International Journal of Industrial Engineering, 17(4), 310-318, 2010.

APPLICATION OF RANKING METHOD IN EVALUATION OF ENGINEERING INVESTMENT PROJECTS

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The hypothesis of this investigation is that in the estimate of several mutually exclusive engineering investment projects and decision-making on the best varieties, the complex ranking method has an advantage over classic method evaluation. Many of ”classical” methods do not give the desired results due to discontinuous character of variables. Our idea is to overcome this problem successfully combining appropriate methods and criteria. In this sense, ranking method allows projects to make the choice of the project on the grounds of more influential elements at the same time. Using this method we mutually compare among themselves according to upfront influential elements different projects. Therefore the methodology of determining the method of ranking projects starts from the determination of influential elements, after that each of these elements receive certain number of scores, and define the character of each of them.

Key words: ranking method, net present value, risk, payback period, investment.

(Received 5 Dec 2008; Accepted in revised form 9 Sept 2010)

1. INTRODUCTION

In current intensive global market match and the uncertain economic conditions the complexity issues election of appropriate development project in modern industrial enterprise deserves an exceptional attention. In literature we can find some research about investment projects evaluation (Sudong, Tiong, 2000), (Chen, Ward, 2000), (Kish, Weng, 2005). Also, significant contribution about investment performance measurement are given in (Feibel, 2003), (Pareja, 2000). The latest research in field of economic evaluation of projects and application of right evaluation techniques and methods could be find (Meyer, 2008), (Jafarizadeh at al., 2008). Sensitivity analysis in investment project evaluation are discussed in (Borgonovo, at al. 2004) as one approach to problem of investment projects ranking. Problem of ranking investment projects are discussed in (Foster, Mitra, 2003), using net present value, irrespective of choice of the discount rate. Therefore financial estimation of possible projects must be based on a comprehensive approach so market characteristics will be integrated with the characteristics of the production process (for example market development, time of the beginning of production, quality of products, time delivery, average size of series, average volume of order, quality of products, price, restrictions during production and so on.)

Before its realization we can simply realize for each project, that it should be processed with three basic aspects: market, technological and financial. Therefore, each project must be the work of experts of various professions. However, this paper will only deal with problems related to financial-market evaluation of projects and method of ranking alternative development projects.

2. TYPES OF PROJECTS AND FINANCIAL -MARKET EVALUATION IN MANAGING DIFFERENT TYPES OF PROJECTS

Strategic plans of the company goals are realized by one or more separate projects. Each project is an individual whole to manage, i.e. a unique business undertaking composed of an array of carefully planned, organized and controlled activities with their deadlines. They are to achieve a goal that is in accordance with available human, material, and time resources. Basic goal of the project must be realizing certain economic interests of the company that can be seen in the profit or creating some value for the owners.

For realizing this basic goal several types of projects can be used. Assuming that projects differ according to which component of the project is included, we can divide them all in:

1) investment projects
2) projects of technological innovations
3) projects of company restructuring
4) projects of financial consolidation of company
5) projects of rationalizing of energy use

6) marketing projects etc.

Of course, projects differ according to which branch of industry they belong to.

In this paper we deal, firstly, with investment projects and from engineering point of view we can make division according to next criteria:

a) according to the status of the market: project of new investment, project of modernization and expanding and project of reconstruction;

b) according to the purpose: we have projects that are related to different types of activities that can be different;

c) according to complexity: projects that we define according to the size of the investment needed - projects of small, medium and large complexity.

Using methods and techniques for financial-market analysis in different types of projects is almost identical and it can be made uniform to a large extent. The most important methods and techniques of this analysis are: calculating of the costs, analysis of financial reports, methods of evaluation of the company's value, and the most important, methods of evaluation financial-market aspects of the project's.

