spending of money). The groups are differentiated according to quality. A subcontractor also chooses the best (desirable) clients. The company CEO sets the requirements to the staff, and according to their needs, they do not consider the candidates who do not meet the minimum requirements.

The classification of the alternatives can also be widely used for creating the database for assessing particular areas, for example, in the case of staff selection according to the criterion of adequacy, etc. (the qualification not less than . . . , having the particular certificates, etc.). It also includes the database of the potential contractors or subcontractors, evaluating their industrial productivity, defining quality criteria, etc., and attributing them to a particular class, such as "reliable", "unreliable" or "not very reliable".

Based on the VAM method, the alternatives can be classified by using various methods (Figure 2). The first method of this type is ORKLASS (Ordinal Classification), allowing for making a complete set of criteria for the alternatives' classification (all the possible alternatives, described by a set of criteria and by their scales' numbers). The other method, which allows for faster solution of the considered task, is CIKL (Catenary Interactive Classification).

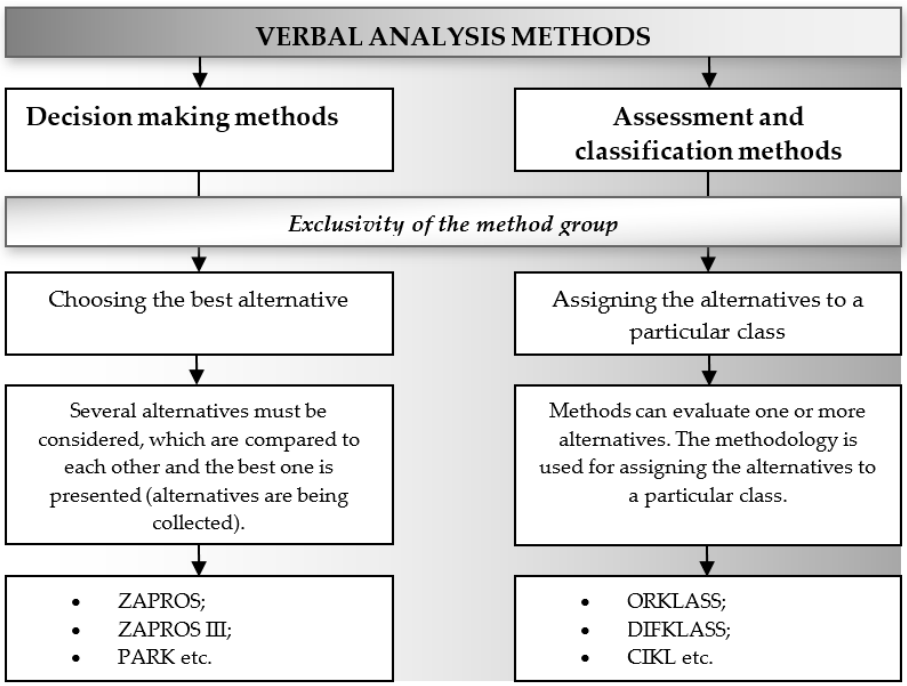

Figure 2. The classification of the verbal analysis methods.

The selection of the best alternative: This task is the main one because the final result depends on its successful solution. This is shown by practical experience. Thus, the right choice of the contractor, the investment project evaluation and selection determine the successful economic, technical, and

social development of the company. It should be noted that these tasks are usually solved when important political decisions, where the number of alternatives is not large and which are complicated for evaluation and comparison, are made. For example, it is necessary to determine the best alternative of the currency and land usage reform. It is worth mentioning that one of the conceptual problem's preferential features is the new alternative's generation in the solution-making process. These types of tasks can be solved by using PARK and SHNUR (SNOD) (normalized ranked differences scale) methods [47]. The SNOD method was created later than PARK and gives a possibility to evaluate a larger number of criteria and alternatives. In Figure 2, the considered methods are presented [23,44,46–56].

Another aspect of the expert classification methods is also worth mentioning. The created database can be not only of a consulting type, i.e., the results of these methods can be always interpreted subjectively and are not highly precise, even though they attribute the considered alternative to one or another class of solutions. In the author's opinion, the solution methods of verbal analysis have some advantages when they are used for solving problems with definite characteristics as follows:

1. There are no reliable ways of changing the evaluation of quantitative criteria. The estimate can be obtained only from experts;
2. There are no reliable statistics, based on which the best rule of the alternative's quality evaluation can be chosen objectively. The main rule can only be based on the subjective DM wishes and demands.

3. Verbal Multiple Criteria Evaluation Method CLARA (Classification of Real Alternatives)

The CLARA method (Classification of Real Alternatives) has been created to solve a classification task. By using this method, it is possible to perform the classification of the whole set of objects, as well as the objects of the known part of the set, thereby minimizing the number of experts' queries.

In this method, the priorities of the examined variants and their significance directly and proportionally depend on the system of criteria adequately describing the alternatives, as well as on their significances and values. The values of the criteria and their significances are determined by experts. These data can be adjusted by the interested parties (e.g., clients, consumers, etc.) according to their goals and potential. Therefore, the alternative's evaluation results reflect the initial data provided by the experts and the interested parties.

Several formal definitions are given below:

Definition 1. *The alternatives* $\boldsymbol{x}, \boldsymbol{y} \in Y$*, are referred to as comparable:* $\boldsymbol{x} \sim \boldsymbol{y}$ *if* $\boldsymbol{x} \geq \boldsymbol{y}$*, or* $\boldsymbol{y} \geq \boldsymbol{x}$*; in the opposite case, they are called incomparable:* $\boldsymbol{x} \nsim \boldsymbol{y}$.

Any other two alternatives, which belong to the same class, are either in a dominating relation, or are incomparable. Thus, in every class, it is possible to determine the subsets of dominating and not dominating alternatives.

Definition 2. *The subset* $B^U(C_n)$ *of class* C_n *alternatives is called the upper boundary of this class if* $\forall\, \boldsymbol{x} \in C_n\ \exists\, \boldsymbol{y} \in B^U(C_n)$ *is such that* $\boldsymbol{y} \geq \boldsymbol{x}$ *and* $\forall\, \boldsymbol{x}, \boldsymbol{y} \in B^U(C_n)$, $\boldsymbol{x} \neq \boldsymbol{y} \Rightarrow \boldsymbol{x} \nsim \boldsymbol{y}$.

Definition 3. *The subset* $B^L(C_n)$ *of class* C_n *alternatives is called the lower boundary of this class if* $\forall\, \boldsymbol{x} \in C_n\ \exists\, \boldsymbol{y} \in B^L(C_n)$ *is such that* $\boldsymbol{x} \geq \boldsymbol{y}$ *and* $\forall\, \boldsymbol{x}, \boldsymbol{y} \in B^L(C_n)$, $\boldsymbol{x} \neq \boldsymbol{y} \Rightarrow \boldsymbol{x} \nsim \boldsymbol{y}$.

