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ANALYTICAL HIERARCHY PROCESS AS A TOOL FOR SELECTING AND EVALUATING PROJECTS

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Abstract
This paper explains the reasons for selecting the right project to conduct business in various organisations. It presents several methods for evaluating and selecting projects. A special focus is on Analytical Hierarchy Process (AHP) method that is becoming increasingly important tool in different decision-making situations. We have used this method in project management and developed a project evaluation and selecting process. We have also developed a simple application in MS Excel that helps with calculating projects' total priority grade. This tool helps us with simulating project importance based on changes in perception of the criteria.
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Key Words: Project Selection, Project Evaluation, Analytical Hierarchy Process, Criteria Simulation

1. INTRODUCTION

Companies and other organisations are often confronted with the decision to select the right projects for their business. The decision on selecting and implementing projects must be carefully considered. Organisations deal with many different problems and opportunities that surround them. We have to recognise the right opportunities and select the right projects. But how? What are the best criteria for selecting projects? It is not an easy decision and wrong decisions can have long-term damaging consequences. We spend a lot of money on projects that do not fulfil customers' needs and demands. Should decision be based strictly on financial analysis, or should other criteria be considered [1]?

There are many different methods to evaluate and select projects. Some of them are strictly qualitative, while others are quantitative. Each of these methods has its strengths and weaknesses. We are going to focus on a method, called analytical hierarchy process (AHP). We are going to look at its basic characteristics, strengths, weaknesses and how to use it as a tool for evaluating and selecting projects. We will support the use of AHP for selecting projects with the computer application in Microsoft Excel. We are going to simulate different scenarios of criteria importance on a specific project.

The use of AHP for evaluating and selecting projects was studied by many authors [2-4]. Their approaches slightly differ, but they are all useful. AHP is based on pair wise comparisons using a ratio scale to indicate strength of preference. Melone and Wharton [5] discussed scoring models in their review of strategies for project selection, and suggested that a weight should be assigned to the cost and to the risk aspects of the alternatives, along with the other attributes. Shoval and Lugasi [6] reviewed various approaches for assigning a weight to the cost aspect and for combining cost and nonmonetary scores in order to obtain a single numerical value for alternative selection. We will present the use of AHP for evaluating and selecting projects based on their findings, but at the same time we will adjust a methodology to make it easier to use.

2. PROJECT SELECTION BASED ON COMPANIES' STRATEGIC GOALS

Companies and other organisations deal with new business challenges and problems. They have to cope with continuous changes in its business environment and evolve. Today, projects are the means for responding to changes and seizing business opportunities. It is also a very well known fact that strategies are implemented with projects. Strategic and project management are more and more interrelated. Projects are key blocks of strategies, since they convert strategies into action [1, 7].

Companies and organisations have to prepare many different scenarios to achieve required goals. These scenarios are basically projects and we have to select the ones that will be later implemented in practice. There are many constraints when we select projects and we want to select those that save money and have the highest payoffs. We have to prepare screening models that help us select the right projects. Souder and Sherman [8] identified five important issues that managers should consider when evaluating screening models:

- Realism – decision model must reflect organisational objectives and mission.
- Capability – a model must allow company to compare different types of projects, meaning it has to be robust enough to accommodate new criteria and constraints.
- Flexibility – a model should be easily modified if changes are required. It must allow adjustments due to changes in exchange rates, tax laws etc.
- Ease of use – a model should be simple enough to be used by people in all areas of the organisation.
- Cost – a model should be cost effective and not time consuming [1].

As already mentioned project selection models come in two general classes: quantitative and qualitative [9]. Quantitative models use numbers as inputs for the decision process. These values can be objective, external values (the amount of cement that is required to build a new road) or subjective, internal values (to design a new home page we will need three software programmers for six weeks). The majority of selection processes involve a combination of subjective and objective data assessment and decision making.

Pinto [1] suggest four groups of factors that influence project selection process:

- risk factors (technical, financial, safety, quality, legal exposure);
- commercial factors (expected return on investment, payback period, potential market share, ability to generate future business/new markets etc.);
- internal operating factors (need to train employees, change in workforce size, change in physical environment, change in manufacturing process);
- additional factors (intellectual property rights, impact on company's image, strategic fit).

