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GRAPHICAL PRESENTATION OF RISK ASSESSMENT IN MANAGEMENT DECISION MAKING PROCESS

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Abstract. The paper introduces the integration of the risk graphic presentation into the complex approach of the evaluation and selection of management decision. The graphic presentation is an easy and accessible way of the risk assessment which has clarity and visibility. It can be carried out on the bases of real data with no big volume. Its important characteristic is the presentation of the risk in its development. Its advantages are a reason to look for the possibility of its integration in a new approach for assessment of alternatives when selection a management decision. The graphical presentation of the risk gives the data necessary for the simultaneous processing of economical, technological and ecological factors. The procedure compares the alternatives factors through there relative usefulness. An arrangement of the factors relative to their importance and weight is introduced for accurate and precise assessment. The new element in the method is the usage of the quality of the risk graphic presentation into a complex, parallel assessment of the alternatives when selecting a management decision in order not to allow loss of resources and get advantage in the competitive struggle. The practical application of the method is presented using factors as price of the acquisition of material assets, exploitation expenses, ecological compliance and risk.

Keywords: management decision, innovation management, risk, evaluation of usefulness.

Jel classification: L11

1. Introduction

The modern business environment is very dynamic. On one hand the enormous opportunities for movement of people and products, the globalization, the extensive development of the science and technology create conditions for accelerated innovation diffusion and on the other hand – increased competition (Mueller 1990; Porter 1990; Schilling 2005). The international economic and legislative norms are tools for regulation and at the same time for limitation. The factor of time is decisive in the pursuit for market leadership (Warring 1996).

The simultaneous impact of all the factors of the environment on the economic entities requires taking management decisions which adjust the internal business parameters in accordance with the changed external environment. There are several possible solutions which are realised in changing conditions. The combination of “possible solution – situation” reaches big numbers and requires effort, time and resources to analyse and select the suitable alternative. If the selection is made on the bases of economic and technological considerations, as suggested by the most widespread methods for analysis and selection, it is possible that the selected alternative may not be the best from the point of view of the different analysis (Balabanov *et al.* 2008; Herman *et al.* 2007). This means that the management of the business entity may be forced to return at the initial stage of the research two or even more times.

The aim of the paper is to present and give reason for a complex approach for combined parallel analysis of all factors, strongly influencing the alternatives during the selection of the best management decision.

2. Description of the complex approach

2.1. Evaluation of the economic, technological and ecological criteria

The chosen criteria are the ones which can influence to the highest degree the results of the future company activities (Kirova *et al.* 2010). It is recommended that their number is not very big (up to three) in order not to complicate too much the scope of the work and reduce the chance of errors. Their dimensions must be equal for the examined criteria in all alternatives (Turskis *et al.* 2011). This group may contain the price, the prime cost, the labour cost, the capital cost, the variable cost, the relative fixed costs, and profit per unit product, production volume or any other considerable economic characteristics (Kaplan *et al.* 2006).

The technological criteria are different norms for materials, energy, consumables.

Both, the progress in the international agreements for environment protection and the deterioration at anthropogenic level, present new challenges to the managers. The companies which offer products with long life cycle and those from the main economic branches evaluate their decisions for applicability in the long run. This means that the business activity and the use of the offered products must comply with the concept for sustainable development (Kirova 2009). If an element of the product is produced with high level of harmful emissions or too much expense of non-renewable primary resources, this is not acceptable whether the production is done by the main vendor or its subcontractors. The right approach is the replacement of the existing product with one with fewer emissions and lower non-renewable primary resources (Armstrong *et al.* 2008; Curran 1996).

2.2. Risk assessment

The risk assessment is an important moment of the solution selection. It is carried out separately because it is more complex and uses the tools of the statistical and economic analysis (Gabrovski *et al.* 2006; Georgiev 2011; Pavlov 2002; Zafirova 2008). The risk assessment must be done with easier applied approaches and within the available information for the rest of the research groups in order to be included in the complex method. It is suitable to use the graphic presentation of the risk factors (Gracheva *et al.* 2010; Kirova 2011; Tihomirov *et al.* 2010). The typical risk factors for the specific cases are selected for the analysis. Their numerical values are determined from the graphics and they are used in the complex evaluation for the solution selection. The advantage of the graphical representation is that it shows the influence of the business factors on the business process not as a static value but as a part of the life cycle of the process. The graphic is drawn on the base of the predicted maximum value of the risk factor and the moment at which it will happen. It is a logical development of the function of the examined factor from the time of the product life cycle factor. The calculations are not difficult and are based on real input data. The new method is trustworthy for the practical applications. The following equation is used

$$C_{max} = C_{ini} * k_{ch}, \tag{1}$$

where:

C_{max} is the parameter value at the moment of evaluation,

C_{ini} – the max value of the studied parameter,

k_{ch} – coefficient of the factor change (may be expressed in percentage).