It is well known that what is needed for the investment project to be acceptable for realization in the formal sense is:

- that the net present value (NPV) is bigger than or equal to zero;
- that internal rate of return (IRR) be bigger than the current individual discount rate (the weighted average interest rate to the sources of investment) ;
- that net cash flow (liquidity) over all the years be positive.

However, if we have more different projects or more variations of the same project, then the accepted one will have the biggest positive net present value. In according to this, one of the rules that has to be obeyed when making decision is that the project with net present value bigger or equal to zero will be accepted, because only such projects satisfy financial demands of the company's provider of the capital, since on the whole, the projects would exclude one another and the ones with the highest NPV will be accepted.

Still, we need to keep in mind that there is no unique method for choosing the right investment project. So much more because the procedure for calculating NPV and internal rate of return is completely exact, which is not the case with the data it is based on. Using these methods often depend on the subjective interpretation of the manager of the project on what is the market and technological future of the project. Therefore the authors of this work suggest that the choice of a certain project or its variation should include the ranking method of projects or some variation of projects according to several elements of influence concurrently.

3. CHOICE OF A PROJECT BY THE RANKING METHOD ACCORDING TO SEVERAL ELEMENTS OF INFLUENCE CONCURRENTLY

When choosing a project, as we previously said, one can come to problems when choosing methods and criterions for their evaluation and selection. Many methods don't end in desired results for discontinuous character of their variables. This problem can easily be solved by combining certain methods and criterions. Having this in mind the method of ranking the project enables the selection of a project to be made on the basis of several elements of relevance concurrently. This method uses comparison of different projects or different variations of one project according to the previously chosen elements of relevance.

Methodology of ascertainment of a method of ranking a project comes from determining elements of relevance, then each of those elements get certain number of points and the character of each of them is determined.

As one may notice reading previous chapters, method of ranking projects contains several specific and complicated phases and activities to perform. Along with determining the group of projects that will further be submitted to selection and choosing, there is also determining and defining elements of relevance for the selection and choosing. This phase of the whole procedure is crucial for applying of the method of ranking and choice. At this point two general problems occur.

First problem is determining the size of the group of elements of relevance. Should one restrict oneself to smaller number elements of relevance (just a few of them) that we consider to be the most important for the selection of a project, or we would be for a bigger number in order to include all the relevant elements we find relevant. The first alternative enables faster and more efficient analysis and choice, but it also causes problems concerning possible excluding of some important elements. The second alternative enables including almost all relevant elements of influence, but it is notably harder and cumbersome for analysis, and it can cause blurry results, especially in quantitative analysis. Most probably the most acceptable solution is determining some middle number of the elements.

Another problem is determining the group of the most acceptable elements of relevance. This problem is as hard and important as the one previously exposed. It represents a new problem of selection and choice. This problem is simplified in practice by making a solution using experience and intuition.

If these two problems are solved, one needs to determine relevant elements to use for selection and the choice of the project. For some specific application in this work we will use net present value, risk of project, height of the level of

investment, payback period for returning the investment and the rise of the market share. One needs to consider that this is only one possible general approach and one group of possible elements of relevance for the selection and the choice of projects.

After choosing is done, we introduce percentage by weight some of the elements of importance, that are used as such for further selection and evaluation. First, each element gets certain weight factor, which reflects its relative importance related to other elements and the whole group of elements. Determining the weight factor of each single element is crucial for the making choice about a project. Therefore determining weight factor must serve to the strategic aims of the investor. Bigger weight factor gets the element which makes the greatest contribution to these goals.

After determining weight factor for each element of relevance, one determines their character. If an element is defined as positive, the project is better, because its absolute value is greater. However, if an element is determined negative, than its bigger absolute value means that the project is worse. Therefore, while determining the final number of points, with these elements inverse of number, because their less absolute sum brings more points.

3.1. Real-Life Example

In addition to presented theory in the paper, we give a "real-life" example for the method of ranking projects according to several elements of relevance concurrently.