In many situations, there are relevant attributes that cannot be measured in monetary terms. These may include product quality, safety and performance aspects; supplier reliability and experience; technology maturity and stability, risk and uncertainty aspects, as well as other characteristics that bear on the costs and benefits to the project stakeholders. The conventional project selection literature offers two main approaches to this problem [10]. One approach consists of setting explicit thresholds for each of the attributes. Then, only alternatives that meet all the threshold conditions are considered further, and from these the most economically attractive alternative is selected. A major drawback of this approach is that it does not distinguish between various levels of performance beyond the threshold, and it does not allow for trade-offs among the various types of benefits.

The second, and most commonly used, approach consists of assigning a weight to each attribute, assigning a numerical score to each of the alternatives with respect to each of the attributes, and computing the sum of the weighted scores for each alternative. The final selection is based on a combination of the weighted sum of scores and the net present value [11].

3. ANALYTICAL HIERARCHY PROCESS

One of the most useful methods for selecting project that is becoming more and more important is AHP. This method was developed by Dr. Thomas Saaty in 1980 as a tool to help with solving technical and managerial problems [12]. It aims at quantifying relative priorities for a given set of alternatives on a ratio scale, based on the judgment of the decision-maker, and stresses the importance of the intuitive judgments of a decision-maker as well as the consistency of the comparison of alternatives in the decision-making process.

Since a decision-maker bases judgments on knowledge and experience, then makes decisions accordingly, the AHP approach agrees well with the behaviour of a decision-maker. The strength of this approach is that it organizes tangible and intangible factors in a systematic way, and provides a structured yet relatively simple solution to the decision-making problems [13]. In addition, by breaking a problem down in a logical fashion from the large, descending in gradual steps, to the smaller and smaller, one is able to connect, through simple paired comparison judgments, the small to the large.

AHP method is very appropriate for those fields where intuition, rationality and irrationality in connection with risk and uncertainty can be found. The problem can include social, political, economic, and technical important amounts, several goals, criteria and possibilities. It is used for assigning priority (in our case for importance of factors and for defining the level of uncertainty) and for making appropriate decisions. It takes apart the complex problems to the level of pair wise comparisons, and then again merges the results which lead to rationally best solution. AHP method is today still the most widely spread and used theory for decision making [14].

AHP is especially suitable for evaluating complex multi-parameter possibilities with inclusion of subjective criteria. The key steps of AHP method application encompass:

- analysis of general decision making problem in hierarchic sense and division into sub-problems, which are easier to evaluate and understand,
- assign priorities to elements on every level of decision making hierarchy,
- assign numerical values to elements,
- analysis and evaluation of possible problem solutions.

The weighted score methodology also has some drawbacks. First, it requires the decision-maker to choose the appropriate values for the weights of the attribute and for the scores of the alternative. This may require a significant effort to achieve consensus among the stakeholders who are involved in the decision process. Moreover, the weights and scores imply certain trade-offs among the various levels of performance on the various alternatives. Regardless of the method used to obtain the weights and scores, these trade-offs are between pairs of alternatives on any given attribute, and presume independence from the scores of the alternatives on other attributes. Consequently they fail to account for the interrelationships among the various attributes. Another type of distortion may occur if some of the attributes used in the evaluation fail to differentiate among the alternatives, which results in the sum of the scores being inflated and the true differences masked [11].

4. THE USE OF AHP FOR EVALUATING AND SELECTING PROJECTS

Practical use of AHP steps will be demonstrated later on a specific project. But first we will look at the specific steps of the AHP process. Each project has its purpose and its goals. They are representing customers' needs and wants. There are usually several possibilities to fulfil these needs and wants [15]. Therefore, we prepare several scenarios in the form of projects. To evaluate and select projects we need criteria. The project customer together with project team decides what the best criteria to evaluate projects are. We have already presented potential criteria in the second chapter.

