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Team Member Selecting Based on AHP and TOPSIS Grey

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Problem of selecting a person as a new personnel or member of any group is a critical issue in human resource management. Personnel selection is a big challenge in all types of companies, organizations and communities, involving multiple issues that should be evaluated simultaneously. A group as a team should work in the best form to attain its goals. Accordingly, a complex decision support methodology for effective team members' selection is required.
The aim of the current research is to develop the decision model for human resource management that aggregates experts' knowledge and deals with uncertain information. The current paper considers a model based on hybrid Multiple Criteria Decision Making (MCDM) methods as a framework for the challenge of personnel selection. Analytic Hierarchy Process (AHP) and the Technique for Order Preference by Similarity to Ideal Solution with Grey Relations (TOPSIS grey) are applied for this aim. AHP is used for identifying the importance of each criterion when selecting a group member. TOPSIS grey is applied for ranking of alternatives, i.e. particular personnel, characterized by a set of criteria that are determined by grey relations and expressed in intervals.
A case study about process of selecting a new drummer for a rock band is presented to demonstrate the applicability and the effectiveness of the proposed model. Criteria as technical ability, ability of accommodation to band and genre, discipline, ability to work with band (teamwork), general issues like age, behavior, ideology and etc., ability of composing and motivation are prioritized from the most important to the least important, respectively, based on AHP results. Four potential candidates are considered. One of them is selected as the best drummer for the band among four applicants based on TOPSIS grey results.
The presented hybrid multiple criteria decision making helps to perform personnel selection effectively and objectively when multiple criteria are evaluated simultaneously. The first part of the proposed methodology, i.e. AHP is useful for determining the importance of each criterion and calculating weight of each criterion, while the second part with TOPSIS grey is useful for evaluating alternatives more precisely than usual crisp TOPSIS. The model can be implemented as an effective decision aid to improve human resources management in various areas of economic activities.

Keywords: *human resource management, personnel selection, group member selecting, AHP, TOPSIS grey, rock bands.*

Introduction and literature review

Human resources management policy and personnel selection is an important part of any business activity. Personnel selection process is aimed at choosing the best candidate to fill the vacancy in a company or in any other group. To improve the group member selection process it is important to develop and apply a proper decision making tool, involving a set of decision criteria and a particular methodology for evaluating and ranking of alternatives.

In literature, there exist numerous studies conducted with the aim of performing personnel selection within the boundaries of objective criteria (Dagdeviren and Yuksel, 2007). Fuzzy sets constitute one group of mathematical methods applied for human resource management. Miller and Feinzig (1993) suggested the fuzzy sets theory for the personnel selection challenge. Liang and Wang (1994) presented an algorithm which also uses the fuzzy sets theory. In this algorithm, subjective criteria, such as personality, leadership, and past experience, along with some objective criteria, such as general aptitude, and comprehension were used. Capaldo and Zollo (2001) presented a case study applying fuzzy logic to personnel assessment. Karsak *et al.* (2003) modeled personnel selection process by using fuzzy multiple criteria programming and evaluated qualitative and quantitative factors together via membership functions in this model. The study of Chien and Chen (2008) aimed at developing data mining framework based on decision tree and association rules to generate rules for personnel selection.

Multiple criteria decision making is other group of methods for personnel selection as reported in literature (Bohanec *et al.*, 1992; Timmermans and Vlek, 1992; Gardiner and Armstrong-Wright, 2000; Spyridakos *et al.*, 2001; Jessop, 2004). These methods can be effectively employed while evaluating a multitude of factors together in the solution of especially large and complicated problems (Dagdeviren and Yuksel, 2007). Some of the recent applications of MCDM methods in personnel selection are briefly reviewed further. Dagdeviren and Yuksel (2007) and Boran *et al.* (2008) used Analytic Network Process (ANP) for personnel selection, while Dagdeviren (2010) combined ANP and TOPSIS; Lin (2010) integrated ANP and fuzzy data envelopment analysis (DEA) approach for the analogous task. DEA was used for human resource allocation by Knezevic *et al.* (2011). Gibney and Shang (2007) used AHP as well as Gungor *et al.* (2009) used fuzzy AHP approach to personnel selection problem. Fuzzy TOPSIS for the same problem was applied by Kelemenis and Askounis (2009). Celik *et al.* (2009) developed fuzzy integrated multi-stages evaluation model on academic personnel recruitment under multiple criteria. As the fuzzy set theory helps to incorporate imprecise data, fuzzy TOPSIS was successfully applied by Kelemenis and Askounis (2010). Dursun and Karsak (2010) proposed a method to manage heterogeneous information using both linguistic and numerical scales, applying 2-tuple linguistic representation and Technique for Order Preference by Similarity to Ideal Solution. Two-tuple linguistic computing for supplier selection was successfully applied by Balezentis and Balezentis (2011). Vainiunas *et al.* (2010) used crisp AHP and Additive Ratio Assessment (ARAS), while Kersuliene and Turskis (2011) applied fuzzy AHP and ARAS for architect selection. Hashemkhani Zolfani *et al.* (2012b) proposed AHP and Complex Proportional Assessment with Grey Relations (COPRAS-G) for quality control manager selection. Unique task of sniper selection as a subset of personnel selection was performed by applying fuzzy ANP, fuzzy TOPSIS and fuzzy ELECTRE technique by Kabak *et al.* (2012).

In the current research a new approach for effective personnel selection is developed. The presented model is based on hybrid MCDM methods and it consists of Analytic Hierarchy Process (AHP) and the Technique for Order Preference by Similarity to Ideal Solution with Grey Relations (TOPSIS grey). A case study of selecting a group member for a rock band is presented.

Methodology: Analytic Hierarchy Process and TOPSIS grey

The multi criteria decision-making could be applied to assess different alternatives of future activities. Multiple criteria decision making (MCDM) is an advanced field of operations research that provides a wide range of methodologies for decision makers and analysts. These methodologies are well suited to the complexity of economical decision problems. For a complex overview see Hwang and Yoon (1981), Figueira *et al.* (2005), Zavadskas and Turskis (2011). Over the last decade a number of researchers have developed a set of new MCDM methods and applied them to solve scientific as well as practical problems. For a complex overview of developments and applications see Kaplinski and Tupenaite, 2011; Kapliński and Tamosaitiene, 2010; Tamosaitiene *et al.,* 2010.

Solving of modern decision making problems is based on integrated models of different approaches in most cases. As the best strategy could be selected from available scenarios and information often dealing with uncertainty, the values of criteria could be determined at intervals from pessimistic value to optimistic one in strategic decisions. The limits of criteria values could be determined by experts. Determination of limits depends on the qualification and experience of expert. Therefore, it is better to collect the objective data (Zavadskas *et al.,* 2010a). Accordingly, there is a wide range of methods based on multi-criteria utility theory as well as a number of modified ones, when grey relations are integrated: SAW (MacCrimon, 1968; Zavadskas *et al.,* 2010b; Podvezko, 2011); TOPSIS (Hwang and Yoon, 1981; Zavadskas *et al*., 2010a; Zavadskas *et al.,* 2010b); COPRAS (Zavadskas *et al*., 2010a).

Analytic Hierarchy Process (AHP), first presented by Thomas L. Saaty in 1971 (Saaty, 1971), is a multiple criteria decision making method, that can be applied to overcome challenges that are under uncertain conditions or need to take several evaluation criteria into account for decision making. It aims providing the decision maker a precise reference for adequately making decision and reducing the risk of making wrong decision through decomposing the decision problem into a hierarchy of more easily comprehended sub-problems, each of which can be evaluated independently. The elements of the hierarchy can relate to any aspect of the decision problem, such as tangible or intangible, carefully measured or roughly estimated, well- or poorly-understood. It has been well utilized in several fields (Saaty, 1980) that require to choose the alternatives and the weight exploration of evaluation indices, like business (Angelou and Economides, 2009), industry (Chen and Wang, 2010).