We analyze problem in domestic company which has a possibility to realize one of these three projects:

1) project of reconstruction,
2) project of modernization and expanding and
3) project of new investment.

Reconstruction means unchanged status of business subject with existing offer of products, but with better quality. Modernization is a type of project that is realized as already existing business subject that can offer new array of products, or that can enlarge the scope of already existing production. Project of new investment is a new business subject with new investment and products.

Project of reconstruction has these relevant elements, that have been determined on the basis of methodology for evaluation (table 1):

Table 1. Elements of influence in the project of reconstruction

Net present value (NPV)	12.000 €
Project risk (PR)	15,68%
Investment (I)	80.000 €
Payback period (PP)	3,30 years
Increase of market share (IMS)	0

In this example the project risk is showed via standard deviation of expected net present value, expressed as a percentage from expected net present value (mathematical expectancy). For example, for project of reconstruction, via the analysis of risks, expected net present value is 10650 €, and the standard deviation 1670 €. The percentage of standard deviation is:

$$\frac{1670}{10650}\cdot 100 = 15{,}68\% \quad \ldots \quad (1)$$

Project of modernization and expanding has the following elements (table 2)::

Table 2. Elements of relevance in project of modernization

NPV	23.000 €
PR	14,29%
I	115.000 €
PP	3,92 years
IMS	5%

Project of new investment, according to methodology for evaluation weather investment is justified, has the following elements (table 3):

Table 3. Influential elements in the new project investment

NPV	31.000 €
PR	16,53%
I	235.000 €
PP	4,22 years
IMS	5%

Value of weighting factor (t_j) and the character of each element is determined by the following (table 4):

Table 4. Value of weighting factor

Influential element	Weighting factor	The character of influential element
NPV	25	function maximum
PR	30	function minimum
I	15	function minimum
PP	20	function minimum
IMS	10	function maximum
Σ	100	

Ranking projects by some individual influential elements (table 5):

Table 5. Influential element: Net present value -NPV

Type of projects	S_{ij}	$\frac{S_{ij}}{\sum_{i=1}^{3} S_{ij}}$	P_{ij}
Reconstruction	12.000	0,18	4,50
Modernization	23.000	0,35	8,75
New investment	31.000	0,47	11,75
Σ	66.000	1,00	25,00

Number of points per element of NPV for the reconstruction project was found in the following manner:

$$P_{ij} = t_j \cdot \frac{S_{ij}}{\sum_{i=1}^{3} S_{ij}} = 25 \cdot 0{,}18 = 4{,}50 \quad \ldots \quad (2)$$

where:

S_{ij} - the net present value of the i-project,

t_j - weighting factor,

P_{ij} - points on the j-element for the i-project.

In this way, there are established points for modernization projects and new investments also.

Calculation of the risk of the project is presented at the table 6.

Table 6. Influential element: Project risk - PR

Type of project	S_{ij}	V_{ij}	$V_{ij} / \sum V_{ij}$	P_{ij}
Reconstr.	15,68%	2,96556	0,32832	9,85
Moderniz.	14,29%	3,25402	0,36025	10,81
New inv.	16,53%	2,81307	0,31143	9,34
Σ	46,50%	9,03265	1,00000	30,00

where – V_{ij} is reciprocal value of influential element for the i-project (46,50:15,68 = 2.96556, etc.). Calculation of investment is presented at the table 7.

Table 7. Influential element: Investment

Type of project	S_{ij}	V_{ij}	$V_{ij} / \sum V_{ij}$	P_{ij}
Reconstruction	80.000	5,37500	0,49114	7,37
Modernization	115.000	3,73913	0,34166	5,12
New investment	235.000	1,82978	0,16720	2,51
Σ	430.000	10,94391	1,00000	15,00

Calculation of payback period is presented at the table 8.