The size of the damage is showed as the hatched area on Fig. 1.

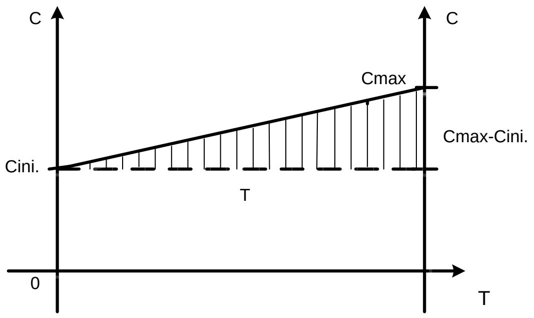

Fig.1. Graphical presentation of the development of a risk factor during the life cycle

$$S_T = (C_{max} - C_{ini}) * T, \tag{2}$$

where:

S_T is the damage for the period;

T – time.

More complex areas may be divided in simple ones for easy calculations. If the function of the graphic is known it could be integrated.

3. Procedure for the integration of the risk graphical presentation

3.1. Conditions for the application of the new approach

The following conditions must be fulfilled in order for the approach of the complex, simultaneous assessment with the integration of the risk graphical presentation to work:

– determine the possible solutions of the problem;

– determine clearly the similar criteria in all alternatives, including in their dimensions;

– convert all values into comparable units;

– arrange all criteria by weight and importance for the overall evaluation of the alternatives;

– the data for all solutions is included in the complex simultaneous assessment for the selection of the most suitable solution;

– a scenario is determined for the selected alternative – beginning, stages, term, means, and end results. This is another check for the correctness of the selection.

3.2. Formulating the matrix of the natural and monetary values

The selected possible solutions are arranged according to the requirements of the previous chapter and they are recorded in Table 1. The alternatives are marked with the symbol A and an index, pointing to its place in the column – A_1, A_2, ..., A_m. Each alternative is presented with its characteristics factors, which are marked with f_1, f_2, .., f_n, as many as the number of alternatives which they characterize. The data in the matrix (table) are representation of the natural or monetary values (Anderson *et al.* 1994; Dimitrov 1995; Kennedy 1992; Pavlov 2002; Yan 2011; Min–Ren *et al.* 2011). The rows have heterogeneous data but the columns must have homogenous data, for example column f_1 for all alternatives should contain the purchase price of the corresponding asset.

Table 1. Natural and monetary values of the alternatives factors

Alt\Fact	f_1	f_2	...	f_n
A_1	q_{11}	q_{12}	...	q_{1n}
A_2	q_{21}	q_{22}	...	q_{2n}
...	...	...	...	...
A_m	q_{m1}	q_{m2}	...	q_{mn}

3.3. Transformation of the natural and monetary values into relative units of usefulness

This data is processed by the formula for relative usefulness in order to become comparable.

For the straight dependence, when the higher value of the factor means higher usefulness

$$F_{ji} = \frac{q_{jn}}{q_{j\max}}, \quad (3)$$

where:

F_{ji} is the relative usefulness factor value,

q_{jmax} – quantitative natural or monetary value of the n factor from the j column with the highest value in the column, corresponding to the higher usefulness,

q_{jn} – the numerical value of the n factor from the corresponding column (Afonichkin *et al.* 2009).

For the reverse dependency the smaller value means bigger usefulness

$$F^*_{ji} = \frac{q_{j\min}}{q_{jn}}, \quad (4)$$

where:

F^*_{ji} is the relative usefulness factor value at the reverse dependency,

q_{imin} – the smallest quantitative natural or monetary value of the n factor from the j column at the reverse dependency, corresponding to the higher usefulness.

The obtained results are recorded in Table 2, which has the same rows and columns as Table 1. In the cells of Table 2 all data is converted to relative usefulness for the factor with the higher usefulness. In this case the data becomes comparable. It is clear that in each column there will be one unit – in the cell in which q_{jmax} and q_{jmin} are referred to themselves – which has the highest usefulness. All other columns have lesser value. In the case when the straight dependency is used the values of F_{ji} obtained by formula (3) are written in Table 2. In the case of the reverse dependency the values of F^*_{ji} *obtained* by formula (4) are recorded in the respective column of the same table.