In general, there have been discovered 13 major conditions that fit well the application of AHP, such as setting priorities, generating a set of alternatives, choosing a best policy alternatives, determining requirements, allocating resources, predicting outcomes, measuring performance, designing system, ensuring system stability, optimization, planning, resolving conflict, risk assessment (Saaty,1980). The recent applications of AHP method for different problems in shortly are presented and listed below in Table 1.

The calculation applying AHP adopts ratio scale for developing pair-wise comparison matrix. It typically can be categorized into 5 major sub-scales based on different levels of importance: equal importance, somewhat more important, much more important, very much more important, and absolutely more important. There are still 4 sub-scales with each level of importance between 5 major sub-scales. Therefore, there is an amount of nine sub-scales. The ratio values from 1 to 9 are given to each sub-scale as it is summarized in Table 2.

Table 1

Recent applications of AHP

Reference	Considered problem
Chen and Wang, 2010	Information service industry
Medineckiene *et al.*, 2010	Sustainable construction
Podvezko *et al.*, 2010	Evaluation of contracts
Sivilevicius, Maskeliunaite, 2010	Quality of transportation
Sivilevicius, 2011a	Modeling of transport system
Sivilevicius, 2011b	Quality of technology
Fouladgar *et al.*, 2011	Prioritizing strategies
Hashemkhani Zolfani *et al.*, 2011c	Forest roads locating
Lashgari *et al.*, 2011	Shaft sinking method selection
Peng *et al.*, 2011	Software defect predictors
Vaidogas and Sakenaite, 2011	Fire protection measures
Zavadskas *et al.*, 2011a	Selecting management strategy

Table 2

The ratio scale and its definition in AHP

Impor-tance	Definition	Description
1	Equal importance	Two factors contribute equally to the objective.
3	Somewhat more important	Experience and judgment slightly favor one over the other.
5	Much more important	Experience and judgment strongly favor one over the other.
7	Very much more important	Experience and judgment very strongly favor one over the other. Importance is demonstrated in practice.
9	Absolutely more important	The evidence favoring one over the other is of the highest possible validity.
2,4,6,8	Intermediate values	When compromise is needed

Resource: Saaty, 1990.

The calculation steps of AHP are presented according to Saaty (1990). Firstly, the pair-wise comparison matrix A by using the ratio scale from Table 2 is established. Let $C_1, C_2,\ldots, C_n$ denote the set of elements, where a_{ij} represents a quantified judgment on a pair of elements C_i, C_j. This yields an n-by-n matrix A as follows:

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix}, \quad (1)$$

where $a_{ij} = 1$, if $i = j$, $a_{ji} = \dfrac{1}{a_{ij}}$, $i = \overline{1,n}$ and $j = \overline{1,n}$.

In matrix A, the main problem lies in assigning to the elements $C_1, C_2,\ldots, C_n$ a set of numerical weights $W_1, W_2,\ldots, W_n$ that reflect the recorded judgments. If A is a consistency matrix, the relations between weights w_i and judgments a_{ij} are simply given by $\dfrac{W_i}{W_j} = a_{ij}$, $i = \overline{1,n}$ and $j = \overline{1,n}$. Saaty (1990) suggested that the largest eigenvalue $\lambda_{\max}$ would be

$$\lambda_{\max} = \sum_{j=1}^{n} a_{ij} \frac{W_j}{W_i}. \quad (2)$$

If A is a consistency matrix, eigenvector X can be calculated by

$$(A - \lambda_{\max} I)X = 0. \quad (3)$$

Saaty proposed utilizing the consistency index (CI) and random index (RI) to verify the consistency of the comparison matrix CR (consistency ratio). CI and CR are defined as follows (Saaty, 1990):

$$CI = \frac{\lambda_{\max} - n}{n - 1}, \quad (4)$$

$$CR = \frac{CI}{RI}, \quad (5)$$

where the RI represents the average consistency index, which is also named as the random index and was computed by Saaty (1997) as the average consistency of square matrices of various orders n which were filled with random entries.

Average consistency values of these matrices are given by Saaty and Vargas (1991) as provided in Table 3. If the CR<0.10, the estimate is accepted; otherwise, a new comparison matrix is solicited until CR<0.10.

Table 3

Values for RI

n	2	3	4	5	6	7	8
RI	0.00	0.52	0.90	1.12	1.24	1.32	1.41

Resource: Saaty and Vargas, 1991.

The TOPSIS method was developed by Hwang and Yoon (1981). The method belongs to MCDM group of methods and identifies solutions from a finite set of alternatives based upon simultaneous minimization of distance from an ideal point and maximization of distance from a negative ideal point. TOPSIS can incorporate relative weights of criteria. Lin *et al.* (2008) developed TOPSIS method with grey number operations for solving the problems with uncertain information. Zavadskas *et al.* (2010a, 2010b) used TOPSIS method with grey numbers operations to risk assessment of construction project and for contractor selection for constructions works. The recent applications of usual as well as modified TOPSIS method are listed below (Table 4).

Table 4

Recent applications of TOPSIS and TOPSIS grey

Reference	Considered problem
Čokorilo *et al.*, 2010	Comparison of the regional aircraft parameters
Ginevičius *et al.*, 2010	Multiple criteria evaluation of competitive strategies of enterprises
Zavadskas *et al.*, 2010a	Risk assessment of construction projects
Zavadskas *et al.*, 2010b	Contractor selection for construction works
Antucheviciene *et al.*, 2010	Ranking building redevelopment decisions
Han and Liu, 2011	Solving hybrid multiple attributes decision-making problems under risk
Hashemkhani Zolfani *et al.*, 2012a	Selecting the best multi-role artist of rock bands of Iran in 2000s

Lin *et al.* (2008) proposed the model of TOPSIS method with attributes values determined at intervals (TOPSIS grey) that includes the following steps:

Step 1: Selecting the set of the most important attributes, describing the alternatives.

Step 2: Constructing the decision-making matrix $\otimes X$. Grey number matrix $\otimes X$ can be defined as:

$$\otimes X = \begin{bmatrix} \otimes x_{11} & \otimes x_{12} & \cdots & \otimes x_{1m} \\ \otimes x_{21} & \otimes x_{22} & \cdots & \otimes x_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ \otimes x_{n1} & \otimes x_{n2} & \cdots & \otimes x_{nm} \end{bmatrix}, \quad (6)$$

where $\otimes x_{ij}$ denotes the grey evaluations of the *i*-th alternative with respect to the *j*-th attribute; $[\otimes x_{i1}, \otimes x_{i2}, ..., \otimes x_{im}]$ is the grey number evaluation series of the *i*-th alternative, $i = \overline{1,n}$, $j = \overline{1,m}$.

Step 3: Constructing the normalized grey decision matrices. The normalized values of maximizing attributes are calculated as (Lin *et al.*, 2008):

$$\otimes \bar{x}_{ij,b} = \frac{\otimes x_{ij}}{\max_i(b_{ij})} = \left(\frac{w_{ij}}{\max_i(b_{ij})}, \frac{b_{ij}}{\max_i(b_{ij})} \right), \quad (7)$$

where w_{ij} and b_{ij} are lower and upper values of attributes, respectively (Zavadskas *et al.,* 2010a).