The classification problem can be solved by presenting the alternatives' card (Y^*) to an expert so as to obtain their distribution into classes. Using the dominating relation (1) and consistency condition (2) provides the ability to considerably reduce the provided number of alternatives, as well as the time of the classification procedure. The possibility to minimize the given number of alternatives occurs because of the possibility to use the data about the already classified alternatives for the remaining alternatives' classification.

The numerical functions $C^U(\boldsymbol{x})$ and $C^L(\boldsymbol{x})$ are needed, which are specified for the set Y as the largest and the smallest class numbers and the allowable $\boldsymbol{x}$, i.e., a class, to which the given $\boldsymbol{x}$ would not violate the classification consistency condition (2). Let us assume the vector $\boldsymbol{x}$ to be referred to class C_k if the condition $C^U(\boldsymbol{x}) = C^L(\boldsymbol{x}) = k$ is satisfied. At the beginning, $\forall\ \boldsymbol{x} \in Y^*$ has to be $C^L(\boldsymbol{x}) = 1$, $C^U(\boldsymbol{x}) = M$.

There is an alternative set Y with the given dominating relation P, as well as M solution classes, arranged according to the criterion of quality. The largest and the smallest numbers of the allowable solution classes $C^U(\boldsymbol{x})$ and $C^L(\boldsymbol{x})$ are associated with every alternative $\boldsymbol{x} \in Y^*$. Before starting the classification, $\forall\ \boldsymbol{x} \in Y$: $C^L(\boldsymbol{x}) = 1$, $C^U(\boldsymbol{x}) = M$. The classification is considered to be performed when $\forall\ \boldsymbol{x} \in Y^*$: $C^L(\boldsymbol{x}) = C^U(\boldsymbol{x})$.

Definition 4. *The alternative $\boldsymbol{x} \in Y$ dominates the alternative $\boldsymbol{y} \in Y$, when $\boldsymbol{x} > \boldsymbol{y}$ and $\nexists\ \boldsymbol{z} \in Y$: $\boldsymbol{x} > \boldsymbol{z} > \boldsymbol{y}$.*

Definition 5. *The alternative $\boldsymbol{x} \in Y$ is dominated by the alternative $\boldsymbol{y} \in Y$, when $\boldsymbol{x} < \boldsymbol{y}$ and $\nexists\ \boldsymbol{z} \in Y$: $\boldsymbol{x} < \boldsymbol{z} < \boldsymbol{y}$.*

A set of alternatives dominating the alternative $\boldsymbol{x}$ is denoted by $Z^U(\boldsymbol{x})$, while the set which is dominated by the alternatives is marked as $Z^L(\boldsymbol{x})$.

Definition 6. *The dominating alternative orgraph G(Y,E) is called the oriented acyclic graph, where the vertex set is the alternatives' set Y, and the set of arches $E \subseteq Y \times Y$ consists of the elements $(\boldsymbol{x}, \boldsymbol{y})$, where the alternative $\boldsymbol{x} \in Y$ dominates the alternative $\boldsymbol{y} \in Y$.*

Definition 7. *The alternatives' sequence $\boldsymbol{w} = \langle \boldsymbol{y_1}, \boldsymbol{y_2}, \ldots\ \boldsymbol{y_l} \rangle$, where $\boldsymbol{y_{i+1}} \in Z^L(\boldsymbol{y_i})$, $1 \le i \le (l-1)$, is called a string. The number $L(\boldsymbol{w}) = l$ of the alternatives' string $\boldsymbol{w}$ is called the string's length. A particular alternative is a string of length* 1.

Classification algorithms: The algorithm CLARA (Classification of Real Alternatives) is based on the concept of the dichotomy of the alternatives' strings. It was first applied to the maximum length string, used in the DIFKLASS algorithm [48] and later in the KLANŠ algorithm [50], where it was adapted to the case of the rarefied areas Y. CLARA is also used as a new adaptive dichotomy idea, allowing for finding the boundaries of the solution classes faster and reducing the time of classification.

The major steps of the analysis of the classification algorithm CLARA:

- When the classification is started, the dichotomy ratio d_i of classes C_i and C_{i+1} in searching for the boundary is assumed to be equal to 1/2.
- The alternative's orgraph G(Y,E) can have a number of combination components, therefore, all the available but unclassified alternatives of the set Y^* are analyzed in the consecutive order. The consistency of the alternatives is important. Any selected alternative $\boldsymbol{x}_s$ is called primary.
- In the combination component of the orgraph G(Y,E) (to which $\boldsymbol{x}_s$ belongs) the maximum length alternative's string $\boldsymbol{w}_{\max}$, going through the primary alternative $\boldsymbol{x}_s$ and having the largest number of unclassified alternatives from Y^*, is established.
- Since classes $\{C_n\}$ are arranged according to their quality, the boundaries between the classes in the string are obtained by separating the upper-quality class C_n from the lower quality class C_{n+1}.
- For the expert's evaluation, the element $\boldsymbol{x}_d$, where $d = d_n \cdot L(\boldsymbol{w}_{\max})$, is taken from the string $\boldsymbol{w}_{\max}$, and, if the alternative $\boldsymbol{x}_d$ seems to be unsuitable or has already been classified, the new $\boldsymbol{x}_d$, the available unclassified string element with the closest index is selected.
- The expert is given the available alternative $\boldsymbol{x}_d$, of the string $\boldsymbol{w}_{\max}$, and its solution is valid for the maximum possible number of elements, whose belonging to classes C_n and C_{n+1} is not determined.
- If $\boldsymbol{w}_{\max}$ still has suitable unclassified elements, the division of the string $\boldsymbol{w}_{\max}$ is continued and ends when all the obtained suitable alternatives appear to be directly or indirectly classified with respect to classes C_n and C_{n+1}. In the opposite case, another boundary between the classes is sought (by returning to the 4th step). If the string has been classified with respect to all classes,

there is an index k in the string $\boldsymbol{w}_{\max}$ for every class where the change from the class C_n to the class C_{n+1} takes place. This index is $d_{nw} = \frac{k}{L(\boldsymbol{w}_{\max})}$. In every further step d_n there is the arithmetic mean of all the above-mentioned calculated d_{nw}.

- The cycle is continued until all possible alternatives of all possible sets Y^* are classified with respect to the pair of these two classes.
- A general schematic view of the CLARA algorithm is given in Figure 3.

