



Evaluation of Product Development Partner Selection Process Using Multi Criteria Decision Making Approach

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Abstract

In today's market, product development (PD) emerges as a business strategy to sustain competitive advantage and the complexity of the process compels firms to seek collaboration. However, collaborative PD (CPD) comes out as difficult to manage with its multi-cultural, multi-spatial, interdisciplinary teams. Hence, the selection of a suitable partner for a firm is not an easy decision and problems featuring high uncertainty, conflicting objectives, multi interests and perspectives. For this reason, PD partner selection process needs Multi criteria decision-making (MCDM) methods to select the most appropriate partner alternative correctly.

In this study spherical fuzzy VlseKriterijumska Optimizacija IKompromisno Resenje (SF-VIKOR) method introduced by (Kutlu Gündoğdu & Kahraman, 2019) is used and utilized model implemented to a Turkish decision case. The originality of the paper comes from its ability to evaluate an effective framework for both Turkey and literature and apply it to a PD selection process.

Keywords: Multi criteria decision making, Partner Selection, VIKOR, Spherical fuzzy sets.

Çok Kriterli Karar Verme Yaklaşımıyla Ürün Geliştirme Partner Seçim Sürecinin Değerlendirilmesi

Öz

Günümüzün rekabetçi pazarında; şirketler, rekabetçi avantajı elde tutabilmek için ürün geliştirme (ÜG) stratejisini benimsemişlerdir. ÜG'nin karmaşık yapısı ise, süreci hızlandırmak ve kolaylaştırmak amacıyla, işbirliği yapılmasını gerekli kılmaktadır. Fakat işbirlikli ÜG (İÜG), farklı kültür ve yerlerden gelen disiplinlerarası ekiplerin varlığıyla yönetilmesi güç bir süreçtir. Öyleki uygun bir işbirlikçi (partner) seçimi yüksek belirsizlik, çelişen hedefler, çoklu çıkarlar ve perspektifler içeren kolay olmayan bir karar sürecidir. Bu sebeple ÜG partner seçim sürecinde en uygun partner alternatifini seçimi için Çok Kriterli Karar Verme (ÇKKV) tekniklerinden yararlanılır. Bu çalışmada (Kutlu Gündoğdu & Kahraman, 2019) tarafından önerilen küresel bulanık VlseKriterijumska Optimizacija IKompromisno Resenje (KB-VIKOR) metodu Türk karar vakası için kullanılmıştır. Araştırmanın özgünlüğü, hem Türkiye hem de literatür için etkili bir yaklaşım ve ÜG seçim sürecine uygulama yeteneğinden kaynaklanmaktadır.

Anahtar Kelimeler: Çok kriterli karar verme, partner seçimi, VIKOR, Küresel bulanık kümeler.

1. Introduction

Companies have made significant efforts to make the most appropriate decision on different issues from past to present. Various approaches have been implemented to facilitate the decision making process (Arslankaya, 2020). Global competition and the rapid development of IT force organizations to continuously change their ways. Nowadays, organizations need partners who make a difference through innovative ideas and who keep up with the rapid changes. Hence, the selection of a suitable partner for a firm is not an easy

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decision featuring high uncertainty, conflicting objectives, multi interests and perspectives (Büyüközkan & Güleriyüz, 2016). This study contributes to PD partner selection process and fuzzy literature by providing a framework based group methodology. Group Decision Making (GDM) processes needs Decision Makers (DMs-experts) are often actively involved in decision making stages when discussing about which partner to work with. Hence, some researchers such as (Büyüközkan, Güleriyüz, & Karpak, 2017) have stressed the necessity of a rational and systematic GDM for partner selection.

This study proposes a model which incorporates one of the most popular MCDM methods, VIKOR evaluate various partner alternatives. It focuses on ranking and sorting a set of alternatives against various, or possibly conflicting and non-commensurable decision criteria assuming that compromising is acceptable to resolve conflicts. Similar to some other MCDM methods, VIKOR relies on an aggregating function that represents closeness to the ideal solution.

In some cases, decision problems may not be expressed mathematically or may need to be expressed linguistically. Fuzzy MCDM methods with utilized extensions can be used in problems that need to be expressed in linguistic variables (Kiraz, Canpolat, Erkan, & Albayrak, 2018b)(Kiraz, Canpolat, Erkan, & Albayrak, 2018a).

The spherical fuzzy sets (SFS) have been recently introduced by (Gündoğdu & Kahraman, 2019) is the extension of Pythagorean fuzzy sets and neutrosophic sets. The SF-VIKOR enables DMs to independently reflect their hesitations in the decision process by using a linguistic evaluation scale based on spherical fuzzy sets (Gündoğdu & Kahraman, 2019). As SFS are becoming widespread in different areas; Delta robot technology design and evaluation (Fatma Kutlu Gündoğdu & Kahraman, 2020b); industrial robot selection (Kutlu Gündoğdu & Kahraman, 2019); renewable energy site selection (Fatma Kutlu Gündoğdu & Kahraman, 2020a); facility location selection (Kutlu Gündoğdu & Kahraman, 2019).The main contribution of this paper is the application of SFS into the VIKOR model in order to evaluate PD partner selection for the first time.