The normalized values of minimizing attributes are calculated as:

$$\otimes \bar{x}_{ij,w} = 1 - \frac{\otimes x_{ij}}{\max_i(b_{ij})} = \left(1 - \frac{b_{ij}}{\max_i(b_{ij})}, 1 - \frac{w_{ij}}{\max_i(b_{ij})} \right). (8)$$

Step 4: Determining weights of the criteria q_j.

Step 5: Constructing the grey weighted normalized decision-making matrix.

Step 6: Determining the positive and negative ideal alternatives for each decision-maker. The positive ideal alternative A^+, and the negative ideal alternative A^- can be defined as:

$$A^+ = \{(\max_i b_{ij} | j \in J), (\min_i w_{ij} | j \in J')|i \in n\} = [x_1^+, x_2^+, ..., x_m^+], \quad (9)$$

$$A^- = \{(\min_i w_{ij} | j \in J), (\max_i b_{ij} | j \in J')|i \in n\} = [x_1^-, x_2^-, ..., x_m^-]. \quad (10)$$

Step 7: Calculating the separation measure from the positive and negative ideal alternatives, d_i^+ and d_i^-, for the group. There are two sub-steps to be considered: the first one concerns the separation measure for individuals; the second one aggregates their measures for the group. Accordingly, the measures from the positive and negative ideal alternatives should be calculated individually. For decision-maker *k*, the separation measures from the positive ideal alternative and negative ideal alternative are computed through weighted grey number:

$$d_i^+ = \left\{ \frac{1}{2} \sum_{j=1}^{m} q_j \left[\left| x_j^+ - \bar{w}_{ij} \right|^p + \left| x_j^+ - \bar{b}_{ij} \right|^p \right] \right\}^{\frac{1}{p}}, \quad (11)$$

$$d_i^- = \left\{ \frac{1}{2} \sum_{j=1}^{m} q_j \left[\left| x_j^- - \bar{w}_{ij} \right|^p + \left| x_j^- - \bar{b}_{ij} \right|^p \right] \right\}^{\frac{1}{p}}. \quad (12)$$

In equations (11) and (12), for $p \geq 1$ and integer, q_j is the weight for the attribute *j*, which can be determined by attribute weight determination methods. If $p = 2$, then the metric is a weighted grey number Euclidean distance function:

$$d_i^+ = \sqrt{\frac{1}{2} \sum_{j=1}^{m} q_j \left[\left| x_j^{k^+} - \bar{w}_{ij}^k \right|^2 + \left| x_j^{k^+} - \bar{b}_{ij}^k \right|^2 \right]}, \quad (13)$$

$$d_i^- = \sqrt{\frac{1}{2} \sum_{j=1}^{m} q_j \left[\left| x_j^{k^-} - \bar{w}_{ij}^k \right|^2 + \left| x_j^{k^-} - \bar{b}_{ij}^k \right|^2 \right]}. \quad (14)$$

Step 8: Calculating the relative closeness c_i^+ to the positive ideal alternative for the group. The aggregation of relative closeness for the *i*-th alternative with respect to the positive ideal alternative for the group can be expressed as:

$$c_i^+ = \frac{d_i^-}{d_i^+ + d_i^-}, \quad (15)$$

where $0 \leq c_i^+ \leq 1$. The larger the index value is, the better the evaluation of alternative will be.

Step 9: Rank the preference order. A set of alternatives now can be ranked by the descending order of the value of c_i^+

Case study

Problem formulation. Rock music is a genre of popular music that developed during and after the 1960s. It has its roots in 1940s and 1950s rock and roll, rhythm and blues, country music and also drew on folk music, jazz and classical music. The sound of rock often revolves around the electric guitar, bass guitar, drums, and keyboard instruments such as Hammond organ, piano, or, since the late 60s, synthesizers. Rock music typically uses simple rhythms in a 4/4 meter; with a repetitive snare drum back beat on beats two and four (Hashemkhani Zolfani *et al.*, 2011a). A group of musicians specializing in rock music is called a rock band or rock group. Many rock groups consist of electric guitarist, lead singer, bass guitarist, and drummer, forming a quartet (Hashemkhani Zolfani *et al.*, 2011a). Rock music is the most popular cultural phenomenon of the second half of the twentieth century and the single greatest propagator of the moral, social, and religious values of our society. Social analysts concur that rock music has become a primary force in shaping the thinking and life-style of this generation (Bacchiocchi, 1999). In the past decade rock genre had a professional change and experience and many young boys and girls have liked to be a rock star and a professional musician in rock genre. We can see people all around world who like listen to rock bands and rock superstars (Hashemkhani Zolfani *et al.*, 2011a).

Due to the developing music industry, being a musician is a professional work and it can cause changes in bands' members; in fact professional musicians can work with several bands during their professional life. Some reasons like death and family matters can cause these kinds of changes in the member of bands but most changes are due to musicians' private and financial matters (Hashemkhani Zolfani, 2012). This research focused on solving this challenge in this genre of music industry on the basis of several criteria which are important in this section and have made decision making so hard. Multi Criteria Decision Making methods (MCDM) in these issues can be useful for decision making. Accordingly, the current research applied these methods for solving this critical challenge. The recent researches about rock bands are listed below in Table 5.

Table 5

Recent researches about rock bands

Reference	Considered problem
Hashemkhani Zolfani *et al.*, 2011a	Applied Fuzzy AHP and VIKOR for evaluating rock bands of Finland in 2000s.
Hashemkhani Zolfani *et al.*, 2011b	Used AHP and TOPSIS for selecting best multi-role artist of rock bands in 2000s.
Hashemkhani Zolfani *et al.*, 2012a	Applied ANP and TOPSIS grey for selecting best multi-role artist of rock bands of Iran in 2000s.
Hashemkhani Zolfani, 2012	Used WeFA framework and Fuzzy Delphi Identifying key criteria of group member selecting of rock bands.

In the current paper, joint methodic applied, combining AHP and TOPSIS grey. AHP is useful for calculating the importance and weight of each criterion and TOPSIS grey is useful for evaluating alternatives (musicians' candidate). The method helps evaluating musicians more precisely than usual TOPSIS where crisp numbers are used for evaluating.

Data survey. One of critical challenges of rock bands is finding an appropriate person as a new member for their bands. Many criteria are important in this realm and need to be analyzed from several aspects. There are many real case studies for this challenge two of which are presented in this article as examples:

1. Avenged Sevenfold band (USA): They lost James Owen Sullivan (The Rev) due to his death on 28 December (2009). Avenged Sevenfold has involved in recording their last album called Nightmare. Michael Stephen Portnoy was the drummer of Dream Theater who joined Avenged Sevenfold just for recording Nightmare album since he is one of Sullivan's friends. Dream Theater fired him after this work and Portnoy left Dream Theater after 25 years. This challenge made a big trouble for these groups. Finally, Avenged Sevenfold hired Richard Arin Ilejay for continuing their career but he isn't a main member of bands, yet. Portnoy joined to Adrenaline Mob band and Dream Theater hired Michael Mangini instead of Portnoy.

2. Nightwish band (Finland): Bands' members decided to dismiss Tarja Soile Susanna Turunen (Lead Vocalist) from band after a concert in October 2005. Band allowed vocalists to send their demo and then band decided to select a vocalist according to their aims. Anette Olzon was selected from Sweden as a new member of this band. Nightwish released two albums in 2007 and 2011 with Anette Olzon after dismissing Tarja Soile Susanna Turunen.