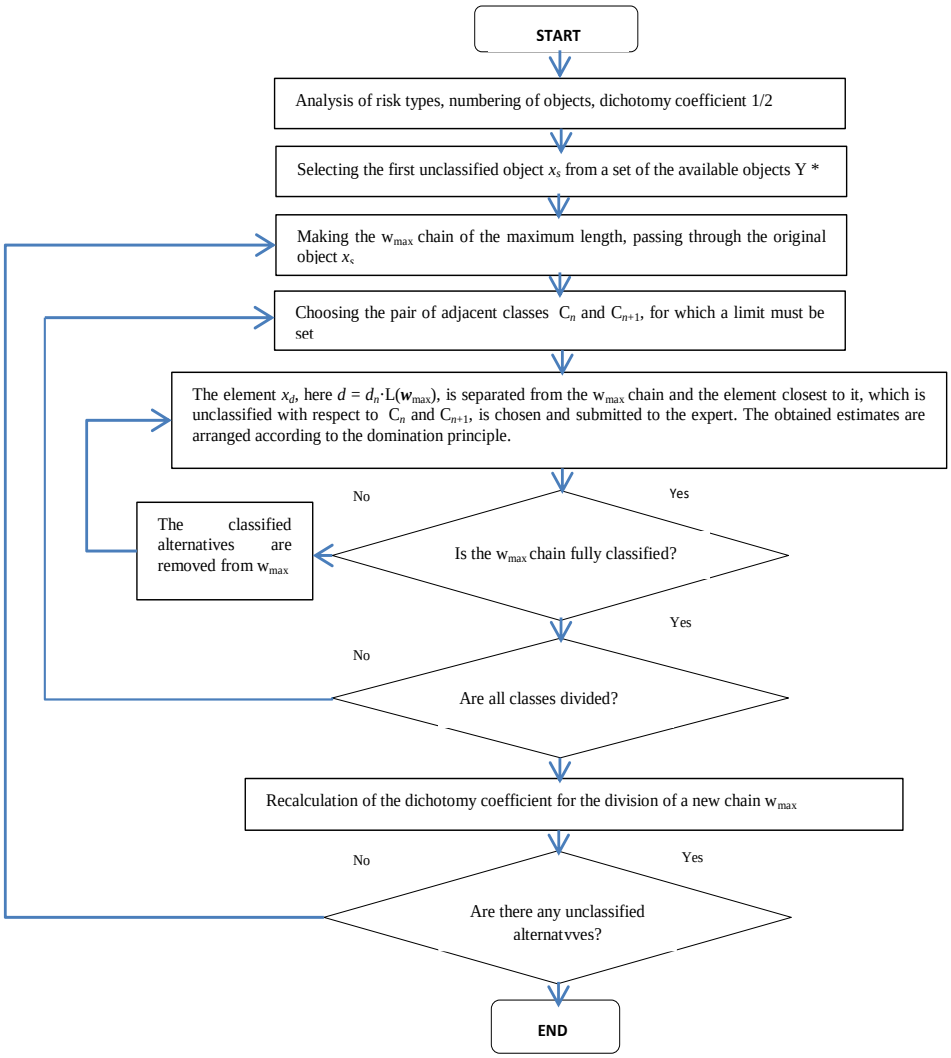

Figure 3. The algorithm of CLARA.

4. Verbal Risk Evaluation of the Companies Performing the Functions of Contractor

The objective is to evaluate the risk level of a building company performing the contractor's functions by using the multi-criteria evaluation method CLARA.

A description of the analyzed object. The considered company is based in Lithuania. The company started its work in 1992 and has the status of JSC. The areas of work: General building tasks; special building tasks; mechanical tasks, etc. To fully satisfy the client's needs, the company pays great attention to the control of the building process quality.

The company's quality principles, goals, and strategy are described. The goal of the JSC "X" quality policies is to justify the client's hopes and trust by performing the tasks on time. To achieve the goals, JSC "X" installed the international quality control software ISO 9001:2000/LST EN ISO 9001:2001. Now, more than 60 people work in this company. The annual turnover in 2007 was 25,000,000 m Eur.

According to the task, verbal risk evaluation of the company "X" performing the contractor's functions was made by using the CLARA method. Only one company was evaluated, and no comparison with any competing companies was made.

Based on the risk analysis of companies performing the contractor's functions (Table 1), as well as the experience of the authors, scientific literature analysis and the data obtained in interviewing managers, the risk types of the hierarchical level 1, which are given below, were determined (the criteria of level 1). The criteria of this risk group refer to hierarchical level 2.

Table 1. The contractor's risks.

No	Types of Risk		
	External (Systemic) Risks		
1.	Environmental (ecological) risk		
2.	Market risk		
3.	Strategical risk		
4.	Legal risk		
5.	Social risk		
6.	Technical-technological risk		
	Internal Risks		
1.	Financial	9.	Resource management
2.	Project	10.	Construction organization
3.	Evaluation	11.	Design
4.	Organizational	12.	Cultural
5.	Contractual	13.	Human resources and work safety
6.	Technological-innovative	14.	Leadership
7.	Investment	15.	Competitiveness
8.	Quality	16.	Operational

The risk types marked in red were determined as most important in analyzing the potential contractors' companies.

The managers of the building companies were interviewed in the regions of Vilnius, Panevezys, and Klaipeda. Based on the obtained data, the risks of the 1st and the 2nd hierarchical levels were combined. When the classification of various risks had been made, the classifier of the incurred risks and the factors causing them was obtained, and when the iterations had been performed, the final evaluation solutions were made (Figure 4). A detailed description of the described groups is given below:

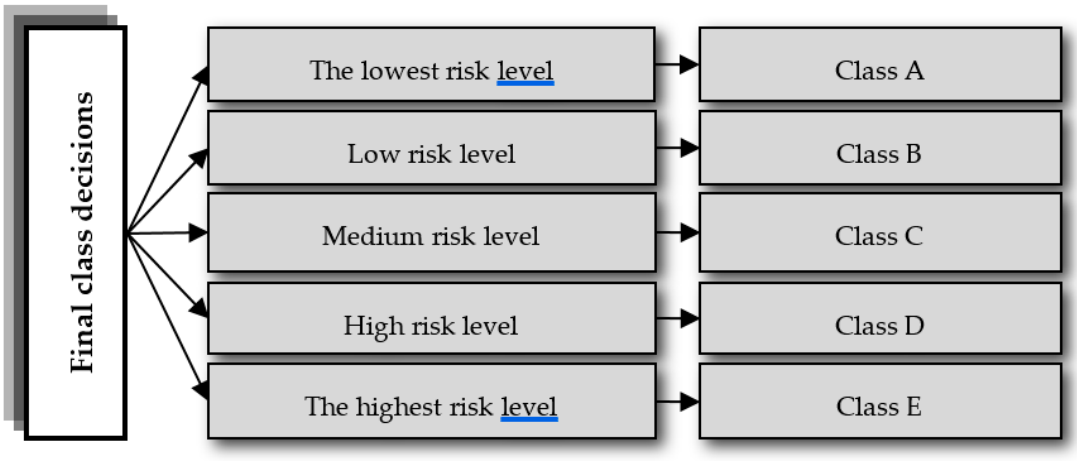

Figure 4. The risk levels.