Table 8. Influential element: Payback period

Type of project	S_{ij}	V_{ij}	$V_{ij} / \sum V_{ij}$	P_{ij}
Reconstruction	3,30	3,46667	0,38112	7,62
Modernization	3,92	2,91837	0,32084	6,42
New invest.	4,22	2,71090	0,29804	5,96
Σ	11,44	9,09594	1,00000	20,00

Also, calculation of the increase market share is shown at the table 9.

Table 9. Influential element: Increase market share

Type of project	S_{ij}	$S_{ij} / \sum S_{ij}$	P_{ij}
Reconstruction	0	0	0
Modernization	5%	0,5	5,00
New invest.	5%	0,5	5,00
Σ	10%	1,0	10,00

Finally, we can create a table ranking the projects by more influential factors at the same time (table 10).

Table 10. Total table of influential elements

Type of project	NPV Rang	NPV Pij	PR Rang	PR Pij	I Rang	I Pij	PP Rang	PP Pij	IMS Rang	IMS Pij	Total Rang	Total Pij
Reconstr.	3.	4,50	2.	9,85	1.	7,37	1.	7,62	3.	0	3.	29,34
Moderniz.	2.	8,75	1.	10,81	2.	5,12	2.	6,42	1.-2.	5,00	**1.**	**36,10**
New inv.	1.	11,75	3.	9,34	3.	2,51	3.	5,96	1.-2.	5,00	2.	34,56

On the basis of influential elements can be concluded that the reconstruction project was twice on the first place, to the elements: investment and payback period. The project of modernization and enlargement was, on the basis of effective elements, once on the first place (PR) and dividing the first place with a new project investment (IMS). Project of new investment, as well as the modernization and expansion project is a once on the first place (NPV) and once shared the first place (IMS). However, the ranking of projects on the basis of several influential elements at the same time shows that the project of modernization and expansion is on the first place with 36,10 points to 100 points, which represents the total number of points for each of three projects. Therefore, it results that the project of modernization and expansion should be accepted and realized.

Hierarchy for given criterions and alternatives are presented on figure 1. Using decision support system, we gets the same results as showed in table 10. This software was used to confirm our results and to suggest that by the use decision support systems in problem of ranking investment projects could be solve in more efficient manner.

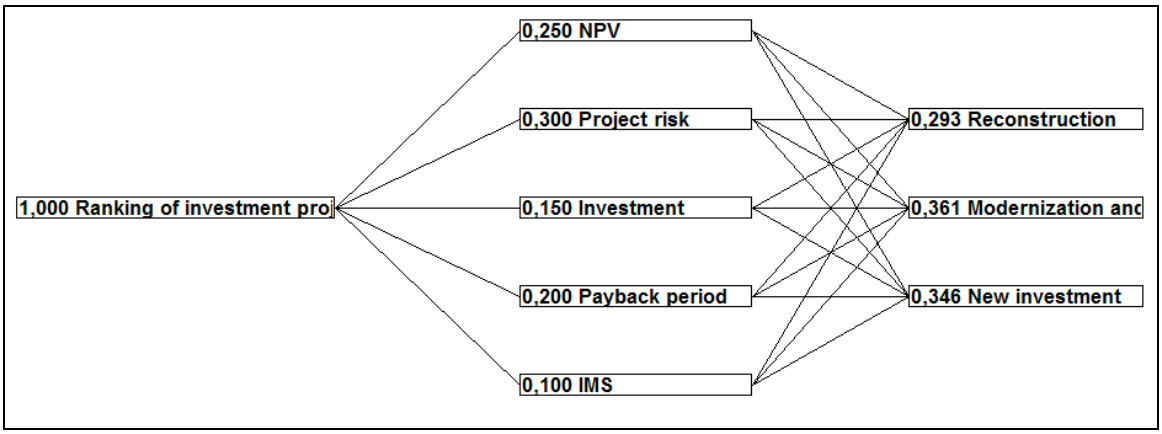

Figure 1. Generating hierarchy

Using AHP method (Analytical Hierarchy Processing) for investment projects ranking for given set of criteria, decision scores and contribution by criteria are showed at Figure 2 and 3. Contribution of criteria "Project risk" has significant influence in ranking all alternatives, while "NPV" criterion has significant contribution only for alternatives "New investment" and "Modernization and exp.". "Payback period" is contribute in ranking projects approximately similar for all three alternatives, but "Investment" contribute more to alternative "Reconstruction" then other two alternatives. Finally, "Increase market share" does not have any contribution in ranking alternative "Reconstruction" which left this alternative in decision score at third place.