Hashemkhani Zolfani (2012) presented the most important criteria for member selecting of rock bands. Based on the nature of seven evaluation criteria, optimization direction for each evaluation criterion is maximizing. The prioritizing result is presented in Table 6.

Table 6

Criteria for band member selecting

Criteria	Titles of criteria
$\otimes x_1$	Technical ability
$\otimes x_2$	General issues like age, behavior, ideology and etc.
$\otimes x_3$	Ability to work with band (Teamwork)
$\otimes x_4$	Ability of composing
$\otimes x_5$	Motivation
$\otimes x_6$	Discipline
$\otimes x_7$	Ability of accommodation to band and genre

Selecting experts. In this section experts are participated for calculating the relative importance (weights) of each criterion based on AHP. Process of selecting and evaluating musicians depends on conditions and is different from case to case process. A numerical example about selecting a new drummer for a band is presented in the chapter. Fifteen professional musicians were selected as experts consisting of 7 guitarist (5 lead guitarists, 1 rhythm guitarist and 1 bass guitarist), 4 drummers and 4 vocalists; 5 musicians of whom are leaders of their bands.

AHP calculations. A questionnaire was sent to a group of experts for pairwise comparison when applying AHP method for decision making. Information about experts is presented in previous subchapter. Criteria under comparison are presented in Table 6. The completed paired comparison matrix and calculated weights of criteria (Eq. 1 – 3) are shown in Table 7.

Table 7

Criteria paired comparison matrix

Criteria	x_1	x_2	x_3	x_4	x_5	x_6	x_7	Weights
x_1	1	5	3	6	2	1/3	3	0.236
x_2	1/5	1	3	1/4	3	1/3	1/3	0.083
x_3	1/3	1/3	1	3	1/2	3	1/4	0.113
x_4	1/6	4	1/3	1	2	1/4	1/5	0.076
x_5	1/2	1/3	2	1/2	1	1/4	1/5	0.056
x_6	3	3	1/3	4	4	1	1/4	0.194
x_7	1/3	3	4	5	5	4	1	0.241
CI =0.120; $CR = CI/RI$=0.090								

The degree of consistency rate of the pairwise comparison matrix is measured with the use of the consistency ratio (*CR*) index (Eq. 4, 5, Table 3). It is considered logically consistent if the *CR* is less than or equal to 0.100. The *CR* value for this pairwise comparison matrix is 0.090, i.e. it is acceptable.

Based on the results of AHP when weights of criteria were determined, it was evaluated that Technical ability, Ability of accommodation to band and genre and

Discipline are the most important criteria in the current case.

Selecting a new drummer with TOPSIS grey. Ranking and selecting of alternatives by applying TOPSIS grey method and the weights which were calculated in a previous step applying AHP, is performed. The initial decision-making matrix with values determined at intervals is illustrated in Table 8.

Given notations q_j are the criteria weights and $A_1,\dots, A_4$ are alternatives (candidates) in Table 8. The group of experts evaluated each candidate according to each criterion. The evaluation was done on a scale from 1 to 9, where 9 meant "very important" and 1 "not important at all".

The normalized decision-making matrix with value of each criterion expressed at intervals is presented in Table 9. As all criteria are maximized in the current case, Eq. 7 for calculating a normalized criteria matrix was applied.

Weighted normalized decision making matrix and the results of the calculation for each alternative (Eq. 9 – 15) are presented in Table 10.

Table 8

Initial decision-making matrix with values (TOPSIS grey method)

Alternatives	**Criteria**													
	$\otimes x_1$		$\otimes x_2$		$\otimes x_3$		$\otimes x_4$		$\otimes x_5$		$\otimes x_6$		$\otimes x_7$	
Optimization direction	max		max		max		max		max		max		max	
Weights q_j	0.236	0.236	0.083	0.083	0.113	0.113	0.076	0.076	0.056	0.056	0.194	0.194	0.241	0.241
A_1	6	7	8	9	7.5	8	7	7.5	7	8	8	9	6	7
A_2	7.5	8	7	8	8	9	7	8	7	8	8	9	7	8
A_3	8	9	8	9	7	8	7.5	8	7.5	8	8	9	7	8
A_4	7	8	8	9	7	8	6	7	7	8	8.5	9	6.5	7.5

Table 9

Normalized decision-making matrix (TOPSIS grey method)

Alternatives	**Normalized values of criteria**													
	$\otimes x_1$		$\otimes x_2$		$\otimes x_3$		$\otimes x_4$		$\otimes x_5$		$\otimes x_6$		$\otimes x_7$	
	$\bar{w}_1$	$\bar{b}_1$	$\bar{w}_2$	$\bar{b}_2$	$\bar{w}_3$	$\bar{b}_3$	$\bar{w}_4$	$\bar{b}_4$	$\bar{w}_5$	$\bar{b}_5$	$\bar{w}_6$	$\bar{b}_6$	$\bar{w}_7$	$\bar{b}_7$
A_1	0.666	0.777	0.888	1	0.833	0.888	0.875	0.937	0.875	1	0.888	1	0.750	0.875
A_2	0.888	1	0.777	0.888	0.888	1	0.875	1	0.875	1	0.888	1	0.875	1
A_3	0.888	1	0.888	1	0.777	0.888	0.937	1	0937	1	0.888	1	0.875	1
A_4	0.777	0.888	0.888	1	0.777	0.888	0.750	0.875	0.875	0.937	0.944	1	0.812	0937

Table 10

Weighted-normalized decision-making matrix (TOPSIS grey method)

Alterna-tives	**Weighted-normalized values of criteria**														**Preference order**	
	$\otimes x_1$		$\otimes x_2$		$\otimes x_3$		$\otimes x_4$		$\otimes x_5$		$\otimes x_6$		$\otimes x_7$			
	$\bar{w}_1$	$\bar{b}_1$	$\bar{w}_2$	$\bar{b}_2$	$\bar{w}_3$	$\bar{b}_3$	$\bar{w}_4$	$\bar{b}_4$	$\bar{w}_5$	$\bar{b}_5$	$\bar{w}_6$	$\bar{b}_6$	$\bar{w}_7$	$\bar{b}_7$	c_i^+	Rank
A_1	0.157	0.183	0.073	0.083	0.094	0.100	0.066	0.071	0.049	0.056	0.172	0.194	0.180	0.210	0.304	4
A_2	0.209	0.236	0.064	0.073	0.100	0.113	0.066	0.071	0.049	0.056	0.172	0.194	0.210	0.241	0.345	2
A_3	0.209	0.236	0.073	0.083	0.087	0.100	0.071	0.076	0.052	0.056	0.172	0.194	0.210	0.241	0.356	1
A_4	0.183	0.209	0.073	0.083	0.087	0.100	0.057	0.066	0.049	0.052	0.183	0.194	0.195	0.225	0.339	3

Due to the TOPSIS grey and the weights that were calculated with AHP method, the order of alternatives ranks is: $A_3 \succ A_2 \succ A_4 \succ A_1$. The third drummer was selected as the best drummer among applicants.

Conclusions

The decision model for personnel selection is developed in the research, involving multiple criteria that are evaluated simultaneously, aggregating experts' knowledge and dealing with uncertain information.

A hybrid model of Analytic Hierarchy Process and the Technique for Order Preference by Similarity to Ideal Solution with Grey Relations is presented. It is proposed to apply AHP for identifying the relative importance of each criterion and then to use TOPSIS grey for evaluating potential applicants.

The case study of group member selection is presented to demonstrate the applicability of the proposed model. The process of selecting a new drummer for joining the rock band is analyzed. Four applicants are evaluated according to seven criteria, using expert judgments and mathematical methodology. Priority order of criteria as well as of applicants is established and the best drummer, most of all satisfying the criteria, is selected.