The "Company's financial risk evaluation" group includes credit evaluation, turnover, liabilities to the bank, interest rate changes, liquidity, profitability, inflation and the evaluation of reserve.

The "Evaluation of the company's technical-technological risk" group includes the experience and qualification of the staff, management skills, innovative technology's adaptation, evaluation/analysis of past factors, optimization of technological processes, quality characteristics/level's standards, project managers' strict responsibility levels, and maintenance of the building and supply processes.

The "Project risk evaluation" group includes the consideration of the projects' types and sizes, designing process coordination, the number of simultaneously performed projects, experience in the field, design solutions, the possibility of failing to finish the project, and the unexpected changes in the project and design faults' analysis.

The "Company's organizational risk evaluation" group includes the company's image and competence, the qualified specialists' team, client's satisfaction, the analysis of failures, claims and lawsuit appearance, the supplier's analysis and the legitimacy of the choices, as well as a set of precise responsibility boundaries in the company, management skills, and the communication processes/policies.

The "Risk evaluation of resources' management" group consists of turnover funds' maintenance, the appropriate use of equipment, the maintenance of the qualified staff number, the maintenance of the appropriate amounts of materials, and the control of the time of the process performance.

The "Quality management risk evaluation" group includes the quality control system, quality management, and risk management policy (company and projects) quality, the environmental requirements' maintenance, and the evaluation of the guaranteed quality.

The "Safety risk evaluation" group includes work safety control, accidents' prevention, work safety requirements, and responsibility assumption.

The "Contractual and legal risk evaluation" group includes uncoordinated agreement conditions, agreement conditions' obscurity, agreement's noncompliance, inaccurate building documentation, uncoordinated laws, law amendments.

The "Company's building risk evaluation" group includes inaccurately planned time of construction, unforeseen problems in transport, problems of transport, supply problems, production quality, and management quality.

The "Ecological risk evaluation" group includes disasters, essential requirements of the environmental laws, the government's attitude to the project's change, etc.

The "Risk evaluation of policies" group—separate criteria.

Then, to determine the risks of the building sector's companies, performing the contractors' functions, a classifier (Figure 5), consisting of the risk evaluation criteria and final classification solutions, was created. Risk evaluation criteria of the contractor's company are given in the description of the hierarchical levels 1 and 2. While evaluating the building contractor's company, the attention was paid to the risk types presented in Figure 4. The first hierarchical level is the main one. Based on the criteria of this level, it is possible to evaluate the risk level of the building contractor's company. All the criteria of the first hierarchical level were evaluated as follows: Low, medium or high. When the evaluation was made, the results were obtained, i.e., risk levels were determined (Figure 4).

The criteria from the first level are not always sufficient (level 1, Figure 6) for determining the risk level of the building contractor. Therefore, all first hierarchical level criteria were divided into subcriteria of a lower level and thus the second hierarchical level was obtained (Figure 7). The criteria of the second hierarchical level were required for performing a thorough analysis of risks (when every type of risk is analyzed).

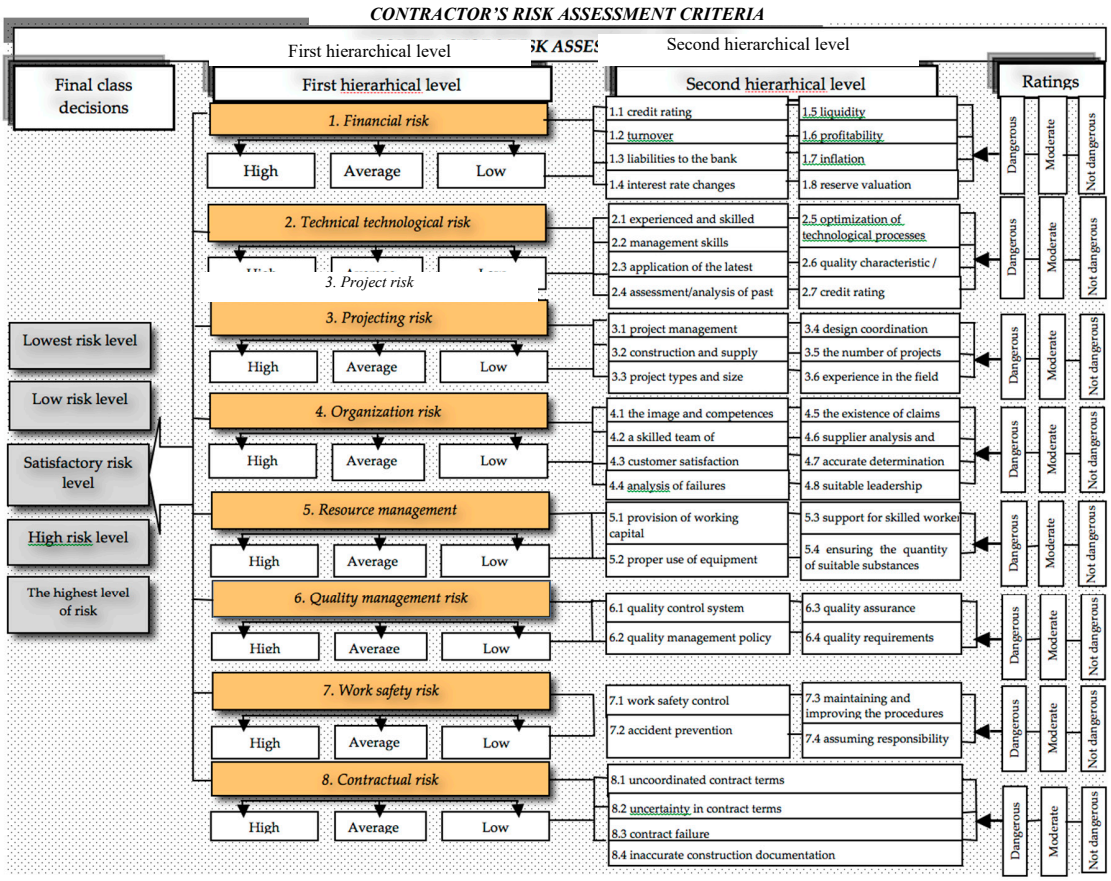

Figure 5. The investment risk evaluation classifier of the contractor.