The first step of the method is to develop criteria hierarchy. The highest level is the decision making goal or project purpose. Structuring project criteria means constructing hierarchy of criteria and its subcriteria. Structuring criteria into subcriteria helps manager to set priorities among projects. Criteria hierarchy reflects the structure of organisational strategy and key performance indicators and at the same time provides a possibility to select project in regard to its alignment with business goals. The first challenge when we select among may strategically important projects for our organisation is to set appropriate and clear criteria. This is also the task of functional managers from marketing, finance, ICT, sales and others. When we choose criteria it is almost immediately clear that they are not equally important and that they are interrelated.

The second step consists of allocating weights to previously chosen criteria and, where necessary, splitting overall criterion weight among subcriteria. Mian and Dai [16] recommend the so called pair wise comparison approach to weighting, in which every criterion is compared every other criterion. We perform this pair wise comparison on every hierarchic level (comparison of two elements which belong to the same group inside a hierarchy) and for every level of the entire hierarchy. Such comparison enables that we always focus on just two of the criteria at the time. In this way we can establish for each combination, which criteria is more important and which criteria is less important and what is the difference between them in importance.

How do we assign weights to criteria? We usually compare two criteria simultaneously and use the points between 1 and 9. The limitation of the scale is the consequence of realisation that human mind can correctly sense and consider only a few elements at once. The most accurate guidelines for assessing the pairs can be found in Table I. In every pair we assign the degree of dominance of one element over another. The exceptional supremacy of one criterion over another can be assessed at 9, equality at 1. If the second criterion is more important than the first one, record the reciprocal value. Thus we obtain the values in the region from 1/9 to 9. This model of assessment of ratios is empirically confirmed as accurate enough for the majority of problems. Greater variety of judgement would lead to lowered symmetry of assessments. To reach the final assessment, employ the procedure of weighted average. This can be obtained by multiplying importance of criteria and level of uncertainty.

Table I: Value of criteria [17].

Value	Description of comparison
1	Equality
3	Somewhat greater importance of one criterion over another
5	Strong superiority of one criterion over another
7	Very strong superiority of one criterion over another (clearly seen in practice)
9	Absolute (highest possible) superiority of one criterion over another
Note: use of values in between (2, 4, 6, 8) is permitted.	

Presumably we have *f* criteria, which importance we wish to determine. The criteria are compared in pairs (values from 1/9 to 9), and these subjective assessments are recorded into a matrix of dimensions $f \times f$ [12, 18]. Cells of the matrix are specified as the closest integer approximations of weight ratio.

Table II: A matrix to evaluate criterion importance.

Criteria	1	2	. . .	*f*
1	1	a_{12}	. . .	a_{1f}
2	a_{21}	1	. . .	a_{2f}
.	.	.		.
.	.	.		.
f	a_{f1}	a_{f2}	. . .	1

To complete the matrix we need $(f^2 - f) / 2$ values. The assessor gives only values (cells) in the upper part of the matrix (above the diagonal). The cells on a diagonal are equal to 1 (one), values of the cells under the diagonal are reciprocal.

For practical use of the equation or the matrix in Table II an approximate solution is sufficient. Two methods are recommended:

- all cells in an individual column of the matrix *[A]* are divided with the sum of the cells of the given column, then all those values are added in a line and then the sum is divided with *f* (calculate the mean value of cells in a row); the result is a vector of criteria priority {*g*};
- multiply *f* cells in an individual line, calculate *f*-th root from the product (geometric mean), then normalize the gained vector (the cells are divided with the sum of the column).

The third step is to assign numerical values to the dimensions on our evaluation scale. It is common to use dimensions, such as *poor, fair, good, very good* and *excellent*. These values are not appropriate for all situations, so we can change them if necessary. We assign a numerical value between 0 and 1 to these qualitative dimensions. It is completely our decision what value is assigned to each dimension. For example: poor – value 0,0; fair – value 0,1; good – value 0,3; very good – value 0,6; excellent – value 1,0.

The differences between numbers on a scale are not equal (if we use values from 1 to 5 there would be no difference between intervals). This is extremely useful since managers can point out exact difference in the importance between two dimensions (in our case the difference between excellent and very good is much bigger than between fair and good).

