

THE ISSUE OF MULTICRITERIA DECISION-MAKING: MODEL EXAMPLE OF BUSINESS PARTNER RISK ASSESSMENT

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ABSTRACT

Decisions are made every day in business practices. Some are implemented intuitively, others by using some of the relevant decision-making methods. Decision-making theory is a relatively young discipline. It has started to develop as a separate area in recent years. Under the influence of globalization, new ideas penetrate into this theory. Decision-making is no longer an intuitive process. Managers are aware of the seriousness of the consequences of each decision. A good decision-making process is the foundation of success. In our contribution, we focus on decisions that have a multicriteria character. The first part of the contribution deals with the theoretical basis of decision-making processes with a focus on multicriteria decision-making under the conditions of globalization. Furthermore, we deal with the rationality of these processes, whose understanding is very important in rapidly changing market conditions. In the practical part of the paper, we deal with the methods and techniques used in the multicriteria decision-making process applied to the model example of business partner risk assessment. In the final part, we evaluate the results of using several methods. The aim of our contribution is to provide a theoretical approach to the issue of the multicriteria decision-making process with a focus on the globalization aspect and application of selected methods to the model example.

KEYWORDS *financial health, Fuller triangle, multicriteria decision-making, Oreste, Pattern.*

1. INTRODUCTION

Decision-making can be defined as one of the basic managerial activity. The quality of this process significantly influence results and effectivity of organizations. At present, decision-making cannot be defined as a random process (Balcerzak et al., 2018). Precise preparation, acquisition of necessary data, their analysis and evaluation form the basis of a rational decision-making process (Krulicky & Horak, 2019). Managers at all levels of management should acquire a set of knowledge and techniques that are important to ensure the quality of the decision-making tasks. The aim of our contribution is to provide a theoretical approach to the issue of multicriteria decision-making with a focus on the globalization aspect and application of selected methods to the model example.

The first part of the contribution describes historical the development of management and decision-making process as an important part of management. This part is also focused on the theoretical background of the decision-making process in the business practice, classification of decision-making process. Attention is especially paid to multicriteria decision-making. Next, authors deal with selected methods and techniques of multicriteria decision-making, namely PATTERN method, Fuller triangle method and ORESTE method that are subsequently used to the model example of business partner risk assessment. In the practical part of the contribution results of model example

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obtained by using selected methods are presented and compared. Final part consists of summary of obtained results.

2. LITERATURE REVIEW AND THEORETICAL BACKGROUND

Knowledge of the history of any subject is necessary to understand where the subject came from, where it is now, and where it is going (Vochozka et al., 2018). It can be said that some forms of management have existed since the beginning of time. The development of management as we know it is a relatively modern concept. The age of industrialization in the nineteenth century and the subsequent emergence of large corporate organizations called for new approaches to management. Management as a term for a new discipline dealing with managing activities in the business has begun since the 19th century in the US. The beginning of management is connected with the period of the onset of the industrial revolution and the rapid development of industrial production. (Gavurova et al., 2017) At that time there was no theory of management as we know it now, nor the possibility of studying it. The beginnings of management theory development were supported by two schools, namely classical and neoclassical. Representatives of classical theory are Frederic Winslow Taylor, Max Weber and Henry Ford. Neoclassical school was focuses on the psychological and sociological aspects of management. Among the leading representatives of the neoclassical school of management is Elton Mayo. Management is referred to as a set of activities leading to the achievement of business goals. (Vinczeova & Kascakova, 2017)

2.1 The role of decision-making in the concept of management

Most contemporary management theorists emphasize the essence of modern management in decision-making. (Kantarelis, 2018) One group of theorists identify management with decision-making as such. Others understand the concept of management in a broader sense than the concept of decision-making. (Sadaf et al., 2019) We also see differences between decision-making and the concept of management. The role of decision-making in the concept of management is shown in the following figure 1.