The presented model proves to be a powerful tool for applying in personnel selection problems. TOPSIS grey is able to consider increasing uncertainty of estimations and evaluates applicant in more detail and carefully way, as compared to usual crisp MCDM methods. AHP allows embracing expert judgments and calculating relative importance of criteria as applied for final decision in TOPSIS grey.

This study can be applicable for personnel selection problems in various areas of economic activities.

References

Angelou, G. N., & Economides, A. A. (2009). A Compound Real Option and AHP Methodology for Evaluating ICT Business Alternatives. *Telematics and Informatics,* 26(4), 353-374. http://dx.doi.org/10.1016/j.tele.2008.02.004

Antucheviciene, J., Zavadskas, E. K., & Zakarevicius, A. (2010). Multiple Criteria Construction Management Decisions Considering Relations between Criteria. *Technological and Economic Development of Economy*, 16(1), 109-125. http://dx.doi.org/10.3846/tede.2010.07

Bacchiocchi, S. (1999). The Worldview of Rock Music. *Endtime Issues No. 33, 15 December 1999.*

Bohanec, M., Urh, B., & Rajkovic, V. (1992). Evaluating Options by Combined Qualitative and Quantitative Methods. *Acta Psychologica*, 80, 67-89. http://dx.doi.org/10.1016/0001-6918(92)90041-B

Balezentis, A., & Balezentis, T. (2011). An Innovative Multi-criteria Supplier Selection Based on Two-tuple MULTIMOORA and Hybrid Data. *Economic Computation and Economic Cybernetics Studies and Research*, 45(2), 37-56.

Boran, S., Goztepe, K., & Yavuz, E. (2008). A Study on Election of Personnel based on Performance Measurement by using Analytic Network Process (ANP). *International Journal of Computer Science and Network Security,* 8(4), 333-339.

Capaldo, G., & Zollo, G. (2001). Applying Fuzzy Logic to Personnel Assessment: a Case Study. *Omega*, 29(6), 585-597. http://dx.doi.org/10.1016/S0305-0483(01)00047-0

Celik, M., Kandakoglu, A., & Er I. D. (2009). Structuring Fuzzy Integrated Multi-Stages Evaluation Model on Academic Personnel Recruitment in MET Institutions. *Expert Systems with Applications*, 36(3), 6918-6927. http://dx.doi.org/10.1016/j.eswa.2008.08.057

Chen, M. K., & Wang, S. C. (2010). The Critical Factors of Success for Information Service Industry in Developing International Market: Using Analytic Hierarchy Process (AHP) Approach. *Expert Systems with Applications,* 37(1), 694-704. http://dx.doi.org/10.1016/j.eswa.2009.06.012

Chien, C. F., & Chen, L. F. (2008). Data Mining to Improve Personnel Selection and Enhance Human Capital: A Case Study in High-Technology Industry. *Expert Systems with Applications*, 34(1), 280-290. http://dx.doi.org/10.1016/j.eswa.2006.09.003

Cokorilo, O., Gvozdenovic, S., Mirosavljevic, P., & Vasov, L. (2010). Multi Attribute Decision Making: Assessing the Technological and Operational Parameters of an Aircraft. *Transport*, 25(4), 352-356. http://dx.doi.org/10.3846/transport.2010.43

Dagdeviren, M., & Yuksel, I. (2007). Personnel Selection using Analytic Network Process. *Istanbul Ticaret Universitesi Fen Bilimleri Dergisi Yıl: 6 Sayı: 11. Bahar 2007/1 s.p.p. 99-118.* http://dx.doi.org/10.1007/s10845-008-0200-7

Dagdeviren, M. (2010). A Hybrid Multi-Criteria Decision-Making Model for Personnel Selection in Manufacturing Systems. *Journal of Intelligent Manufacturing,* 21(4), 451-460.

Dursun, M., & Karsak, E. (2010). A Fuzzy MCDM Approach for Personnel Selection. *Expert Systems with Applications.* 37(6), 4324-4330. http://dx.doi.org/10.1016/j.eswa.2009.11.067

Figueira, J., Greco, S., & Ehrgott, M. (2005). *Multiple Criteria Decision Analysis: State of the Art Survey.* Springer.

Fouladgar, M. M., Yazdani-Chamzini, A., & Zavadskas, E. K. (2011). An Integrated Model for Prioritizing strategies of the Iranian Mining Sector. *Technological and Economic Development of Economy*, 17(3), 459-484. http://dx.doi.org/10.3846/20294913.2011.603173

Gardiner, A. R., & Armstrong-Wright, D. (2000). Employee Selection and Anti- Discrimination Law: Implications for Multi-Criteria Group Decision Support. *Journal of Multi-Criteria Decision Analysis,* 9, 99-109. http://dx.doi.org/10.1002/1099-1360(200001/05)9:1/3<99::AID-MCDA271>3.0.CO;2-G

Gibney, R., & Shang, J. (2007). Decision Making In Academia: A Case of The Dean Selection Process. *Mathematical and Computer Modeling*, 46(7–8), 1030-1040. http://Dx.Doi.Org/10.1016/J.Mcm.2007.03.024

Ginevicius, R., Krivka, A., & Simkunaite, J. (2010). The Model of Forming Competitive Strategy of An Enterprise under The Conditions of Oligopolic Market. *Journal of Business Economics And Management,* 11(3), 367-395. http://Dx.Doi.Org/10.3846/Jbem.2010.18

Gungor, Z., Serhadlıoglu, G., & Kesen, S. E. (2009). A Fuzzy AHP Approach to Personnel Selection Problem. *Applied Soft Computing,* 9(6), 641-646. http://Dx.Doi.Org/10.1016/J.Asoc.2008.09.003

Han, Z., & Liu, P. (2011). A Fuzzy Multi-Attribute Decision-Making Method Under Risk With Unknown Attribute Weights. *Technological and Economic Development of Economy,* 17(2), 246-258. http://Dx.Doi.Org/10.3846/20294913.2011.580575

Hashemkhani Zolfani, S., Basirat Baygi, M., & Donyavi Rad, M. (2011a). The Evaluation of Rock Bands Using a Hybrid MCDM Model - an Empirical Study Based on Finland (2000s). *European Journal of Scientific Research,* 61(4), 590-600.

Hashemkhani Zolfani, S., Aghdaie, M. H., & Donyavi Rad, M. (2011b). Using Hybrid MCDM Approach for Selecting The Best Multi-Role Artist of Rock Bands In 2000s. *International Journal of Management and Innovation,* 3(2), 35-45.

Hashemkhani Zolfani, S., Rezaeiniya, N., Zavadskas, E. K., & Turskis, Z. (2011c). Forest Roads Locating Based on AHP-COPRAS-G Methods – An Empirical Study Based On Iran. *E A M: Ekonomie A Management,* 14(4), 6-21.

Hashemkhani Zolfani, S. (2012). Identifying Key Criteria of Group Member Selecting in Rock Bands Based on Wefa Framework and Fuzzy Delphi. *Proceeding of 2th Conference on Application of Fuzzy Logic in Media Sciences* (Iran, 2012).