The fourth step provides the total grade of the project. First we multiply to criteria assigned weights and numerical value of the project. The total grade of the project is the sum of all products of weights and numerical values (scores) of the project:

$$P = W_1 \cdot K_1 + W_2 \cdot K_2 + \ldots + W_n \cdot K_n \tag{1}$$

where: *P* is the total grade of the project, *W* is the assigned weight of the criteria, and *K* is the numerical value (score) of the dimension.

This is the AHP process for evaluating all projects. The best project is the one that receives the highest total grade (maximum value is, of course, 1).

5. CASE STUDY – THE USE OF AHP FOR SELECTING THE BEST PROJECT

We are going to evaluate four projects (based on Pinto [1]). They are all strategically important projects for organisation X. They are supposed to contribute to increase organisation's competitiveness on different levels. The project customers (organisation's top management) had to select three criteria to evaluate project alternatives:

- A – financial benefits,
- B – contribution to organisation strategy,
- C – contribution to IT infrastructure.

Financial benefits criteria focus on tangible benefits of the project and is further subdivided into long-term and short-term benefits. Contribution to strategy is an intangible factor, subdivided into three subcriteria: increasing market share for product A, retaining existing customers for product B and improving cost management.

Table III: Hierarchy of selection criteria choices.

First level	Second level
1. financial benefits (A)	A1: short-term A2: long-term
2. contribution to organisation strategy (B)	B1: increasing market share for product A B2: retaining existing customers for product B B3: improving cost management
3. contribution to IT infrastructure (C)	C1

First we have to compare criteria on the first level.

Table IV: Criteria weights on the first level.

	A	**B**	**C**		
A	1	3	5	1,9000	**63,33 %**
B	1/5	1	3	0,7815	**26,05 %**
C	1/3	1/3	1	0,3185	**10,62 %**
	1,5333	4,3333	9,000	3,0000	100,00 %

If we look at our example, we can see that the financial benefits criterion is slightly more important than the contribution to organisation strategy criterion. At the same time financial benefits criteria is much more important than contribution to IT infrastructure criterion. Contribution to organisation strategy criterion is slightly more important than contribution to IT infrastructure criterion. The last column in the table presents the importance of the criteria expressed in percentage on the first hierarchy level.

Two criteria have additional subcriteria. Financial benefits criterion has two subcriteria. To assign weights to criteria in this case we do not use the AHP process. We just compare both criteria and determine their interdependence. For example, we believe that long-term financial benefits are more important than short-term financial benefits. We assign value 25 % to short-term financial benefits and 75 % to long-term financial benefits (together, of course, 100 %). Both values have to be translated on the first level with the following simple procedure:

$$A1 = 0{,}6333 \cdot 0{,}25 = 0{,}1583 = 15{,}83\ \%$$
$$A2 = 0{,}6333 \cdot 0{,}75 = 0{,}4749 = 47{,}49\ \%$$

Contribution to organisation strategy criteria has three subcriteria that we have to compare. Our analysis provided the following values for all of them: increasing market share for product A – 35 %, retaining existing customers for product B – 47,78 % and improving cost management – 17,22 %. These values have to be transformed on the first level:

$$B1 = 0{,}2605 \cdot 0{,}35 = 0{,}0912 = 9{,}12\ \%$$
$$B2 = 0{,}2605 \cdot 0{,}4749 = 0{,}1237 = 12{,}37\ \%$$
$$B3 = 0{,}2605 \cdot 0{,}1722 = 0{,}0448 = 4{,}48\ \%$$

Now we have basically six criteria to evaluate our four projects. By far is the most important criteria long-term financial benefits (47,49 %). The next step is to select qualitative dimensions and to assign numerical values to them on the scoring scale. We have decided for the following:

- poor – value 0,0;
- fair – value 0,15;
- good – value 0,35;
- very good – value 0,7;
- excellent – value 1,0.

In the last step we evaluate all four projects. We must analyse each project individually and decide what the level of fulfilment of each selected criteria is. Value "excellent" means that this project completely fulfils a specific criterion. Value "good" means that this project fulfils the criterion much less than it should.

Table V: Evaluation of project in regard to criteria fulfilment.