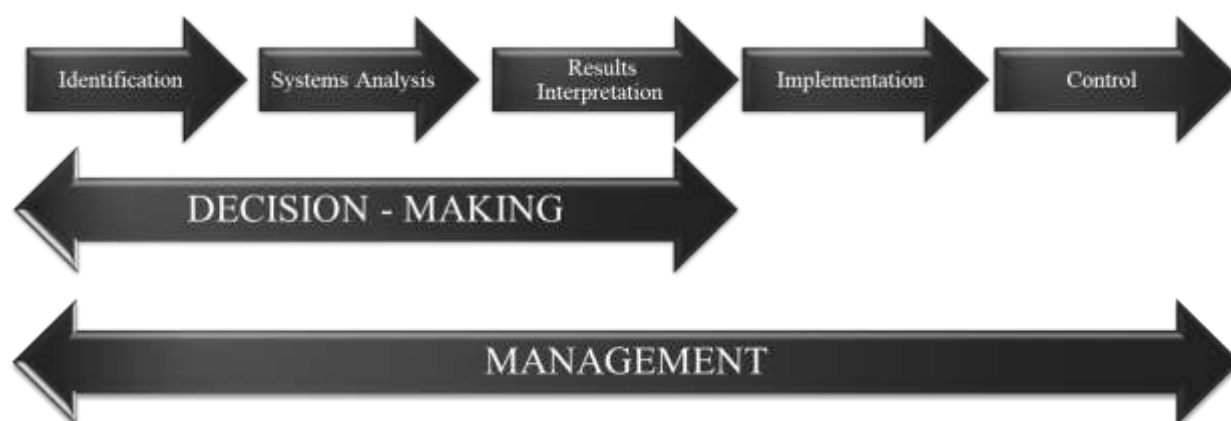


Figure 1. The role of decision-making in the concept of management

Source: Authors

Management represents a purposeful influence on the object in order to achieve the stated goal, while decision-making can be understood as a purposeful activity connected with the selection of one variant. (Rogalska, 2018) All activities form the essence of management and are fully characteristic of the activities of managers. Despite the fact that we do not identify the terms "management" and "decision-making" we state that decision-making has a privileged position in

the management. The results of planning, organizing, coordinating and working with people are realized through decision-making.

2.2 Characteristics and the elements of decision-making process

Decision-making processes are defined as processes of solving tasks with more than one solution variants. They are processes of finding the optimal solution. If there is no more than one solution or there is no solution, we cannot talk about the decision-making process (Neary et al., 2018). Figure 2 shows the structure of decision-making process.



Figure 2. Structure of decision-making process

Source: Fotr et al., 2010

Intelligence activities consist of analysis of business environment. Business environment significantly influence each company, decision-making process in the company and also possibilities of solving problems. Design activities lead to design of available solutions. Review activities can be defined as a control of realized decisions. The decision-making process in the company is cyclical. New decision-making situations arise in the company every minute. The decision-making process in a company does not usually end with one decision. One decision will create the need for more.

Authors (Cicekli et al., 2018) distinguish these main elements of decision-making process:

- Objective of decision - making
- Decision - making criteria
- Decision-making problem
- Subject of decision-making
- Object of decision-making
- Decision-making variants
- Consequences of decision - making
- World states (states of surroundings)
- Decision-making methods

Individual elements of decision-making process are describe at model example in the methodology part of our contribution.

2.3 Methods and its classification

The decision-making methods are a summary of the rules and procedures that are used by the decision-maker and help to choose the optimal option within the given decision problem. (Frini & Ben Amor, 2019)

The choice of the appropriate method is determined by the character of the decision-making process, the conditions of decision-making, the availability and quality of information, the qualification of the decision-maker and others factors.