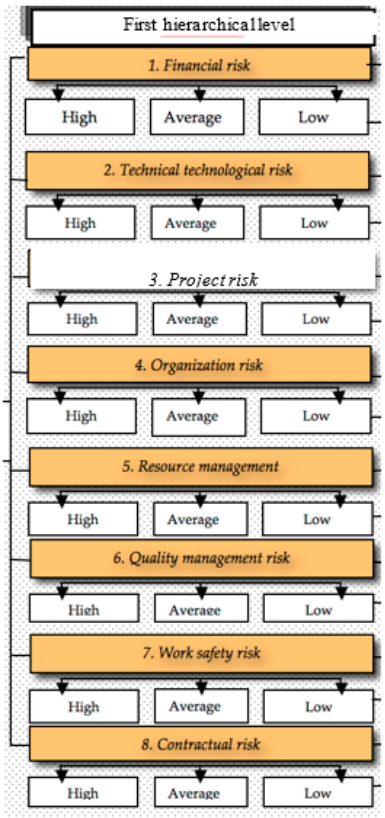

Figure 6. The first hierarchical level.

According to the created scheme (Figure 5), the sequence of risk evaluation procedures is as follows: The evaluation of the second hierarchical level criteria ⇒ the evaluation of the first hierarchical level criteria ⇒ the criteria of the second hierarchical level are given in Table 2.

Table 2. The criteria of the second hierarchical level.

No	*Criteria*	No	*Criteria*
1	credit rating	31	supplier analysis and feasibility of choice
2	turnover	32	liabilities of the company
3	liabilities to the bank	33	leadership skills
4	interest rate changes	34	communication processes/policies
5	liquidity	35	provision of working capital
6	profitability	36	use of equipment
7	inflation	37	support of skilled workers
8	the evaluated reserve	38	provision of the required materials
9	experienced and skilled workforce	39	monitoring and ensuring the timelines of ongoing processes
10	management skills	40	quality control system
11	application of the latest and most innovative technologies	41	quality management and risk management policies
12	assessment/analysis of past factors	42	quality and environmental requirements
13	optimization of technological processes	43	quality assurance evaluation
14	quality characteristics/level	44	work safety control
15	credit rating	45	accident prevention
16	project management and the responsibility levels of managers	46	maintaining and improving the procedures ensuring the required work safety level
17	construction and supply processes	47	assumed responsibility
18	project types and sizes	48	uncoordinated contract terms
19	design coordination	49	uncertainty in contract terms
20	the number of simultaneously performed projects	50	contract failure
21	experience in the field of activities	51	inaccurate building documentation
22	design solutions	52	uncoordinated laws
23	possibility of non-completion of design	53	law changes
24	unexpected project changes	54	inaccurately planned and exceeded construction time limit
25	design errors	55	unplanned site conditions
26	the image and competence of the company	56	transport problems
27	a skilled team of professionals	57	supply problems
28	customer satisfaction	58	quality of production
29	the analysis of failures	59	management quality
30	the existence of claims and cases	60	

Therefore, let us determine the risk level of the company "X", performing the contractor's functions. Using the classifier's scheme (Figure 5), the risk level can be determined, but many criteria should be compared. It is a complicated process, which takes much time to perform. Therefore, the use of the SPPS CLARA software, employing verbal classification method (of alternatives) is required.

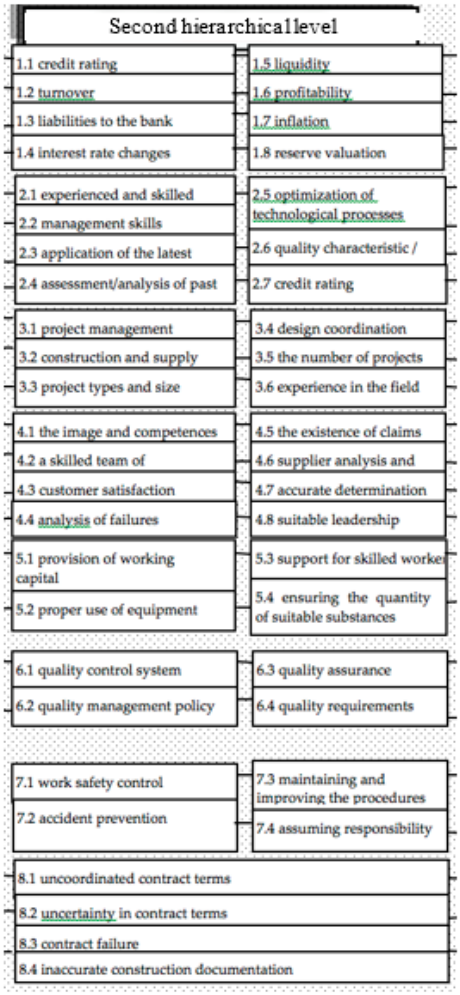

Figure 7. The second hierarchical level.

5. Entering the Data into the Software

Let us demonstrate the operation of SPPS CLARA software by analyzing the evaluation of the risk level of a particular contractor's company at various stages. The provided software screenshots present various stages of the contractor's company's risk level evaluation.

The task is to assess the risk level of the contractor's company at various stages (first hierarchical level: Financial risk; technical technological risk; project risk, etc.) and refer the company to those of the particular risk level (final class decisions: Class A—the lowest risk level; class B—low risk level etc.). For this purpose, a set of evaluation criteria was defined (second hierarchical level). A more detailed company's analysis is given in Section 4.

To perform the task, a classifier was made (Figure 5), including the considered risk levels (final class decisions (Figure 4)), the first hierarchical level (Figure 6), and the second hierarchical level (Figure 7).

According to the classifier (Figure 5), the data of the first and the second hierarchical levels were entered into the program (Figures 8 and 9). In a similar way, the data on the types of risks associated with the project, the company and other types of risks (of the first and the second hierarchical levels) were entered into the program. When all the criteria used in evaluating the contractor's company were entered, the last step, including the comparison, was made. The comparison of the criteria was performed as follows: The program had chosen one estimate of each criterion and made their combinations. An expert assigned the evaluated combination to a particular class. The created database allowed for easy and fast evaluation of the risk level of the considered object (in this case,

the contractor's company) by assigning the respective values of the criteria of the first and the second hierarchical levels.

