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PERSONNEL SELECTION BASED ON A NOVEL MODEL OF GAME THEORY AND MCDM APPROACHES

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Abstract. Personnel selection is one of important topics in Human Resource Management (HRM) field. There are so many methodologies in this area but this research has tried to present a novel powerful method based on combination of Game Theory and MCDM concepts. In this regard MCDM framework is applied for evaluating strategies and weighting the Criteria and Game Theory for final evaluating of applicants. In this research SWARA method is used as an appropriate MCDM method and this research will show how MCDM framework (SWARA) can develop Game Theory concept. This novel methodology can be useful in other fields and issues.

Keywords: personnel selection, human resource management, game theory, multi criteria decision making (MCDM), SWARA.

JEL classification: C70, J21, M12, M51.

1. Introduction

Personnel selection has become a big challenge for organizations regarding the recent developments within organizations and within organizational business environments specially in technological changes, globalization, social trends and changes of work itself (Lievens *et al.* 2002).

Researchers (Hough, Oswald 2000; Robertson, Smith 2001; Beckers, Bsat 2002; Liao 2003) have claimed that personnel selection practices are influenced by many issues including changes in personnel, changes in work behavior, change in work, change in society, change of laws, advancements in information technology, and others. The rating biases, from a practical viewpoint of personnel selection, are recognized as a common problem in the selection process (Arvey, Campion 1982; Lin 2010).

In any enterprise, personnel selection plays an important role in human resource management policy as it determines the input quality of personnel. One of goals in personnel selection process is to choose the best candidate to fill the defined vacancy in a company (Dursun, Karsak 2010; Balezentis *et al.* 2012).

Human resources management policy and personnel selection is an important part of any business activity. Applying and developing a proper decision making tool is essential to improve the group member selection process which involves a set of decision criteria and a particular methodology for evaluating and ranking of alternatives (Hashemkhani, Antucheviciene 2012).

Human resources are considered as vital capital and the core competences for an organization to increase its competitive advantage in a knowledge economy. Personnel selection significantly affects the character of employees and quality of administration comparing other functions of human resource management; therefore it has attracted considerable attention and has become an important topic for organizations (Lin 2010). The organizations are seeking more powerful ways of ranking employees or personnel who have been evaluated in terms of different competencies (Gungor *et al.* 2009).

As we mentioned above, one of real life applications of MCDM is the personnel selection problem (Kelemenis, Askouni 2010). Many scholars become interested in investigating this problem from the multi-criteria perspective. The applications of MCDM methods in personnel selection are includes: internal auditor selection (Seol, Sarkis 2005), TQM consultant (Saremi *et al.* 2009) to IS personnel (Chen, Cheng 2005), in IT officer selection (Kelemenis, Askouni 2010), project manager selection (Zavadskas *et al.* 2008), support managers (Kelemenis *et al.* 2011), for quality control manager selection (Hashemkhani *et al.* 2012) and team member (Hashemkhani, Antucheviciene 2012) selection.

Some kinds of personnel selection are so complicated and important because some positions are so critical and important for all sections of a company or organization. This research is focused on CEO selection between two final applicants with different strategies and ideas. In this study, a novel methodology is presented based on MCDM methods and game theory. SWARA in this study is applied as an MCDM method for evaluating and weighting strategies of applicants.

In this study, a different way is applied in defining a game. The complete steps of that are presented in section 3 of this article.

This framework is established to empower decision makers to make dynamic decision. In section 3, this issue is illustrated in details.

2. Methodology

As mentioned in introduction section, game theory and MCDM framework are applied in this research in the field of human resource management and specially personnel selection.

A new simple application of the game theory and MCDM framework is developed in this research for the first time. This novel methodology can be developed in some special important topics and this study is established to show the capability and application of this methodology decision making.

2.1. Game Theory

The mathematical theory of interactive decision situations is named Game theory (Mohammadi 2010). To understand the possible strategies that individuals may follow when competing or collaborating in games, Game Theory provides useful mathematical tools (Binmore 1994). Nowadays, this branch of applied mathematics is utilized in the social sciences (mainly economics), biology, engineering, political science, international relations, computer science and philosophy (Burguillo 2010).

It has been proved that Game theory is a useful tool in the modeling and analysis of many phenomena involving interaction between multiple agents (Rego, Halpern 2012).