The most common classification of decision-making methods is determined by level of awareness. (Herbert, 1960) We can distinguish:

- Decision-making methods under the conditions of certainty
- Decision-making methods under the conditions of risk
- Decision-making methods under the conditions of uncertainty

Under the conditions of certainty, the manager has enough information to know for sure the outcome of the decision before it is made. The task of the manager is to compare the results of the options and to choose the option that will bring him the most benefit. Most managerial decisions are made under conditions of risk. Risks exist when the individual has some information regarding the outcome of the decision but does not know everything when making decisions under conditions of risk, the manager may find it helpful to use probabilities. To the degree that the probability assignment is accurate; he or she can make a good decision. Uncertainty exists when the probabilities of the various results are not known. The manager feels unable to assign estimates to any of the alternatives. (Kolios et al., 2010; Kittur et al., 2015)

3. MULTICRITERIA DECISION-MAKING

Under the conditions of certainty, authors distinguish two types of decision-making based on the number of criteria. The simpler type is decision-making based on the only one criterion. More difficult but in practice more often is multicriteria decision-making. Contribution is focused on the multicriteria decision-making. Basic characteristics of multicriteria decision-making are: (Tzeng & Huang, 2011; Mulliner et al., 2016)

- *Multicriteria character of decision problems*

It means that we consider more than one criterion.

- *Non-additivity of criteria*

It means that criteria are expressed in different units of measure.

- *Mixed set of criteria*

It means that some criteria are quantitative, some qualitative, some of them the decision maker wants to maximize, others minimize.

Multicriteria decision-making can be divided into two steps. The first step consists of the rough assessment of criteria and variants to exclude non-compliant ones (dominance principle, limiting criteria, setting minimum or maximum values for criteria that a decision maker is willing or be able to respect). The second step is focused on detailed evaluation of the reduced number of criteria and variants. There are several methods that can be used within this type of decision-making. In the framework of multicriteria decision-making, 2 problems are solved:

- *Modeling preferences between criteria by using the selected weighing method*
- *Modeling preferences among alternatives in terms of individual criteria and aggregating them to express overall preference by using the selected methods for assessing variants*

In this theoretical part, classification of this methods created by authors can be seen.

Most multicriterial decision-making methods require the determination of weights for individual assessment criteria first. Weighting methods are used to model preferences between criteria - thus determining how important each criterion is for the decision maker. Weights of individual criteria

means its significance coefficients numerically expressed. The more significant the criterion is, the higher its weight is and vice versa. Weights are normally standardized. It means that the sum of weights is 1.

3.1 Classification of weighting methods

Classification of weighting methods depends on the answer to the question: Is it necessary to know the consequences of options?

- "YES"
 - *Methods for direct determination of weights*
 - Point scale
 - Allocation of 100 points
 - Determination of preferential order
 - *Indirect weighting methods based on pairwise comparison of significance criteria*
 - Paired comparison method (Fuller's triangle)
 - Saaty's method
- "NO"
 - *Compensation methods for determining the weights of individual criteria*

3.2 Classification of methods for assessing variants

Methods of assessing variants are used to model preferences among alternatives in terms of individual criteria. According to the decision-maker's information on preferences among the criteria, we distinguish:

- *Methods that do not require preference information*
- *Methods with information on aspiration levels of criteria*

It means that manager is able to express his preferences among the criteria by entering an aspiration level criteria - i.e. minimum or maximum allowable value, which makes the alternatives divided into acceptable and unacceptable.

- *Methods with ordinal information on criteria*

It means that manager can arrange the criteria from the most important to the least important.

- *Methods with cardinal information*

It means that manager can decide on the relative importance of the criteria, which can be expressed by using a vector of weights.

Methods used in this contribution are described in details in the methodology part of paper.

4. METHODOLOGY

Every decision-making process is defined by its partial elements. Decisions are made every day in each sphere of business. Managers solve many situation that need to be decided. Decision problem and others partial elements of chosen model decision-making process are described below.

Decision-making problem

We decided to describe model example of multicriteria decision-making process based on business partner risk assessment. Entering to business relationships is the essence of business. Most business owners are not indifferent with who enter into a business relationship. The business partner's approach, performance, stability, and integrity reflect and influence the quality and success of both business partners. The reputation of a business partner, its stability, and the ability to fulfil contractual obligations has a significant impact on the position, business success and performance of their business. Respondents of the Slovak Compliance Circle survey (www.slovakcompliancecircle.sk) identified the risks associated with the operation, sale and

reputation of the company as the most serious impacts. They state that the problem in one business relationship negatively affects the others. The companies deal with business relations, up to 9 out of 10 respondents confirmed that their companies are conducting business relations screening in some form. Half of them approach this screening systematically, thoroughly and independently. Businesses also have internal rules for this. Our model example deals with risk assessment for establishing a business relationship with a new business partner.