		Total	**Finance**		**Strategy**			**IC**
			Short-term	Long-term	Market share	Custo-mers	Costs	
			0,1583	0,4749	0,0912	0,1237	0,0448	0,1062
1	**Project 1**		excellent	excellent	very good	excellent	very good	excellent
2	**Project 2**		good	excellent	good	excellent	good	excellent
3	**Project 3**		excellent	good	excellent	good	excellent	good
4	**Project 4**		very good	very good	very good	very good	very good	very good

We must transform qualitative values from Table V into numerical ones.

Table VI: Calculation of the project total grade.

		Total grade	**Finance**		**Strategy**			**IC**
			Short-term	Long-term	Market share	Custo-mers	Costs	
			0,1583	0,4749	0,0912	0,1237	0,0448	0,1062
1	**Project 1**	0,9583	1,00	1,00	0,70	1,00	0,70	1,00
2	**Project 2**	0,8078	0,35	1,00	0,35	1,00	0,35	1,00
3	**Project 3**	0,5410	1,00	0,35	1,00	0,35	1,00	0,35
4	**Project 4**	0,6994	0,70	0,70	0,70	0,70	0,70	0,70

The calculation of the total grade for the first project:

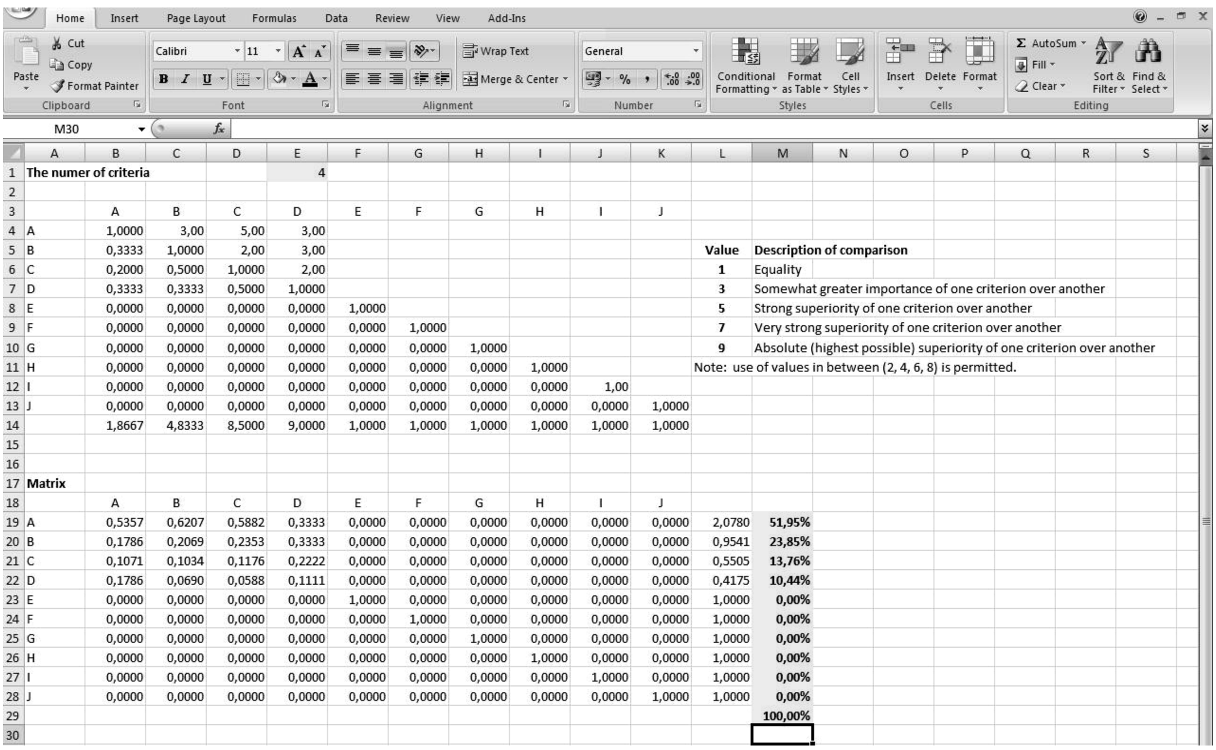
$$P1 = 0{,}1583 \cdot 1{,}00 + 0{,}4749 \cdot 1{,}00 + 0{,}0912 \cdot 0{,}70 + 0{,}1237 \cdot 1{,}00 + 0{,}0448 \cdot 0{,}70 + 0{,}1062 \cdot 1{,}00$$
$$P1 = 0{,}9583$$