The necessary elements of a game include (1) the players, (2) the strategies or preferences they choose, (3) the information available to them, (4) the order of play, and (5) the outcome or payoff of the game, which is influenced by the previous four elements. A game consists of at least two players who make decisions and who can be individuals, communities, corporations, or the government. Each player has his/her own preference and strategy, which is ‘‘a complete plan of action that describes what a player will do under all possible circumstances’’ (Davis 1997; Law, Pan 2009).

As Heap, Varoufakis (2004) summarized, four basic assumptions about the rationality of human behaviors are the basis of the game theory:

- Instrumental rationality – actors in a game make decision rationally and purposefully;
- Common knowledge of rationality – each actor in a game has expectations about other actors, and they are possibly to inform what it is rational for the actor to do;
- Common priorities – the same inferences will be drawn on how a game is to be played by rational individuals in a game;
- Action within the rules of game – the rules of the game are perceived by individuals; that is, they know all the possible actions and the way of combining them to yield particular payoffs for each player.

Game theory problems are often a kind of multi-criteria multi-decision-maker problems. Conventional optimization methods are used to solve such problems; finally the problem is usually converted to a single-decision-maker problem with a single composite objective for the whole system such as an overall economic or social welfare function or a weighted constrained multi-objective function (Madani 2010).

Matrix games are mainly applied for the selection of variants, which is a problem of multi-criteria decisions (Meszek 2001; Meszek 2004; Peldschus, Zavadskas 2005; Antuchevičienė *et al.* 2006; Zagorskas, Turskis 2006; Peldschus 2007; Meszek 2007; Ustinovichius *et al.*, 2007; Zavadskas, Turskis 2008).

2.2. Multiple Criteria Decision Making (MCDM)

Multiple criteria decision making (MCDM), often called multi criteria decision aid (MCDA) and multi criteria analysis (MCA), is a set of methods

which provide an opportunity to aggregate and consider many (often conflicting) criteria in order to select, rank, sort or depict a set of alternatives to help a decision process (Zopounidis 1999; Mulliner *et al.* 2013). To determine the best solution among several alternatives according to multiple attributes or criteria, multi-criteria analysis is highly effective (Chang, Hsu 2009). To address the numerous quantitative and qualitative criteria that affect both housing affordability and sustainability, MCDM is a suitable tool which allows the quantitative and qualitative criteria be incorporated into one evaluation process (Mulliner *et al.* 2013). Applying MCDA supports decision-makers who are faced with numerous and conflicting choices (Lootsma 1999; Barfod *et al.* 2011).

Based on this subject, several MADM methods are proposed in the literature that can be applied under the above mentioned conditions which are called classical MADM methods (Stanujkic *et al.* 2012).

The concise overview of these methods, their characteristics and applicability are presented in Hwang, Yoon (1981), Triantaphyllou, Lin (1996) and Yoon, Hwang (1995). The most applicable MADM methods were includes:

Simple Additive Weighting (SAW) method (MacCrimon 1968), Technique for Ordering Preference by Similarity to Ideal Solution (TOPSIS) method (Hwang, Yoon 1981), Analytic Hierarchy Process (AHP) method (Saaty 1980), Step-wise weight assessment ratio analysis (SWARA) method (Keršuliene *et al.* 2010), Factor Relationship (FARE) method (Ginevicius 2011). ELimination and Choice Expressing REality (ELECTRE) method (Roy 1991), Preference Ranking Organisation Method for Enrichment Evaluations (PROMETHEE) method (Brans, Vincke 1985), COmplex PRoportional ASsessment (COPRAS) method (Zavadskas *et al.* 1994, 2009; Ginevicius *et al.* 2013), VIKOR (VIsekriterijumska optimizacija i KOmpromisno Resenje – in Serbian) method (Opricovic 1998), a newly-proposed Additive Ratio Assessment (ARAS) method (Zavadskas, Turskis 2010; Zavadskas *et al.* 2010) and Weighted Aggregates Sum Product Assessment (WASPAS) method (Zavadskas *et al.* 2012).

2.3. Step-wise weight assessment ratio analysis (SWARA) method

SWARA method is one of the new brand methods among MADM methods that can be used instead of AHP, ANP and FARE methods. Keršuliene *et al.* (2010) first introduced SWARA which experienced much development in recent years.

As the experts' viewpoints have considerable importance role in evaluations and calculating weights in the process of SWARA, it is defined as an expert-oriented method. It means prioritizing of criteria is selected directly with experts' ideas. In the next steps of this method, the value of each criterion is determined and all the criteria are ranked from the first to the last one using experts' opinions. Then, the importance and weight of each criterion is calculated and all the criteria are calculated based on experts' implicit knowledge, information and experiences. Based on the mediocre value of ranks, the overall ranks of the group of experts are determined (Kersuliene, Turskis 2011).