Hashemkhani Zolfani, S., Rezaeiniya, N., & Saparauskas, J. (2012a). Selecting The Best Multi-Role Artist of Rock Bands Of Iran In 2000s by Applying ANP and TOPSIS GREY. *Economic Computation and Economic Cybernetics Studies and Research (In Press).*

Hashemkhani Zolfani, S., Rezaeiniya, N., Aghdaie, M. H., & Zavadskas, E. K. (2012b). Quality Control Manager Selection Based on AHP- COPRAS-G Methods: A Case in Iran. *Economska Istrazivanja-Economic Research,* 25(1) *(In Press).*

Hwang, C. L., & Yoon, K. (1981). Multiple Attribute Decision Making: A State Of The Art Survey. *Lecture Notes in Economics and Mathematical Systems,* 186, Springer-Verlag, Berlin.

Jessop, A. (2004). Minimally Biased Weight Determination in Personnel Selection. *European Journal of Operational Research*, 153, 433-444. http://Dx.Doi.Org/10.1016/S0377-2217(03)00163-2

Kabak, M., Burmaoglu, S., & Kazancoglu, Y. (2012). A Fuzzy Hybrid MCDM Approach for Professional Selection. *Expert Systems with Applications*, 39(3), 3516-3525. http://Dx.Doi.Org/10.1016/J.Eswa.2011.09.042

Karsak, E. E., Sozer, S., & Alptekin, S. E. (2003). Production Planning in Quality Function Deployment Using a Combined Analytical Network Process and Goal Programming Approach. *Computers and Industrial Engineering,* 44, 171-190. http://Dx.Doi.Org/10.1016/S0360-8352(02)00191-2

Kapliński, O., & Tamosaitiene, J. (2010). Game Theory Applications In Construction Engineering and Management. *Technological and Economic Development of Economy*, 16(2), 348-363. http://Dx.Doi.Org/10.3846/Tede.2010.22

Kapliński, O., & Tupenaite, L. (2011). Review of The Multiple Criteria Decision Making Methods, Intelligent and Biometric Systems Applied in Modern Construction Economics. *Transformations in Business & Economics,* 10(1), 166-181.

Kelemenis, A. M., & Askounis, D. T. (2009). An Extension of Fuzzy TOPSIS for Personnel Selection. *Systems, Man and Cybernetics, SMC 2009.* IEEE International Conference, 11-14 Oct. 2009, 4704-4709.

Kelemenis, A. M., & Askounis, D. T. (2010). A New TOPSIS-Based Multi-Criteria Approach To Personnel Selection. *Expert Systems with Applications*, 37(7), 4999-5008. http://Dx.Doi.Org/10.1016/J.Eswa.2009.12.013

Kersuliene, V., & Turskis, Z. (2011). Integrated Fuzzy Multiple Criteria Decision Making Model for Architect Selection. *Technological and Economic Development of Economy*, 17(4), 645-666. http://Dx.Doi.Org/10.3846/20294913.2011.635718

Knezevic, N., Trubint, N., Macura, D., & Bojovic, N. (2011). A Two-Level Approach for Human Resource Planning Towards Organizational Efficiency of A Postal Distribution System. *Economic Computation and Economic Cybernetics Studies and Research,* 11(4), 155-168.

Lashgari A., Fouladgar M. M., Yazdani-Chamzini A., & Skibniewski M. J. (2011). Using an Integrated Model for Shaft Sinking Method Selection. *Journal of Civil Engineering And Management*, 17(4), 569-580. http://Dx.Doi.Org/10.3846/13923730.2011.628687

Liang, S. L., & Wang, M. J. (1994). Personnel Selection Using Fuzzy MCDM Algorithm, *European Journal of Operational Research*, 78(2), 2-33.

Lin, H. C. (2010). Personnel Selection Using Analytic Network Process and Fuzzy Data Envelopment Analysis Approaches. *Computers & Industrial Engineering*, 59, 937-944. http://Dx.Doi.Org/10.1016/J.Cie.2010.09.004

Lin, Y.-H., Lee, P.-C., Chang, T.-P., & Ting, H.-I. (2008). Multi-Attribute Group Decision Making Model Under the Condition of Uncertain Information. *Automation in Construction,* 17(6), 792-797. http://Dx.Doi.Org/10.1016/J.Autcon.2008.02.011

Medineckiene, M., Turskis, Z., & Zavadskas, E. K. (2010). Sustainable Construction Taking Into Account the Building Impact on The Environment. *Journal of Environmental Engineering and Landscape Management*, 18(2), 118-127. http://Dx.Doi.Org/10.3846/Jeelm.2010.14

Maccrimon, K. R. (1968). Decision Making Among Multiple Attribute Alternatives: A Survey and Consolidated Approach. *Rand Memorandum, RM-4823-ARPA.*

Miller, G. M., & Feinzig, S. L. (1993). Fuzzy Sets and Personnel Selection: Discussion and an Application. *Journal of Occupational and Organizational Psychology,* 66, 163-169. http://Dx.Doi.Org/10.1111/J.2044-8325.1993.Tb00525.X

Peng Y., Kou G., Wang G., Wu W., & Shi Y. (2011) Ensemble of Software Defect Predictors: an AHP-Based Evaluation Method. *International Journal of Information Technology & Decision Making*, 10(1), 187-206. http://Dx.Doi.Org/10.1142/S0219622011004282

Podvezko, V., Mitkus, S., & Trinkuniene, E. (2010). Complex Evaluation of Contracts for Construction. *Journal of Civil Engineering and Management*, 16(2), 287-297. http://Dx.Doi.Org/10.3846/Jcem.2010.33

Podvezko, V. (2011). The Comparative Analysis of MCDA Methods SAW and COPRAS. *Inzinerine Ekonomika-Engineering Economics,* 22(2), 134-146.

Saaty, T. L. (1971). How to Make a Decision: the Analytic Hierarchy Process. *European Journal of Operational Research,* 40, 9-10.

Saaty, T. L. (1980). *The Analytic Hierarchy Process.* Mcgraw-Hill, New York.

Saaty, T. L. (1990). How To Make A Decision: the Analytic Hierarchy Process. *European Journal of Operation Research,* 48(1), 9-26. http://Dx.Doi.Org/10.1016/0377-2217(90)90057-I

Saaty, T. L., & Vargas, L. G. (1991). *Prediction, Projection and Forecasting.* Dordrecht: Kluwer Academic Publishers.

Saaty, T. L. (1997). That Is Not the Analytic Hierarchy Process: What the AHP Is and What It Is Not. *Journal of Multi Criteria Decision Analysis*, 6, 324-335. http://Dx.Doi.Org/10.1002/(SICI)1099-1360(199711)6:6<324::AID-MCDA167>3.0.CO;2-Q

Sivilevicius, H., & Maskeliunaite, L. (2010). The Criteria for Identifying the Quality of Passengers' Transportation by Railway and Their Ranking Using AHP Method. *Transport*, 25(4), 368-381. http://Dx.Doi.Org/10.3846/Transport.2010.46

Sivilevicius, H. (2011a). Modeling the Interaction of Transport System Elements. *Transport*, 26 (1), 20-34. http://Dx.Doi.Org/10.3846/16484142.2011.560366

Sivilevicius, H. (2011b). Application of Expert Evaluation Method to Determine the Importance of Operating Asphalt Mixing Plant Quality Criteria and Rank Correlation. *Baltic Journal of Road and Bridge Engineering*, 6(1), 48-58. http://Dx.Doi.Org/10.3846/Bjrbe.2011.07

Spyridakos, A., Siskos, Y., Yannacopoulos, D., & Skouris, A. (2001). Multicriteria Job Evaluation for Large Organizations. *European Journal of Operational Research,* 130, 375-387. http://Dx.Doi.Org/10.1016/S0377-2217(00)00039-4

Tamosaitiene, J., Bartkiene, L., & Vilutiene, T. (2010).The New Development Trend Of Operational Research In Civil Engineering and Sustainable Development as a Result of Collaboration Between German–Lithuanian–Polish Scientific Triangle. *Journal of Business Economics and Management,* 11(2), 316-340. http://Dx.Doi.Org/10.3846/Jbem.2010.16

Timmermans, D., & Vlek, C. (1992). Multi-Attribute Decision Support and Copmlexity: an Evaluation and Process Analysis of Aided Versus Unaided Decision Making. *Acta Psychologica*, 80, 49-65. http://Dx.Doi.Org/10.1016/0001-6918(92)90040-K

Vaidogas, E. R., & Sakenaite, J. (2011). Multi-Attribute Decision-Making In Economics of Fire Protection. *Inzinerine Ekonomika-Engineering Economics*, 22(3), 262-270.