Total grades for the other three projects are in the Table VI. We can see that Project 1 got the highest grade. Obviously, it is the best choice for our organisation. It is interesting to analyse Project 2 and Project 3. They both got the same number of values "excellent" and "good". But the difference in the project total grade is extremely different. The reason for that is especially the fact that the Project 2 got an excellent value for the most dominant criteria – long-term financial benefits.

6. MS EXCEL SOFTWARE FOR THE AHP PROCESS

There are many different software that help with the use of AHP process, but they are mostly commercial and quite expensive (e. g. Expert Choice). Therefore, we have developed a simple computer application in widely popular Microsoft Excel 2007. This application enables help with simple AHP procedures. There are several steps to use the application:

- First we have to decide, how many criteria we are going to use. At the moment this application enables the use of 10 criteria. The other limitation is that all criteria have to be on the first level. We have demonstrated how this is done in the above described example.
- The application has a 10*10 matrix where we enter subjective assessments of compared pairs of criteria. We are using only the upper part of the matrix (above right of the diagonal). The values under the diagonal are calculated automatically. When we enter the subjective assessment value we have to consider which criteria is the first and which the second. For example; if the criterion A is much more important than the criterion B then we enter the value 7. If criterion B is much more important than criterion A, then we enter value 1/7 (Fig. 1).



	A	B	C	D	E	F	G	H	I	J
The numer of criteria				4						
	A	B	C	D	E	F	G	H	I	J
A	1,0000	3,00	5,00	3,00						
B	0,3333	1,0000	2,00	3,00						
C	0,2000	0,5000	1,0000	2,00						
D	0,3333	0,3333	0,5000	1,0000						
E	0,0000	0,0000	0,0000	0,0000	1,0000					
F	0,0000	0,0000	0,0000	0,0000	0,0000	1,0000				
G	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	1,0000			
H	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	1,0000		
I	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	1,00	
J	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	1,0000
	1,8667	4,8333	8,5000	9,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000

Value	Description of comparison
1	Equality
3	Somewhat greater importance of one criterion over another
5	Strong superiority of one criterion over another
7	Very strong superiority of one criterion over another
9	Absolute (highest possible) superiority of one criterion over another

Note: use of values in between (2, 4, 6, 8) is permitted.