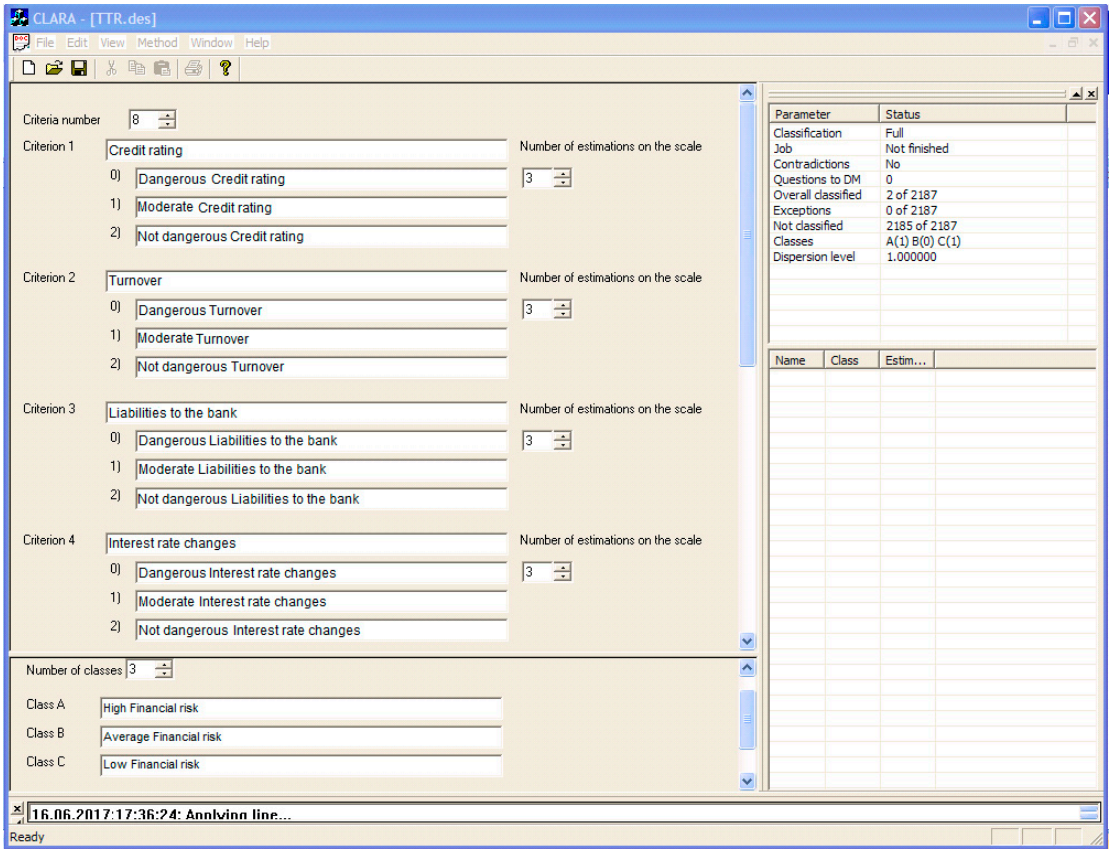

Figure 8. Financial risk evaluation criteria of the contractor's company.

The evaluation of the risk level of the contractor's company was performed with respect to the first hierarchical level (Figure 10), i.e., every risk type could be assessed as high, medium or low. Based on the obtained results, a company could be referred to a particular risk level (final class decision).

If the data allowing for evaluating the criteria (risk types) of the first hierarchical level were insufficient, the criteria of the second hierarchical level were evaluated (Figure 11). In this way, a thorough analysis and evaluation of the company's risk level (taking into account various criteria) were performed.

STAGE 1: Financial risk evaluation of the contractor's company (Figure 8). Eight evaluation criteria of the second hierarchical level were inserted (criterion 1, credit evaluation; criterion 2, turnover; criterion 3, obligations to the bank; criterion 4, interest rate changes; criterion 5, liquidity; criterion 6, profitability; criterion 7, inflation; criterion 8, reserve's evaluation).

Criterion evaluation classes: Class A, high; class B, average; class C, safe. Criteria 1–8 were chosen for the risk evaluation of the contractor's company.

While analyzing the company (alternative 1), the expert determined if the company's credits allow the company to meet the obligations to the bank. Moreover, it was also determined if the turnover complies with the forecasted indicators and if the company's financial indicators ensure the planned company's liquidity and profitability levels. After analyzing the company's financial risk, it was determined if there were any faults or contradictions in the classification.

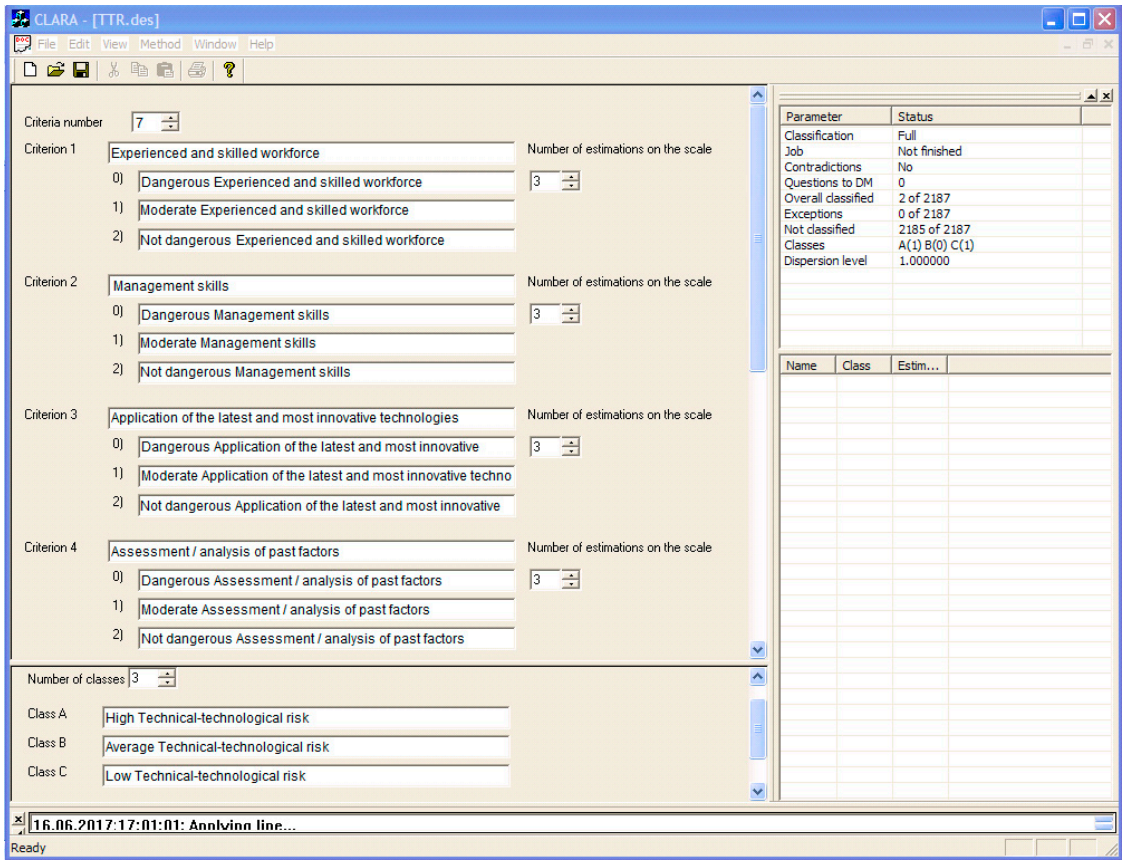

Figure 9. The criteria of technical–technological risk assessment of contractor.