Table 2. Suggested table for the values of the relative usefulness

Alt\Fact	F_1	F^*_2	...	F_n
A_1	F_{11}	F^*_{12}	...	F_{1n}
A_2	F_{21}	F^*_{22}	...	F_{2n}
...	...	...	...	...
A_m	F_{m1}	F^*_{m2}	...	F_{mn}

3.4. Arrangement of the usefulness factors

It is not correct to use this data with the obtained values for comparing and selection because it could happen that a factor with the smallest influence on the quality of the alternative will have the highest value. That is why the values of the factors must be arranged with the formulas:

$$F^{**}_{ji} = F_{ji} * k_i \quad (5)$$

at straight dependency or

$$F^{**}_{ji} = F^*_{ji} * k_i \quad (6)$$

at reverse dependency,
where:

F^{**}_{ji} is arranged relative usefulness.

Another way for the arrangement of the factors is to compare them in pairs. The quickest way is the determination of the weigh coefficient by expert value on the bases of statistical data, past experience, etc. This coefficient k is the same for all factors from one column and it is designated with indexes 1, 2, ... n according to the factor place in the rows. Its value is between 0 and 1 and it is used to multiply the relative usefulness. The data is recorded in Table 3, which is similar to Table 1 and Table 2.

3.5. Selection of alternative

The data which are summed by row determines the best alternative – the one with the highest sum in

Table 3. Arranged values of the relative usefulness

Alt\ Fact	F_1^{**}	F_2^{**}	...	F^{**}_n	$\sum_1^n F_j^*$	F_{n+1}^{**}
A_1	F_{11}^{**}	F_{12}^{**}	...	F^{**}_{1n}		
A_2	F_{21}^{**}	F_{22}^{**}	...	F^{**}_{2n}		
...			...			
A_m	F_{m1}^{**}	F_{m2}^{**}	...	F^{**}_{mn}		

the columns – $\sum_{1}^{n} F_j^{**}$. A column for additional functions may be introduced in the last table for additional functions $F^{**}_{n+1.}$ These functions have practical value but no alternatives posses them. They may be used when the assessments of the different alternatives are similar or equal in order to determine the best one.

In simpler cases it is possible for the procedures to join by two in one table in order to reduce the volume of work. This activity should come from experience. For the fair selection it is necessary to evaluate correctly the weight coefficients and the risks. The approach should be cautious and well grounded. All known methods can be used including the simplest but without reducing the quality of the evaluation.

4. Example of practical application

The presented approach is applied for the evaluation and selection of decision of a design company. The decision which must be taken is about selection of alternative for central office heating where the most effective option must be selected. The building has electricity and gas but not central heating. The possible heating options are: with convection electrical radiators; with inverter air conditioning; with gas convector heaters.

The equipment is specified on the bases of catalogue data for area of 70 m^2 and volume 175 m^3. The selected options are three: convector radiator Tacit, France (Heaters Airelec 2010); invertor air conditioning system Toshiba RAS-22SKV (Heaters Vimax 2010); gas converter Italkero XN-45, Italy (Gas magazine 2010). The prices for buying, mounting and connection are inserted in column f_1 from Table 1.

The following additional data is necessary for the following calculations: annual energy expense for heating the office, from past experience – 4MWh; amortization period of the heaters – 10 years; maintenance expense – 12 % from the purchase price; prices of different energy sources (State commission for energy and water regulations 2011).

The company management decides if it wants to use inverter air conditioning to buy one 2kW converter heater for additional reserve heating power which is advantageous then the purchase of more powerful air condoning system. This is necessary for the reliable work of the air conditioning during cold weather, when the air conditioning power may be reduced.

The monetary expenses of the three alternatives are determined for the 10 year period after the calculation of the consumed energy.

The assessment of the ecological factors should consider the emissions in the environment from the energy production. In the energy mix of Bulgaria the electricity from coal powered plants is accompanied by 58.4 % emissions from the overall production of energy. The quantity of the emitted CO_2 is one kg per kWh and the coal usage is 0.7 kg/kWh. The slag quantity is 10 % of the coal volume production (MIET 2005). The energy used for the production of coal is 28.8 kWh/ton (Minin *et al*. 1989). The burning of one kg natural gas emits 2.75 kg CO_2 and 2.25 kg water (Batov 1998). The preceding emission data is written in Table 1, column f_3 for the usage of non-renewable primary resources, f_4 for the emission of CO_2 and f_5 for the hard waste.