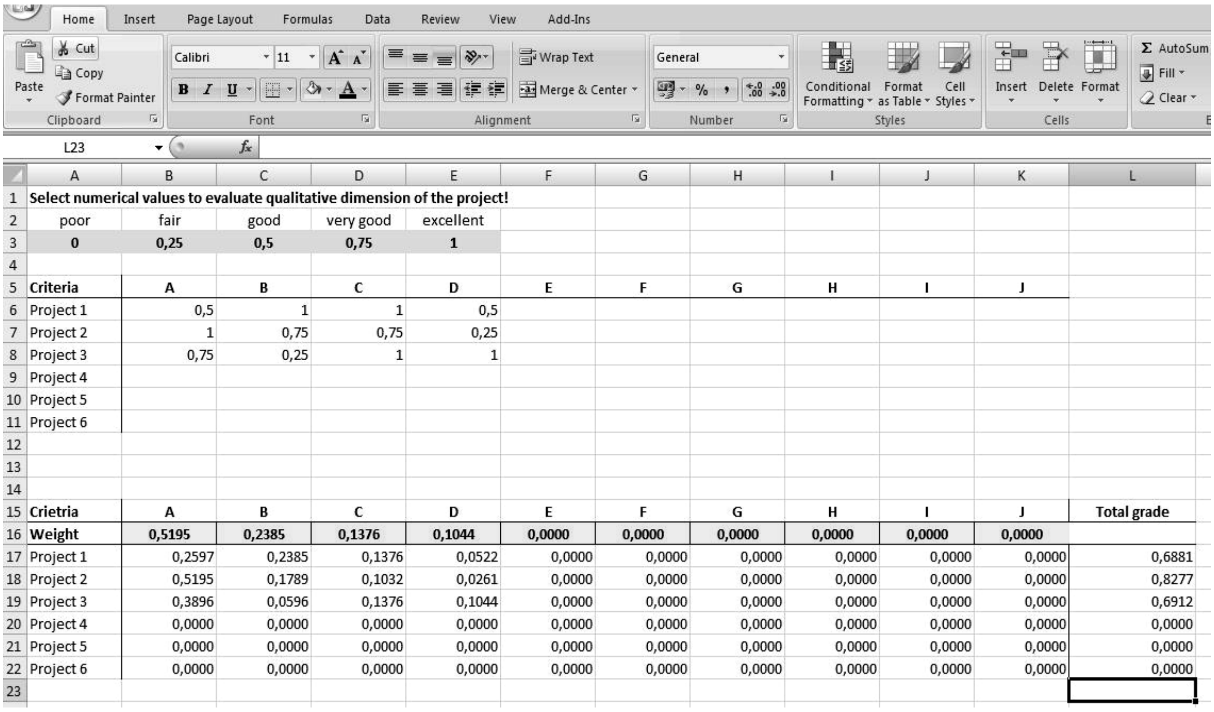
Matrix

	A	B	C	D	E	F	G	H	I	J		
A	0,5357	0,6207	0,5882	0,3333	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	2,0780	51,95%
B	0,1786	0,2069	0,2353	0,3333	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,9541	23,85%
C	0,1071	0,1034	0,1176	0,2222	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,5505	13,76%
D	0,1786	0,0690	0,0588	0,1111	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,4175	10,44%
E	0,0000	0,0000	0,0000	0,0000	1,0000	0,0000	0,0000	0,0000	0,0000	0,0000	1,0000	0,00%
F	0,0000	0,0000	0,0000	0,0000	0,0000	1,0000	0,0000	0,0000	0,0000	0,0000	1,0000	0,00%
G	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	1,0000	0,0000	0,0000	0,0000	1,0000	0,00%
H	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	1,0000	0,0000	0,0000	1,0000	0,00%
I	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	1,0000	0,0000	1,0000	0,00%
J	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	1,0000	1,0000	0,00%
												100,00%

Figure 1: The calculation of criteria importance with the AHP MS Excel application.

The application automatically calculates the weight factors of the criteria importance. These values are also automatically transferred into the next phase. The first task in the second phase is to establish the scoring scale for the qualitative dimensions of the project.

Each qualitative dimension receives a numerical value and these values are entered in the second matrix. The application enables analysis of 6 projects at the time. The application calculates the total grade for all projects based on criteria weights and qualitative dimensions expressed in numerical values (Fig. 2).



	A	B	C	D	E	F	G	H	I	J	K	L
1	Select numerical values to evaluate qualitative dimension of the project!											
2	poor	fair	good	very good	excellent							
3	0	0,25	0,5	0,75	1							
4												
5	Criteria	A	B	C	D	E	F	G	H	I	J	
6	Project 1	0,5	1	1	0,5							
7	Project 2	1	0,75	0,75	0,25							
8	Project 3	0,75	0,25	1	1							
9	Project 4											
10	Project 5											
11	Project 6											
12												
13												
14												
15	Crietria	A	B	C	D	E	F	G	H	I	J	Total grade
16	Weight	0,5195	0,2385	0,1376	0,1044	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	
17	Project 1	0,2597	0,2385	0,1376	0,0522	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,6881
18	Project 2	0,5195	0,1789	0,1032	0,0261	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,8277
19	Project 3	0,3896	0,0596	0,1376	0,1044	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,6912
20	Project 4	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
21	Project 5	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000
22	Project 6	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000

Figure 2: The calculation of project total grade with the AHP MS Excel application.