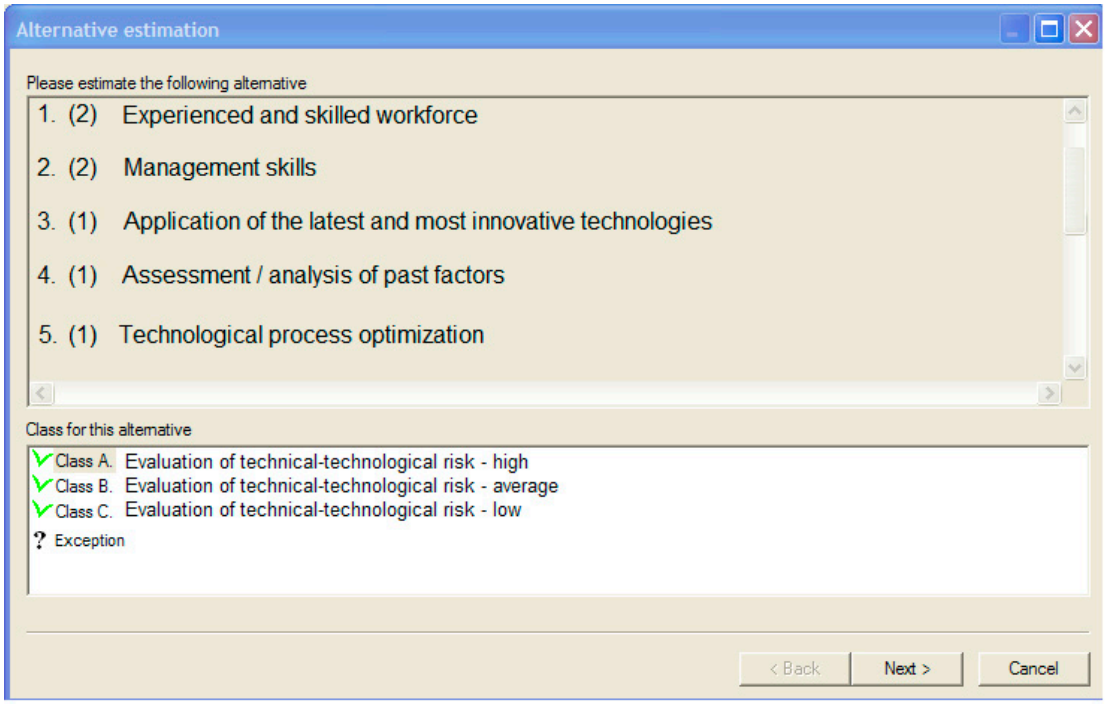

Figure 10. The assessment of alternatives.

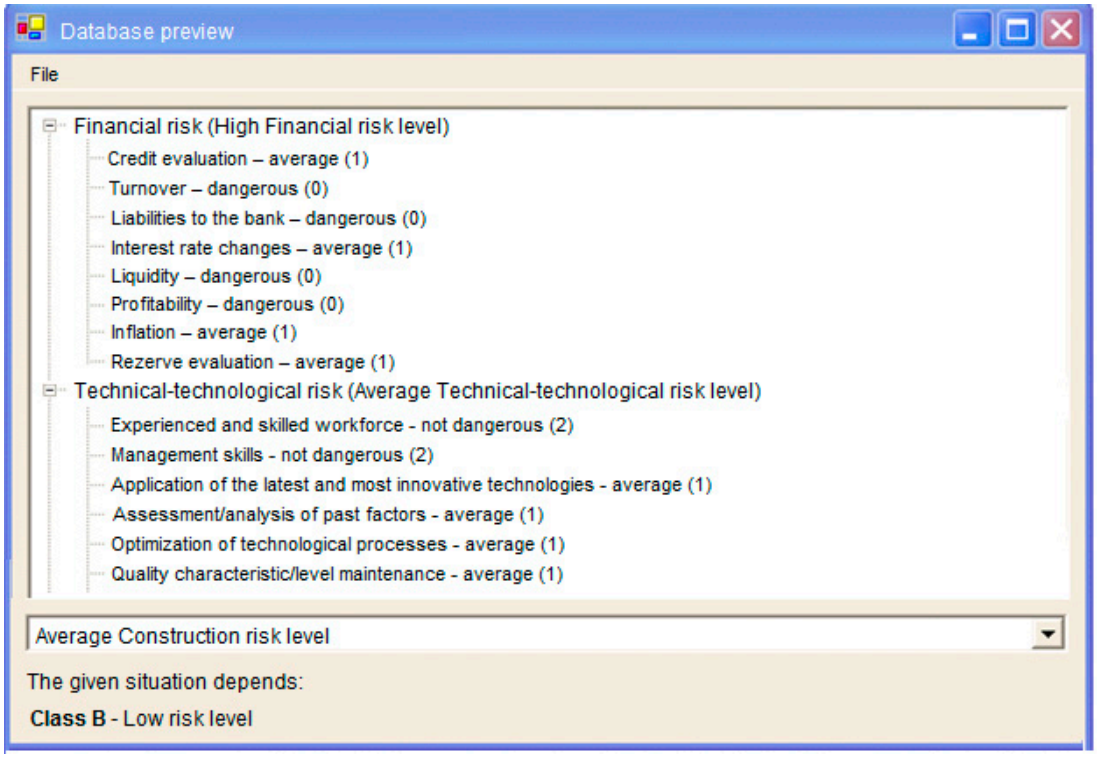

Figure 11. The database with the assessment criteria for the contractor's company.

STAGE 2: The company's technical–technological risk evaluation (Figure 9) includes the analysis of the criteria as follows: Criterion 1, experienced and skilled workforce; criterion 2, management skills; criterion 3, the use of innovative technologies; criterion 4, the assessment/analysis of past factors; criterion 5, technological process optimization; criterion 6, quality characteristics; criterion 7, the boundaries of project managers' responsibility; criterion 8, the processes of building and supply.