Decision-maker

Because it is a model example authors were set as decision-maker.

Decision-making object

As a decision-making object new business partners with whom we plan to potentially establish cooperation can be understood.

The aim of decision-making process

Selection of a suitable business partner based on the assessment of potential risks.

Criteria, variants (alternatives) and consequences

Multicriteria matrix can be used to describe these three elements of multicriteria decision-making process.

$$\begin{array}{c}
 \\
 a_1 \\
 a_2 \\
 \cdot \\
 \cdot \\
 a_p
 \end{array}
 \begin{bmatrix}
 f_1 & f_2 & \cdot & \cdot & f_k \\
 y_{11} & y_{12} & \cdot & \cdot & y_{1k} \\
 y_{21} & y_{22} & \cdot & \cdot & y_{2k} \\
 \cdot & \cdot & \cdot & \cdot & \cdot \\
 \cdot & \cdot & \cdot & \cdot & \cdot \\
 y_{p1} & y_{p2} & \cdot & \cdot & y_{pk}
 \end{bmatrix}$$

Where:

$f_1, f_2, \dots, f_k$ the decision criteria used to select the most appropriate alternative,

$a_1, a_2, \dots, a_p$ the variants (alternatives),

$y_{11}, y_{12}, \dots, y_{pk}$ the consequences.

In determining the criteria, we used the results of the above survey. The survey has shown that businesses focus on different areas when screening a business partner. They are most interested in the financial stability of the partner (92% of those involved in screening), its background and ownership structure (81%), but also in establishing, referring and reputation in terms of association with illegal / unethical conduct (around 70%). on the basis of the above, the following criteria were established:

- selected indicators of financial-economic analysis (liquidity indicator, maturity of liabilities, achievement of profit during the last 3 years),
- duration of market operation,
- a type of ownership.

Five companies from the same industry have been selected for the example application that we will consider as potential business partners and identify them as a_1, a_2, a_3, a_4, a_5 .

4.1 Methods of decision-making process

We decided to use three methods. The first is so called PATTERN method. It means Planning Assistance Through Technical Evaluation of Relevance Number. It is one of the most used methods from methods of determining the utility of variants. Using one of the two formulas is depend on the type of criteria. The following formula is used for criteria that the decision maker wants to maximize.

$$h_i^j = \frac{x_i^j}{x_i^0} \quad (1)$$

The following formula is used for criteria that the decision maker wants to minimize.

$$h_i^j = \frac{x_i^0}{x_i^j} \quad (2)$$

Where:

- h_i^j partial evaluation of the j -th variant with respect to the i -th criterion,
- x_i^j consequence of the j -th variant with respect to the i -th criterion,
- x_i^0 consequence of the the lowest-performing variant with respect to the i -th criterion.

For the overall evaluation of individual variants we use the following formula.

$$H^j = \sum_{i=1}^n v_i \cdot h_i^j \quad (3)$$

Where:

- H^j overall evaluation of j -th variant,
- v_i weight of i -th criteria,
- h_i^j partial evaluation of the j -th variant with respect to the i -th criterion,
- n number of criteria.

The next method is so called ORESTE method. This method requires knowledge of cardinal information. The extended ORESTE method consists of six partial steps, with only the first three often used to solve common problems in practice to simplify it. The first step is consists of calculation of vector q the matrix P . The vector $q = (q_1, q_2, \dots, q_k)$, where q_j express the order of importance of j -th criterion. The matrix $P = (p_{ij}), i = 1, 2, \dots, p$ a $j = 1, 2, \dots, k$, where p_{ij} is the order of a_i variant according to the j -th criterion. Then we calculate a distance matrix from a fictitious beginning using. To calculate the elements of the matrix $D = (d_{ij})$ the following formula is used.

$$d_{ij} = \left[\frac{(p_{ij})^r}{2} + \frac{(q_j)^r}{2} \right]^{1/r}, \text{ where } r = 3 \text{ is the most common. It is also called as Dumjovic exponent.}$$

The next step is arranging the alternatives and a matrix creation $R = (r_{ij})$ according the following criteria. We assign d_{ij} values from the smallest to the largest and give them a serial number. We enter their order in the R matrix instead of the values d_{ij} . We calculate a row total for each variant, sorting it from the smallest to the largest to get the preferential arrangement of the variants.