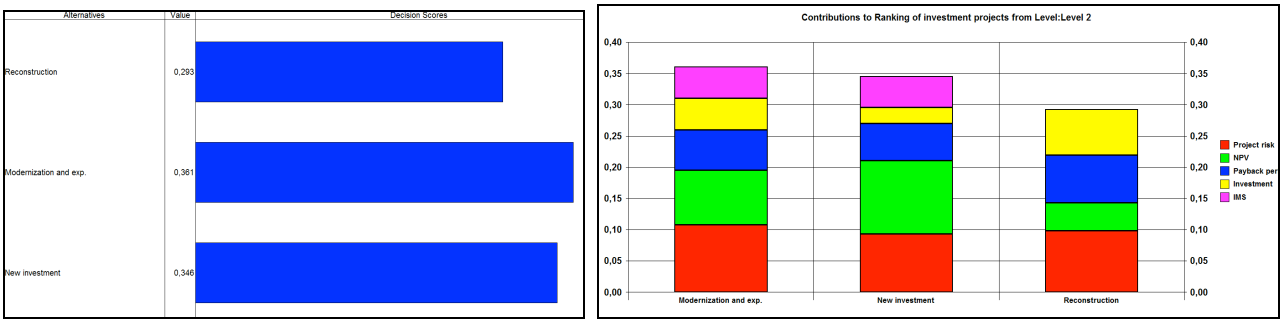

Figure 2. Results – Decision score and contribution of influence criteria in final decision score