The data were inserted in the software in the same way as at the first stage. At this stage, the company's technical–technological potential criteria were evaluated.

All the remaining data were inserted into the software in the same way as at the first and the second stages. After inserting all the data from the hierarchical level 2, the data from hierarchical level 1 were inserted (criterion 1, financial risk; criterion 2, technical-technological risk; criterion 3, project risk; criterion 4, organizational risk; criterion 5, resources management risk; criterion 6, quality management risk; criterion 7, safety management risk; criterion 8, legal–contractual risk; criterion 9, building risk). After inserting the data from the verbal risk evaluation scheme into the software, the classification was started.

The classification process in the software: After inserting all the criteria used in the company's evaluation, the last step of comparing the criteria was made. The comparison (Figure 10) was performed as follows: The software had chosen one of each criterion's estimates and created their combinations. The expert attributed the particular combination of estimates to a particular class. For example, the expert attributed the following combination to class B (the average level): Quality control system—average; quality management and risk management policy—average; quality and environmental requirements—average; quality guarantee's estimate—average.

After performing the attribution, the next step was made (by pressing the button "NEXT"). Another combination of estimates was given. The process was continued until all the combinations were attributed to particular classes. In performing this task, the expert could make mistakes and change his/her judgment, which could result in contradictions in the estimates. In that case, the software could show a warning about the presence of contradictions and ask to confirm the new judgment or change it. By using the CLARA software, all the contradictions were removed.

When the operation was performed, the software saved all the data and performed the analysis, which had shown the number of DM questions, the process of making the combinations and the number of the removed combinations. It also had shown how many evaluated combinations were attributed to classes A, B, and C.

In the same way, the estimates of all the second hierarchical level criteria were determined. In the considered case, ten files were analyzed based on which the contractor's company risk level was determined.

The estimates were inserted into the database of CLARA software (Figure 11):

The financial risk evaluation of the company includes:

- credits' evaluation—(1),
- turnover—(0),
- liabilities to the bank—(0),
- interest rate variation—(1),
- liquidity—(0),
- profitability—(0),
- inflation—(1),
- reserves' evaluation—(1).

The obtained data, which were entered into the software, demonstrated that the company's financial risk was high—class A (risky).

In a similar way, the evaluation of the company's technical-technological risk, designing risk, organizational risk, resources' management risk, quality management risk, safety risk, contractual and legal risk, and the company's building risk was performed. The respective database is given below. It is connected to the criterion classification in the CLARA software. A person who wants to determine the risk level of the building investment project has to enter the estimates of the experts into the database.

Final solution analysis: The final analysis was performed based on the data obtained in the first hierarchical level evaluation (Figure 12). The performed final analysis allows for determining the company's risk level. Five criteria of the first hierarchical level were used. The classes of the evaluation criteria are given in Figure 11.

Result*:* According to this data, the company was attributed to class B—low risk level.

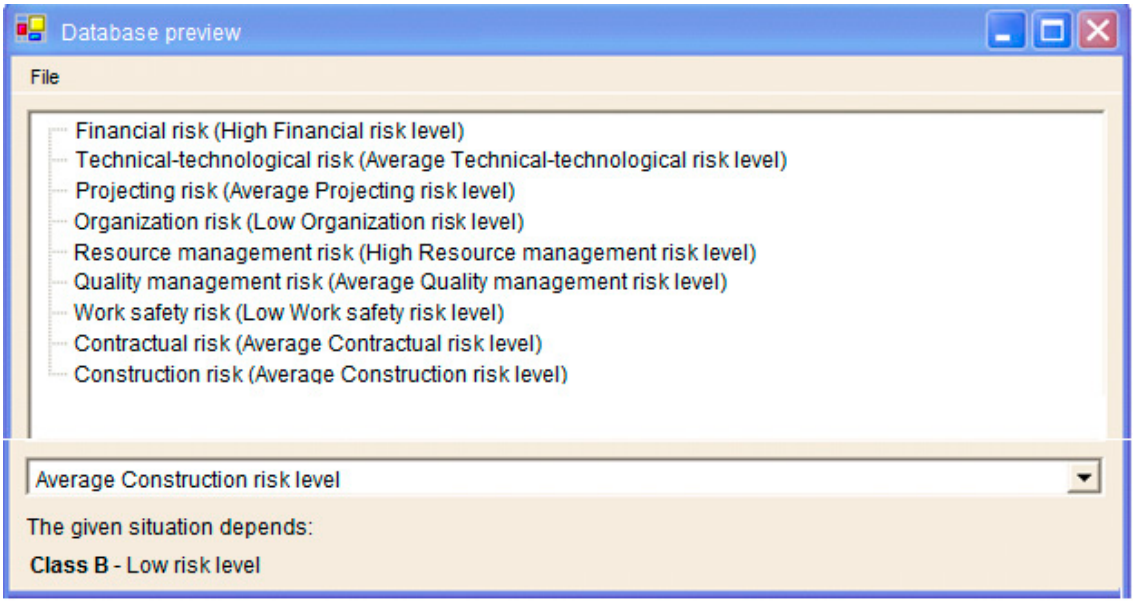

Figure 12. The database (the hierarchical level 1 for the contractor).

6. Conclusions

The analysis of the scientific literature has shown that a number of criteria, describing the activities or projects, should be considered in evaluating social, economic, political, cultural, and other types of risk. New methods allowing for a thorough analysis of the risks to which various activities or projects are exposed should be used and developed.

A great number of decision-making methods and techniques have been created in the world. Some methods were introduced as "universal" methods, allowing for achieving the best (optimal) solutions. However, their application to solving the problems in various areas has revealed some drawbacks of these methods as follows: They are not highly reliable, are difficult to use, and there is a lack of alternatives.

In making investment decisions, risk assessment, and management is one of the main tasks. Risk management is an integral part of project management and investment solutions' assessment.

The effectiveness of applying the verbal analysis methods to solving the problems of the contractor's risk assessment and management was assessed. It has been found that verbal analysis methods could be successfully used in the less structured decision-making areas involving risk assessment problems. The analysis of the global experience has shown that the proposed risk assessment methods could not allow the contractors to assess the risks associated with making companies' investment decisions and to perform multicriteria analysis for evaluating the criteria, expressed not only by discrete but also by lexicographical values. Therefore, the verbal analysis method CLARA was offered for the solution of this problem.

The verbal analysis method CLARA is based on multicriteria classification of the alternatives. The algorithm (CLARA), proposed for the alternatives' classification, helps to create complete and compatible databases allowing the contractors to make the appropriate building investment decisions.

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