The last one using method is Fuller Triangle also known as method of paired comparison. The Fuller method can be used for a number of criteria. It is based on a paired comparison of criteria where it is necessary to decide on the importance of the criterion. For this evaluation, it is possible to use the Fuller triangle, provided that the criteria are marked with serial numbers $1, 2, 3, \dots, n$. It is made up of double rows in which each pair of criteria occurs only once. For each pair, the criterion that is more important for the scorer is marked. For the standard weight criterion v_i the following formula is used.

$$v_i = \frac{f_i}{\sum_{i=1}^n f_i} \quad (4)$$

Where:

- v_i the standard weight of i -th criterion,
 f_i the number of preferences of the i -th criterion,
 n number of criterion.

Subsequently, preferences between alternatives are calculated in the same way. The result is the sum of the multiple of the weight of the criterion and the number of preferences relative to the alternatives.

5. RESULTS AND DISCUSSION

Results of the model example by using selected methods of multi-criteria decision are presented in this part of the contribution. At the beginning we create the matrix that describes criteria, alternatives and consequences of selected alternatives considering the selected criteria.

Table 1. Multicriteria matrix

	f_1	f_2	f_3	f_4	f_5
a_1	1,24	41	yes (1)	12	Limited Liability Company (1)
a_2	0,8	69	yes (1)	22	Self-employed (0)
a_3	1,92	22	no (0)	3	Limited Liability Company (1)
a_4	0,75	59	no (0)	5	Limited Liability Company (1)
a_5	1,38	30	yes (1)	10	Self-employed (0)

Source: Authors.

Three quantitative criteria liquidity indicator (f_1); maturity of liabilities (days, f_2); and duration of market operation (years, f_4) were used to describe potential business partners ($a_1 - a_5$) and also two qualitative criteria achievement of profit during the last 3 years (yes or no, f_3); and the type of ownership (f_5). Qualitative criteria were transformed to quantitative. If company achieves profit during the last 3 years – 1, otherwise – 0. Our sample included businesses with two types of ownership. In general, the limited liability company is considered to be more reliable, so this type has been marked as – 1, otherwise – 0. Another feature of multicriteria decision-making is that manager wants to maximize some criteria, while minimizing others. We want to minimize the only one criterion – f_2 .

5.1 Results of using PATTERN Method

Formulas 1,2 are used to calculate the utility of each variant considering the selected criteria. As was mentioned above, the type of equation depends on whether it is a criterion we want to maximize or minimize.

Table 2. Results of using PATTERN Method

	f_1	f_2	f_3	f_4	f_5	$H^j = \sum_{i=1}^n v_i \cdot h_i^j$	Order of variants from optimal
a_1	1,65	1,68	1	4,00	1	9,33	2.
a_2	1,07	1,00	1	7,33	0	10,40	1.
a_3	2,56	3,14	0	1,00	1	7,70	4.
a_4	1	1,17	0	1,67	1	4,84	5.
a_5	1,84	2,30	1	3,33	0	8,47	3.

Source: Authors.

If we do not consider different importance of individual criteria (we do not set the weight), the order of variants is shown in the table 2.

5.2 Results of using Fuller Triangle Method

Determination of the weights in this method is based on the number of preferences that the criterion gets when pairwise comparison of criteria is done. We assume that:

- Liquidity is less important than maturity of liabilities and profit. It is more important than ownership and the number of years in the market
- Maturity of liabilities is less important than profit but more important than ownership and the number of years in the market.
- Profit is less important than the number of years in the market but more important than ownership.
- The number of years in the market is more important than ownership.