Vainiunas, P., Zavadskas, E. K., Turskis, Z., & Tamosaitiene, J. (2010). Design Projects' Managers Ranking Based on Their Multiple Experience And Technical Skills. *The International Conference "Modern Building Materials, Structures And Techniques",* Selected Papers, Vol. 1, Ed. By P. Vainiunas, E. K. Zavadskas, May 19-21, 2010. Lithuania, Vilnius, 544-548.

Zavadskas, E. K., & Turskis, Z. (2011). Multiple Criteria Decision Making (MCDM) Methods In Economics: an Overview. *Technological and Economic Development of Economy*, 17(2), 397-427. http://Dx.Doi.Org/10.3846/20294913.2011.593291

Zavadskas, E. K., Turskis, Z., & Tamosaitiene, J. (2010a). Risk Assessment of Construction Projects. *Journal of Civil Engineering and Management,* 16(1), 33-46. http://Dx.Doi.Org/10.3846/Jcem.2010.03

Zavadskas, E. K., Vilutiene, T., Turskis, Z., & Tamosaitiene, J. (2010b). Contractor Selection for Construction Works By Applying SAW-G and TOPSIS Grey Techniques. *Journal of Business Economics and Management,* 11(1), 34-55. http://Dx.Doi.Org/10.3846/Jbem.2010.03

Zavadskas, E. K., Turskis, Z., & Tamosaitiene, J. (2011). Selection of Construction Enterprises Management Strategy Based on the SWOT and Multi-Criteria Analysis. *Archives of Civil and Mechanical Engineering,* 11(4), 1063-1082. http://Dx.Doi.Org/10.1016/S1644-9665(12)60096-X

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Kolektyvo narių parinkimas taikant AHP ir TOPSIS *grey*

Santrauka

Itin svarbus ir daug lemiantis žmogiškųjų išteklių valdymo klausimas – tinkamo asmens parinkimas. Parinkti tinkamiausią asmenį iš esamų potencialių kandidatų gali tekti įvairiais atvejais: formuojant personalą, ieškant naujo darbuotojo ar renkant bet kokio žmonių kolektyvo grupės narį įvairaus pobūdžio įmonėse, organizacijose ar bendruomenėse. Pastaruoju metu sėkmingai besivystančios įmonės vis daugiau dėmesio skiria personalo parinkimui. Svarbu suformuoti gerai funkcionuojančią komandą, kurios efektyvus darbas padėtų įmonei ar organizacijai siekti jos tikslų.

Norint padidinti priimamų sprendimų efektyvumą, parenkant personalą ir formuojant komandą, svarbu taikyti tinkamas sprendimų rėmimo priemones. Sprendimo rėmimo priemonės turėtų apimti rodiklių kompleksą bei atitinkamą metodiką, kuri padėtų įvertinti potencialias galimų sprendimų alternatyvas bei nustatyti jų prioritetą pagal įgyvendinimo tinkamumą. Šiame straipsnyje pirmiausia atlikta žmogiškųjų išteklių valdymui ir ypač personalo parinkimui taikomų matematinių metodų bei sprendimų rėmimo priemonių apžvalga. Vieną grupę metodų sudaro *neraiškiųjų aibių* teorija. Trumpai apžvelgti šaltiniai, pradedant nuo 1993 metų, kai *neraiškiųjų aibių* logiką siūlyta taikyti renkant personalą. Kitą grupę sudaro daugiatikslių sprendimų priėmimo metodų taikymas kolektyvų nariams parinkti. Straipsnyje apžvelgti gausūs literatūros šaltiniai nuo 1992 iki 2012 metų, daugiau dėmesio skiriant pastarųjų metų publikacijoms. Įvairūs autoriai siūlo metodiką bei pateikia metodikos taikymo pavyzdžių, kai paskirstomi žmogiškieji ištekliai ar formuojamas personalas. Plačiai naudojami klasikiniai, gan gerai akademinėje visuomenėje žinomi metodai, tokie kaip *Analitinis hierarchinis procesas* (AHP), *Analitinis tinklinis procesas* (ANP), *Artumo idealiam taškui metodas* (TOPSIS). Vėlesniaisiais metais imta taikyti modifikuotus metodus, integruojant klasikinius daugiatikslių sprendimų priėmimo metodus ir neraiškiųjų aibių elementus. 2010 – 2012 metais Lietuvos autoriai taip pat paskelbė publikacijų nagrinėjama tematika, kai matematiniais metodais spręstas statybos bei kitokio pobūdžio įmonių darbuotojų – tiekėjų, architektų, vadybininkų – parinkimas. Čia siūlyta taikyti naujesnius metodus, tokius kaip daugiakriterinio kompleksinio proporcingo projektų įvertinimo metodą (COPRAS), adityvinį kriterijų santykių įvertinimo metodą (ARAS).

Šiame straipsnyje autoriai parengė kompleksinį modelį kolektyvo nariams parinkti. Siūloma hibridinė metodika, susidedanti iš dviejų daugiatikslių sprendimų priėmimo metodų bei *pilkųjų skaičių* teorijos elementų. Taikomi *Analitinis hierarchinis procesas* (AHP) ir *artumo idealiam taškui metodas* su rodiklių reikšmėmis, apibrėžtomis intervaluose (TOPSIS *grey*). *Analitinis hierarchinis procesas* taikomas rodiklių, kuriais aprašomos pasirinkimo alternatyvos, santykiniams reikšmingumams nustatyti. TOPSIS *grey* metodu atliekami tolimesni skaičiavimai, naudojant AHP nustatytus rodiklių santykinius reikšmingumus ir apskaičiuojami alternatyvų santykiniai reikšmingumai bei sudaroma alternatyvų prioritetinė eilė. Uždavinio modelis, aprašytas *pilkaisiais santykiais*, itin efektyviai taikomas uždaviniams su neapibrėžtais pradiniais duomenimis spręsti.

Analitinis hierarchinis procesas (AHP) paskelbtas Thomas L. Saaty 1971 metais bei sėkmingai taikomas įvairiose verslo ir pramonės šakose. Metodas gali būti naudojamas prioritetams nustatyti, alternatyvoms generuoti, geriausioms alternatyvoms išrinkti, poreikiams nustatyti, resursams paskirstyti, rezultatams prognozuoti, konfliktinėms situacijoms spręsti, rizikai įvertinti. Pateikta pastarųjų metų (2011 – 2012) AHP taikymų įvairiose ekonomikos ir technologijos srityse trumpa apžvalga. Taip pat pateiktas išsamus metodikos aprašymas pagal pradininko Thomas L. Saaty 1990 metų publikaciją (1 – 5 formulės). Metodo esmė – porinės lyginimų matricos (šiuo atvejų lyginamų rodiklių) sudarymas. Matricą sudaro santykių koeficientai, apibūdinantys skirtingus rodiklių svarbos lygius. Pagal Saaty skalę skiriami 9 svarbos lygiai, kuriems suteikiami atitinkami koeficientai (2 lentelė). Matrica užpildoma apklausus ekspertus. Tikrinamas ekspertų nuomonių suderinamumas, skaičiuojant nepriештaringumo indeksą *CI* (plg. angl. *consistency index*), atsitiktinumo indeksą *RI* (plg. angl. *random index*) ir nepriештaringumo koeficientą *CR* (plg. angl. *consistency ratio).* Jei apskaičiuotas $CR < 0{,}1$, tai ekspertų nuomonių suderinamumas pakankamas ir ekspertinio vertinimo rezultatus galima taikyti rodiklių santykiniams reikšmingumams nustatyti.