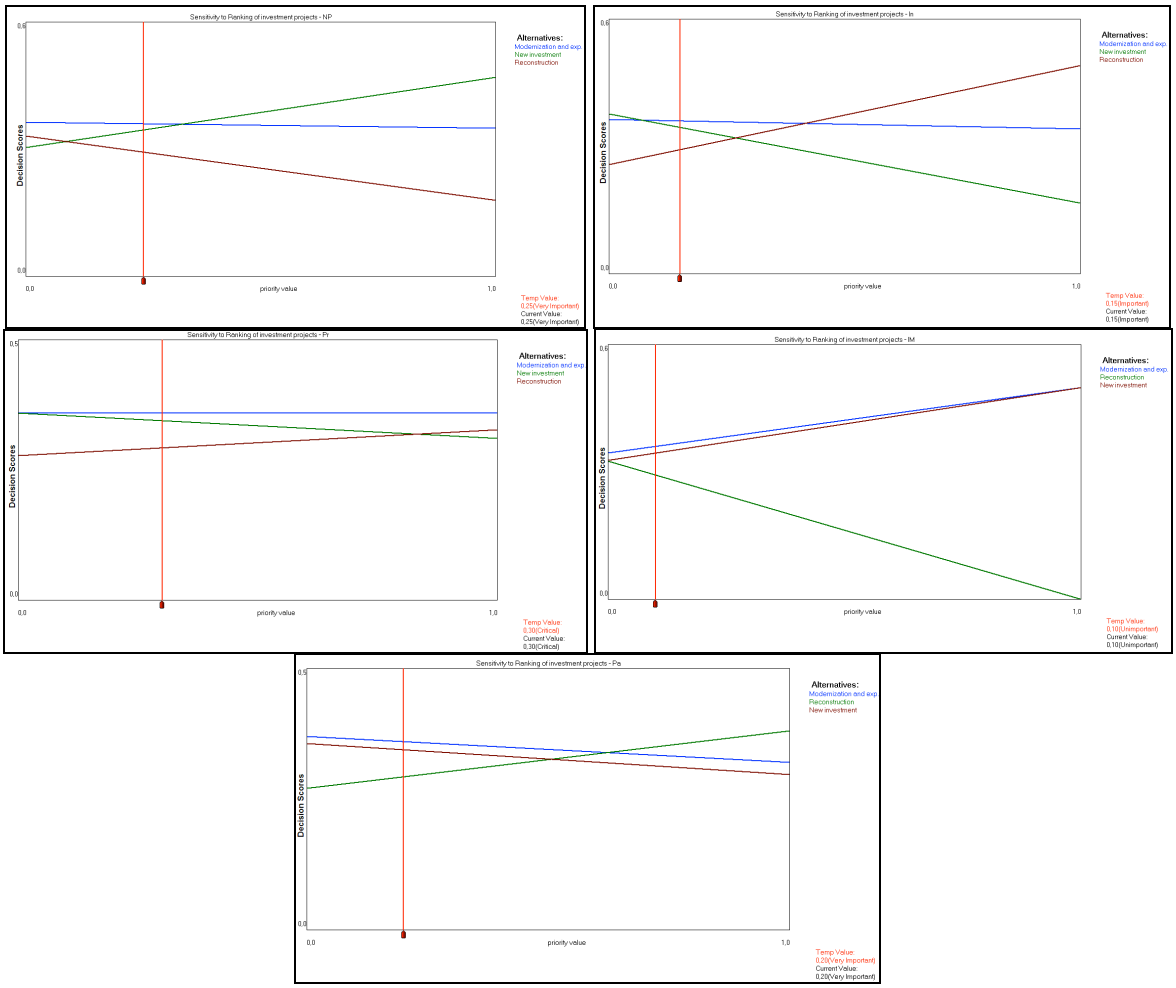

Figure 3. Sensitivity analysis for five criteria at first level

Sensitivity analysis shows that two (NPV and Investment) of five used criteria are sensitive to changes in weights priority. This mean that possible change in weights priority could affect on decision scores on sensitivity diagrams for criteria NPV and Investment. So, finally, if we perform scenario analysis and suppose that weights priority for criteria NPV and Investment are increased, the final decision scores will be the same in all variants, so decision maker could use these decision scores in consideration with great reliability and improve some of decision making phases (Mortensen at al, 2008).

4. CONCLUSION

The previous exposure have shown us, that the process of selecting the most successful investment projects represents a complex and responsible task that requires the maximum responsibility of all those who participate in it. In all this, special attention is given to financial-market evaluation of each investment project. It should show that the financial effects of the project surpass investment in the project. However, for the selection of the project between several different projects or variants of the same project, must be used method of ranking projects by more influential factors at the same time. The whole analysis process has shown that if we only use net present value (or internal rate of return) we cannot make the correct choice in situation when we have more projects for the realization of a project task. The method of ranking projects overcomes their shortcomings, which are expressed in the election process successful project. It enables the combined use NPV (or IRR) with other methods and criteria. Of course, there are some difficulties using this method to which we have to give some attention. One of these problems is determining the size of influential factors, and the other one is how to extract from a larger set of these elements relatively small number of the most influential elements. Not less important there is the

problem of dispatching value of weighting to each influential element. In our work we tried to give the adequate contribution in solving these problems.

Finally, it should be noted that we missed our theoretical considerations, through the lens of one specific example. First, we have all the projects assessed from the point of view of influential elements - NPV, PR, I, PP and IMS, and then we make the second phase of the ranking of each project by all elected influential elements at the same time. Selected example showed that, on the basis of ranking method, project of modernization and expansion has an advantage compared to other projects. However, if we have used only NPV method for example, we would conclude that the project of new investment is the most acceptable, which at the end is proved to be incorrect.

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