Table 3. Results of using Fuller Triangle Method

	Number of preferences	Modified number of preferences	Standardized modified number of preferences (weight of criterion)
f_1	2	3	0,2
f_2	3	4	0,27
f_3	3	4	0,27
f_4	2	3	0,2
f_5	0	1	0,07

Source: Authors.

In the next step we compare the alternatives in pairs considering the selected criteria.

Table 4. Results of using Fuller Triangle Method.

	Order of variants from optimal
a_1	1.
a_2	3.
a_3	2.
a_4	4.
a_5	1.

Source: Authors.

5.3 Results of using ORESTE Method

The ORESTE method requires knowledge of ordinal information. This means that the decision maker is able to order the criteria from the most important to the least important. The generated vector is an expression of this ordering. We assume that the ordering of criteria is as follow: the most important indicator is maturity of liabilities, achievement of profit during the last 3 years, liquidity indicator, duration of market operation and the least important is the type of ownership.

$q = (3, 1, 2, 4, 5)$

Then we create the matrix P .

$$\begin{pmatrix} 3 & 3 & 2 & 3 & 2 \\ 4 & 5 & 2 & 1 & 4,5 \\ 1 & 1 & 4,5 & 5 & 2 \\ 5 & 4 & 4,5 & 4 & 2 \\ 2 & 2 & 2 & 4 & 2 \end{pmatrix}$$

In the next step we create the matrix D .

$$\begin{pmatrix} 3,00 & 3,00 & 2,60 & 3,00 & 2,60 \\ 3,19 & 3,98 & 1,65 & 1,00 & 3,58 \\ 1,65 & 1,65 & 3,67 & 4,05 & 2,00 \\ 4,55 & 4,00 & 4,26 & 4,00 & 3,30 \\ 4,05 & 4,05 & 4,05 & 4,55 & 4,05 \end{pmatrix}$$

Then we create the matrix R .

$$\begin{pmatrix} 9 & 9 & 6,5 & 9 & 6,5 \\ 11 & 15 & 3 & 1 & 13 \\ 3 & 3 & 14 & 20 & 5 \\ 24,50 & 16,5 & 23 & 16,5 & 12 \\ 20 & 20 & 20 & 24,50 & 20 \end{pmatrix}$$

We calculate a row total for each variant, sorting it from the smallest to the largest to get the preferential arrangement of the variants.

Table 5. Results of using ORESTE Method.

	Order of variants from optimal
a_1	1.
a_2	2.
a_3	3.
a_4	4.
a_5	5.

Source: Authors.

6. CONCLUSION

This contribution presents an application of multiple criteria decision-making methods to model example of financial health assessment. The default of companies is the problem of every economy in the world. Defaults can have various forms, various manifestations and consequences. In particular, the consequences are the engine of research and development of methods and models that help predict the failure in advance. (Valaskova et al., 2018). Businesses enter into business relationships with other businesses on a daily basis. Financial health is also largely influenced by the financial health of trading partners. Every corporation has an economic and moral responsibility to its stockholders to perform well financially. However, the number of bankruptcies in Slovakia has been growing for several years without an apparent macroeconomic cause. (Kliestik et al., 2018) One of the four invoices in the enterprise is overdue. (Siekelova, 2015; Siekelova & Podhorska, 2016) This fact is very striking. Therefore, it is important for businesses to assess the financial health of a business partner before they enter into a business relationship. This evaluation is mainly based on the evaluation of selected indicators of financial analysis. We used several methods of multicriteria decision-making to assess the potential financial risk of the business partner. Decision-making theory is a relatively young discipline. It has started to develop as a separate area in recent years. Under the influence of globalization, new ideas penetrate into this theory. Decision-making is no longer an intuitive process. In conclusion, we can state that:

- Despite all efforts, the decision-making process is largely subjective and thus influenced by the person of the decision-maker.
- The choice of the method and its complexity depend on the decision-making situation.
- The use of computer technology plays an increasingly important role in the decision-making process.
- We recommend supporting one method with the other.
- Different methods produce different results.

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