Hwang ir Yoon 1981 metais sukūrė alternatyvų prioritetiškumo eilės nustatymo teoriją, kurioje teigiama, kad potencialiai geriausia alternatyva yra mažiausiai nutolusi nuo idealaus sprendimo ir labiausiai nutolusi nuo idealiai neigiamo (blogiausio) sprendinio. Ši teorija vadinama variantų racionalumo nustatymu artumo idealiam taškui metodu TOPSIS (*Technique for Order Preference by Similarity to Ideal Solution*). Uždavinys formuluojamas sudarant sprendimų matricą iš *n* alternatyvų, aprašytų *m* rodikliais, t.y. sudaroma pradinė sprendimų priėmimo matrica $\{x_{ij}\}$, $i = 1, \ldots, n$, $j = 1, \ldots,$ m. Lietuvoje klasikinis TOPSIS metodas gerai žinomas ir taikomas nuo 1986 metų. Straipsnyje pateikta trumpa pastarųjų metų (2010 – 2012) įprasto bei modifikuoto metodo taikymų apžvalga. 2008 metais Lin ir kiti autoriai pasiūlė integruoti TOPSIS ir *pilkųjų skaičių* teoriją uždaviniams su neapibrėžtais duomenimis spręsti. Zavadskas ir kt. 2010 metais šią metodiką (TOPSIS *grey*) pritaikė statybos valdymo uždaviniams. Kadangi šis modifikuotas metodas gana naujas ir nėra itin plačiai žinomas bei taikomas, straipsnyje pateiktas išsamus metodikos aprašymas (6 – 15 formulės). Šiuo atveju 11 – 14 formulėse taikomi rodiklių santykiniai reikšmingumai q_j, nustatyti AHP metodu. Naujos metodikos pritaikymui ir efektyvumui parodyti, pateiktas pavyzdys su kolektyvo nario (t. y. naujo būgnininko roko grupei) parinkimu. Plėtojantis muzikos rinkai, grupės nario parinkimas šioje srityje yra toks pats svarbus žmogiškųjų išteklių valdymo ir personalo parinkimo klausimas, kaip ir kitose ekonominėse veiklos srityse. Profesionalūs muzikantai gali dirbti keliose grupėse, todėl dažnai atsiranda neišvengiamų grupių sudėties pokyčių, susijusių su profesinėmis ar finansinėmis priežastimis. Straipsnyje yra aptarti konkretūs atvejai, kada buvo susidurta su problemomis, keičiantis grupių sudėčiai. Autoriai teigia, jog matematinis sprendimų rėmimo metodas padėtų efektyviau išspręsti tokias problemines situacijas. Pateikta vieno iš autoriaus tyrimų apžvalga, kurioje, taikant tam tikrus daugiatikslių sprendimų priėmimo metodus, sprendžiami roko grupių kolektyvų formavimo klausimai. Išsamiai nagrinėjama konkreti situacija, kai reikia išrinkti tinkamiausią būgnininką iš keturių kandidatų. Suformuluoti rodikliai, pagal kuriuos vertinami potencialūs kandidatai: techniniai gebėjimai, gebėjimas dirbti komandoje, motyvacija, disciplina, gebėjimai kurti muziką, gebėjimai prisitaikyti prie muzikos žanro bei grupės, bendrosios savybės (amžius, elgsena, ideologija ir pan.). Nemaža dalis šių rodiklių yra universalūs, tinkami nagrinėjant bet kokio kolektyvo nario parinkimo klausimą. Rodiklių santykinis reikšmingumas (svarba) nustatytas apklausus ekspertus ir pritaikius AHP metodą. Pasitelkta 15 ekspertų, visi profesionalūs muzikantai. Informacija apie ekspertus pateikta 7 lentelėje. Porinė lyginimų matrica pateikta 8 lentelėje. Patikrintas ekspertų nuomonių suderinamumas. Apskaičiuotas nepriештaringumo koeficientas $CR = 0{,}09$ tenkina leistinas ribas, todėl, naudojant šios apklausos duomenis, nustatyta rodiklių santykinė svarba: svarbiausi gebėjimai yra prisitaikyti prie muzikos žanro bei grupės ($q_j = 0{,}241$), techniniai gebėjimai ($q_j = 0{,}236$), taip pat disciplina ($q_j = 0{,}194$).

Kiekvieną iš keturių kandidatų ekspertai įvertino pagal visus rodiklius, taikydami Saaty balų skalę nuo 1 iki 9. Vertinimai išreikšti intervalais pagal *pilkųjų skaičių* teoriją ir sudaryta pradinė sprendimų priėmimo matrica (9 lentelė). Atlikti skaičiavimai taikant TOPSIS *grey* algoritmą (6 – 15 formulės). Pateikta normalizuota sprendimų priėmimo matrica (10 lentelė), svorinė normalizuota sprendimų priėmimo matrica (11 lentelė), apskaičiuotas alternatyvų santykinis reikšmingumas bei nustatyta alternatyvų prioritetinė eilė. Kiekvienos alternatyvos, t. y. kiekvieno kandidato, A_i , $i = 1, \ldots, 4$, santykinis reikšmingumas nustatytas $A_1 = 0{,}304$, $A_2 = 0{,}345$, $A_3 = 0{,}356$, $A_4 = 0{,}339$. Geriausiu sprendiniu laikomas tas, kurio santykinis reikšmingumas didžiausias. Tad šiuo atveju tinkamiausias būgnininkas grupei būtų trečiasis kandidatas.

Pateiktas pavyzdys parodė, jog pasiūlyta metodika yra tinkamas ir efektyvus būdas renkantis personalą bei kitiems žmogiškųjų išteklių valdymo klausimams nagrinėti. TOPSIS *grey* padeda atsižvelgti į didėjantį vertinimų neapibrėžtumą ir yra tinkamesnis nei įprastas klasikinis metodas. Į kompleksinę metodiką integruotas AHP padeda panaudoti ekspertų, puikiai išmanančių nagrinėjamą sritį patirtį ir žinias, lyginant ir vertinant potencialias sprendimų alternatyvas bei priimant galutinį sprendimą TOPSIS *grey* metodu. Taikant pasiūlytąją metodiką, gali būti sprendžiami kiti svarbūs muzikos sferos klausimai. Be abejonės, analogiška daugiatikslių sprendimų priėmimo metodika būtų tinkama kolektyvų nariams parinkti įvairaus pobūdžio įmonėse ar organizacijose, taip pat kitiems žmogiškųjų išteklių valdymo klausimams skirtingose ekonominės veiklos sferose nagrinėti.

Raktažodžiai: *žmogiškųjų išteklių valdymas, personalo parinkimas, grupės nario parinkimas, AHP, TOPSIS grey, roko grupės.*

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