7. CRITERIA SIMULATION

The MS Excel application does not just allow simple calculation of the project total grade based on the AHP process, but it also helps with decision-making process when we have to simulate different situations. This situations address changes in setting criteria importance. The process of determining differences in importance of two criteria is still very subjective assessment. By changing the values in pair wise comparisons of the criteria, we can immediately see the effect of these changes on the total grade of the project. We are going to present the effects of these changes on a hypothetical example with two projects that are evaluated with 5 criteria. Let us assume that the initial comparison of the criteria has been performed with the results presented in Table VII. The lower part of the Table VII presents how both projects fulfil specific criteria.

We can see that the criterion A is the most important (48,99 %). We can also see that based on qualitative evaluation of both projects considering the criteria fulfilment, Project 1 is slightly better choice than Project 2.

There is no disputes on the fact how both project fulfil selected criteria – all managers completely agree. But the managers do not agree on the importance of specific criteria. The top manager of the company believes that criterion A is even more important in comparison to other four criteria. He wants to raise values from 3 to 5, from 5 to 7 and from 7 to 9. What happens? Criterion A receives the weight of 57,72 %. But how does that affect the total grade of the project? The analysis shows that Project 1 does not have the highest total grade. Suddenly Project 2 receives a higher grade and it is better choice than Project 1 (Project 1: 0,7671 and Project 2: 0,7974). By simulating differences in the criteria importance we can instantly see what happens to the total grade of projects. It is a direct proof that selecting criteria and determining their importance should be a very carefully implemented process.

Table VII: Case study 1.

	A	B	C	D	E	**Weight**
A	1,0000	**3,00**	**5,00**	**5,00**	**7,00**	**48,89 %**
B	0,3333	1,0000	**3,00**	**1,00**	**5,00**	**20,57 %**
C	0,2000	0,3333	1,0000	**3,00**	**3,00**	**14,37 %**
D	0,2000	1,0000	0,3333	1,0000	**3,00**	**14,41 %**
E	0,1429	0,2000	0,3333	0,3333	1,0000	**4,63 %**

Criteria / Project	**A**	**B**	**C**	**D**	**E**	**Total grade**
Project 1	0,75	0,4	0,4	0,75	0,75	**0,7728**
Project 2	1	0,4	0,4	0,75	0,4	**0,7553**

Another situation can occur when we evaluate and select projects. It is quite possible that we have to change certain project characteristics. Maybe we have decided to reduce or enlarge project scope, change specific goals, eliminate, change or add some resources, remove or add some activities etc. In this case there is a big chance that the project suddenly fulfils selected criteria differently. Therefore, we have to evaluate each project again and determine the level of satisfying each criterion.

We will use the above described case. The B criterion is our case is the level of available funds for the project. We had to add specific human resources to Project 1 in order to improve the quality of project's end results. Additional resources were external and much more expensive than internal human resources. Therefore, we had to raise the project budget. Suddenly, our Project 1 fulfils criterion B on a much lower level – e. g. level good. Look what happens. Project 1 receives much lower total grade.

Table VIII: Case study 2.

Criteria / Project	**A**	**B**	**C**	**D**	**E**	**Total grade**
Project 1	0,75	1	0,4	0,75	0,75	**0,6493**
Project 2	1	0,4	0,4	0,75	0,4	**0,7553**

The software application helps with calculating project total grades when we simulate different levels of criteria fulfilment.

8. CONCLUSIONS

The AHP process is nowadays used in various decision-making situations. We have decided to present its use for evaluating and selecting projects. AHP can dramatically improve the process of developing project proposals. Its biggest strength is systematic approach in several steps and its ability to lower subjectivity of managers who have to decide between project alternatives. On the other hand, AHP has several weaknesses when used for selecting projects. The first weakness is that it ignores that certain choices can lead to negative results. The second limitation is that AHP requires that all criteria must be fully exposed and accounted at the beginning of the selection process. It also allows more powerful members of the organisation to cheer for their own projects and hinder the open selection process. The process itself can be quite difficult to understand, it also requires some mathematical effort. Therefore, we have developed a simple to use software application that can help managers when evaluating project proposals. At the same time this tool enables simple simulation.

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