The risk factors are evaluated using the assessment of risk damages by their graphic presentations. The following risk factors are possible: change of the prices of the electricity; change of the prices of natural gas; maintenance expenses of the heating equipment. The graphics of the risk factors are drawn by using the maximum predicted value of the possible damage. Its moment of occurrence is determined by expert evaluation and is accepted to be the end of the period of using the heaters. The base for the evaluation is the dynamics of the prices in the last ten years.

It is assumed that at the end of the period the energy prices may increase by 30 % relative to the present period and the natural gas can increase up to 50 %. The obtained results are written in column f_6 for the risk of the energy prices and f_7 – for the risk of maintenance expenses.

5. Processing of the results

All data in Table 1 and 2 are in natural or monetary expressions. They are comparable in the columns but not in the rows. Further work is necessary so they can become comparable. For this the category “usefulness” is used. In order to compare the data in each cell from the respective table columns, they are related to the one with the highest usefulness by using formula (2). Attention should be paid that in this case the dominant factors are in reverse dependence or the bigger factor value relates to the smallest usefulness. The applicable formula for these cases is formula (3) after the arrangement of the factors according to the weigh coefficients.

For the columns of the purchase price f_1 and exploiting expenses f_2 the coefficients with weight k_1 and k_2 are assigned, because these values are with the highest significance as a volume of expenses. For the columns with the ecological factors f_3, f_4 and f_5, the weight coefficients are k_3=0.2, k_4=0.2 and k_5=0.2. These coefficients have lower weight values because all compared heaters comply with the EU standards. Coefficients of columns f_6 and f_7 are equal to k_6=0.3 and k_7=0.3. These values are determined on the bases that if there is unfavourable development of the factors the prices of the company's products also will change in a similar way, with the change of the risk factors. Thus the influence of the risk factors is compensated which is a reason for the relatively lower weigh coefficient. The values in all cells are multiplied with these coefficients.

The sum of the rows in Table 4 gives the assessment for each alternative. These values determine the selection of the best possible solution by comparing the sums in the columns. For the specific example this is A_3 – using of gas converter with total result 2.25. This solution is the biggest value of the total usefulness.

Table 4a. Arranged values of the relative usefulness for the practical example

Alt\Fact	F_1^{**}	F_2^{**}	F_3^{**}	F_4^{**}	F_5^{**}
A_1	0.500	0.420	0.560	0.920	0.015
A_2	0.155	1.000	0.120	0.200	0.032
A_3	0.370	0.880	0.200	0.196	0.200

Table 4b. (continuation). Arranged values of the relative usefulness for the practical example

Alt\Fact	F_6^{**}	F_7^{**}	$\sum_{1}^{7} F_j^{**}$	F_8^{**}
A_1	0.126	0.300	1.509	0.000
A_2	0.300	0.093	1.900	0.500
A_3	0.159	0.220	2.250	0.000

If the alternatives have equal or close values, an additional factor may be introduced for the different alternatives which could determine the right selection. In our case the factor f_8 is additional function with weight coefficient k_8=0.5 (Table 4). This is an additional function "summer cooling" $F^{**}_8 = f_8^{*} * k_8 = 1*0.5=0.5$, which is available for alternative A_2 – heating with inverter air conditioning. In this case the selection of the best solution, the one with the highest usefulness, is A_2 with sum 2.4.

6. Conclusions

The presented complex approach enables the simultaneous parallel assessment of all alternative factors during the selection of the management decision. All different dimensions of the factors are converted to one comparable factor – relative usefulness.

The factor of relative usefulness is clear and easy to apply and it excludes errors from complicated calculations.

The integration of the graphical representations of the risks with the factor of relative usefulness makes it possible to take the management decision based on small volume of input data.

The inclusion of the ecological factors and the factors of the concept for sustainable development makes this approach perspective from the point of view of the society development and the environmental protection.

The new integrated approach for parallel analysis may be applied on the bases of specific data for company or business environment, project data, initial prospect data, aggregated data for different processes. This enables the selection of the management decision before the expenses for expensive R&D without the reduction of the selection quality.

During the realization of the complex parallel analysis in some cases other known methods may be used except those presented in the paper as the method for arrangement and comparison. This makes the presented approach applicable for broad varieties of issues.

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