SWARA method has the ability to estimate experts' opinion about importance ratio of the criteria in the process of their weight determination which illustrates the dominant and powerful attributes of this method (Keršuliene *et al.* 2010). This method also creates a helpful way for experts' data collecting and data organizing. The experts can easily work together based on the simplicity of the mentioned process (Hashemkhani *et al.* 2013). Other indispensable attributes of SWARA method that makes it different from other methods such as AHP and ANP is that priorities can be defined without any need to evaluate and rank the criteria when some companies or countries' policies are clear and transparent, but in AHP and ANP methods, experts' evaluations will affect the priorities and the ranks and the model is created based on criteria. AHP and ANP are working based on paired comparisons of criteria and relations of criteria establish the main part of decision making procedure. Hence, it can be analyzed that SWARA is a valuable method because SWARA directly make decision about criteria and their prioritize and can be recommended to be applied in certain environments of decision making when the priorities are known based on the situation (Hashemkhani, Zavadskas 2013). The all past and recent researches with SWARA methodology are presented below:

- Keršuliene *et al.* (2010) in rational dispute resolution method selection;
- Kersuliene, Turskis (2011) for architect selection;
- Hashemkhani *et al.* (2013a) in product design;
- Hashemkhani *et al.* (2013b) in selecting the optimal alternative of mechanical longitudinal ventilation of tunnel pollutants;
- Hashemkhani *et al.* (2013c) in investigating on the success factors of online games based on explorer;

– Hashemkhani *et al.* (2013d) in Decision making on business issues with foresight perspective;
– Hashemkhani, Zavadskas (2013) in sustainable Development of Rural Areas' Building Structures Based on Local Climate;
– Hashemkhani, Saparauskas (2013) in Prioritizing Sustainability Assessment Indicators of Energy System;
– Hashemkhani, Bahrami (2014) in Investment Prioritizing in High Tech Industries;
– Aghadie *et al.* (2013a) in the machine tool selection;
– Aghadie *et al.* (2013b) in market segmentation and selection;
– Alimardani *et al.* (2013) in agile supplier selection;

The procedure of SWARA method is shown in Figure 1.

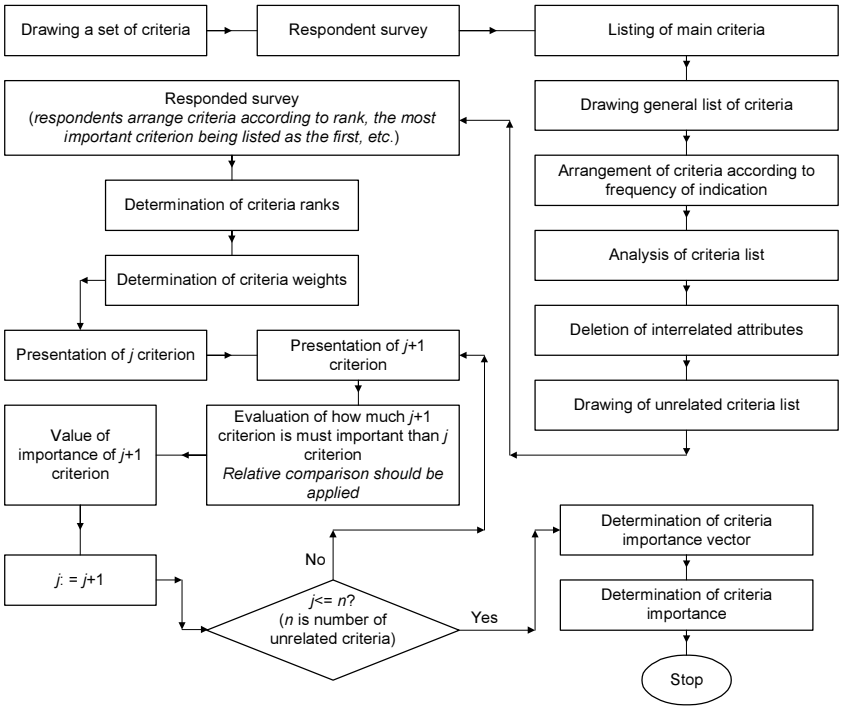

Fig. 1. Determining of the criteria weights based on SWARA (source: Kersulienė, Turskis 2011)

3. General model of research

In this section, a real case is selected for illustrating the model of research. GATA is a new privately management consultancy company in Tehran, Iran. GATA is known for its board of directors but CEO has not been selected in this company yet. In the first round of selection of CEO for GATA Company, board of directors selected two candidates for further selection of the best one to be their CEO. In the next round, the board of directors invited candidates and received their future programs for the company. Each candidate presented his main strategies for directing and managing company. Each candidate presented three main strategies due to the requirements that are shown in Tables 1 and 2.

Table 1. Strategies of first applicant (A)
(source: compiled by authors)

No	Strategies
A_1	Developing on government's (National) projects
A_2	Concentrate on capital of Iran (Tehran)
A_3	Developing joint projects (Specially international projects)

Table 2. Strategies of second applicant (B)
(source: compiled by authors)

No	Strategies
B_1	Developing in industries level
B_2	Concentrate on industries in all around the Iran
B_3	Establishing some branches in metropolitan cities in Iran

After receiving plans and strategies of candidates, board of directors made decision about the importance of the strategies and identified the priority of strategies and then calculated the weights of each strategy based on SWARA methodology.

The results of SWARA method were gained from the ideas of directors. The board of directors includes five persons. The results of SWARA method are shown in Table 3.

Table 3. Final results of SWARA method in weighting all strategies (source: compiled by authors)

Criterion	Comparative importance of average value s_j	Coefficient $k_j = s_j + 1$	Recalculated weight $w_j = \frac{x_{j-1}}{k_j}$	Weight $q_j = \frac{w_j}{\sum w_j}$
A_1	s_j	1	1.0000	0.2375
B_1	0.15	1.15	0.8696	0.2065
B_2	0.19	1.19	0.7307	0.1736
A_2	0.17	1.17	0.6246	0.1483
A_3	0.18	1.18	0.5293	0.1257
B_3	0.16	1.16	0.4563	0.1084

In the next step, a debate was designed. Coordinators asked questions and each candidate defended from his strategies and ideologies. Coordinators wanted to know more about their strategies and final coordinators evaluated each candidate's pay off.

The important point in this step is defining pay offs. In this research, payoffs defined in a different way and based on abilities of candidates. Each strategy can have high potential to be conducted but coordinators compared the abilities of candidates in implementing strategies. Eventually candidates and their plans and strategies were evaluated and compared.

The payoffs are defined in this manner: the ability of candidates based on percentage of success possibility. For instance, 50% can be shown in crisp number such as number 5 and so on.

Table 4 shows the coordinators' evaluation from candidates.

Table 4. Pay offs matrix (source: compiled by authors)

A \ B	1	2	3
1	8,8	8,6	8,7
2	6,8	6,6	6,7
3	8,8	8,6	8,7

The preliminary results showed that the first candidate was the best one in the strategies 1 and 3 and also the second candidate was the best in strategy 1. Their abilities in strategy 2 were the same. In this step, weighted pay off matrix should be considered. Weighted pay off matrix is shown in Table 5.

According the results board of coordinators should make a decision about candidates. Candidate A has highest payoff in first strategy and after that first strategy of candidate B is a better choice.

Table 5. Weighted pay offs matrix (source: compiled by authors)

A \ B	Weights	1	2	3
		0.2065	0.1736	0.1084
1	0.2375	1.9, 1.65	1.9, 1.05	1.9, 0.76
2	0.1483	0.89, 1.65	0.89, 1.05	0.89, 0.76
3	0.1257	1.01, 1.65	1.01, 1.05	1.01, 0.76

In the next level, the strategy 2 of candidate B is better and then strategy 2 of candidate A is better. Generally, the pay offs of the candidate A are better but if coordinators consider to delete the third strategies of the candidates, what will happen? The candidate B is better now. This application of game theory can help decision makers to make better decisions. This framework has a dynamic structure for decision makers to have more details with more concentration on issues.

4. Conclusions

The simple application of game theory and MCDM methods is shown in this research article. This new model can be useful in some cases of personnel selection and human resource management.

As we mentioned earlier, SWARA method is applied for evaluating and also weighting candidates' strategies. This issue can make pay off matrix much more accurate.

In this study, pay off matrix is established with new perspective and each candidate's ability is evaluated in each strategy.

Authors propose that this methodology can be helpful in top level of human resource management field where selecting the best applicant can totally change the future of organizations and companies.

Another advantage of this new methodology is that the process of decision making can be dynamic. Decision makers make different decisions with

more depth in issues regarding the situation of alternatives (players) and also strategies.

This new methodology can also be helpful in making decision in other important topics in other fields where decision making on players is so complicated and hard.

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