The paper is organized as follows. Section 2 gives a brief description of the VIKOR method and the basic definitions and notations of fuzzy logic concepts involved. Section 3 presents the application with SF- VIKOR method in a group decision making context. Section 4 gives some concluding remarks.

2. Materyal ve Metot

2.1. Spherical Fuzzy Sets

A spherical fuzzy set \tilde{A}_S of the universe of discourse U is given by;

$$\tilde{A}_S = \{ \langle u, (\mu_{\tilde{A}_S}(u), v_{\tilde{A}_S}(u), \pi_{\tilde{A}_S}(u)) \mid u \in U \} \tag{1}$$

Where

$$\mu_{\tilde{A}_S}: U \rightarrow [0,1], \quad v_{\tilde{A}_S}(u): U \rightarrow [0,1], \quad \pi_{\tilde{A}_S}: U \rightarrow [0,1]$$

and

$$0 \leq \mu_{\tilde{A}_S}^2(u) + v_{\tilde{A}_S}^2(u) + \pi_{\tilde{A}_S}^2(u) \leq 1 \quad \forall u \in U$$

For each u , the numbers $\mu_{\tilde{A}_S}(u)$, $v_{\tilde{A}_S}(u)$ $\pi_{\tilde{A}_S}(u)$ are the degree of membership non membership and hesitancy of u to \tilde{A}_S (F. Kutlu Gündoğdu & Kahraman, 2019).

2.1.1. SF-VIKOR

In literature, there are a variety of MCDM methods which are implemented at different branches. Among the various MCDM techniques, Analytic Hierarchy Process (AHP), Elimination and Choice Translating Reality English (ELECTRE), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), VIKOR and Preference ranking organization method for enrichment evaluation (PROMETHEE) are the most frequently used methods (Miç & Antmen, 2019). MCDM ensures that more than one discipline coexist, and the DM evaluates in more than one dimension. However, it also provides the opportunity for optimum decision-making.(Ersöz, Kınıcı, & Ersöz, 2018) (Zeydan, Bostancı, Oralhan, Eroğlu, & Aydiner, 2020)(Çolak & Boyacı, 2018)

VIKOR method, (Vise Kriterijumska Optimizacija I Kompromisno Resenje) was developed as a viable technique in 1998 by Opricovic used for selecting and sorting alternatives when there are conflicting criteria (AK, 2019). After pioneering works and the important contributions, researchers are recently focusing on SF with MCDM. These methodologies have been applied in different research areas for evaluation purposes, as summarized in Table 1.

Table 1. Summary of studies that use SF

References	Applied techniques	GDM	Aim of the study	Illustrative/Case study
Kutlu Gündoğdu & Kahraman (2019)	SF-CODAS, IF-CODAS, IF TOPSIS	x	Methodology proposal	Illustrative
Kutlu Gündoğdu & Kahraman (2019)	SF-VIKOR, SF-TOPSIS	x	Warehouse site location selection problem	Illustrative
Kutlu Gündoğdu & Kahraman (2019)	SF-TOPSIS, IF-TOPSIS	x	Supplier selection problem	Illustrative
Kutlu Gündoğdu & Kahraman (2019)	SF-WASPAS, IF-TOPSIS	x	Industrial robot selection.	Illustrative
Kutlu Gündoğdu & Kahraman (2019)	SF-TOPSIS, Interval-valued spherical fuzzy sets	x	3D printer selection	Illustrative
Kutlu Gündoğdu & Kahraman (2020)	SF-TOPSIS QFD	x	Delta robot technology design and evaluation	Case study given by (Alvares, Gasca, & Jaimes, 2018)
Kutlu Gündoğdu & Kahraman (2020)	SF-AHP, Neutrosophic AHP	x	Site selection of wind power farm	Case study

Although the VIKOR method has numerous advantages, the performance ratings and criteria’s weights are quantified as crisp values. In some situations, crisp data are inadequate to model real-life applications. Since human judgments including preferences are often vague, it is difficult to rate them as exact numerical values. Therefore fuzzy sets are useful approaches in case of conflicting situations or criteria evaluations of DMs (Büyüközkan & Ruan, 2008). In this study methodology used in the paper introduced by (Kutlu Gündoğdu & Kahraman, 2019) is utilized.

3. Araştırma Sonuçları ve Tartışma

3.1. Case study

A product development partner selection problem, which is a revised version of the problem proposed by (Büyüközkan & Güler, 2016a) as a case study. Based referenced study 4 evaluation criteria are determined. Competency (C1): Potential partner’s competency is a significant criterion in partner evaluation. Trust (C2): High-performance partnerships are characterized by high mutual trust and commitment among partners. Willingness to share information (C3): Various teams from different businesses engaged for the same purpose is a key factor in collaboration. A firm open to collaborate and share information increases the probability of PD partnership success. Technological capability (C4): Technical expertise includes keeping up with the technological change, implementing up to date infrastructure to improve development quality. In this process, a decision committee consisting of three experts from the company, DM1, DM2, and DM3 has been formed to determine the most appropriate partner among four possible alternatives. The weights of these DMs who have different experience levels are 0.2, 0.3, 0.5 respectively. The evaluations of DMs on alternatives, which are depicted in Table 2.

Table 2. Assessments of DMs

DM1		DM2					DM3				
SMI	HI	SMI	SMI	SMI	HI	HI	SMI	SMI	SMI	VHI	HI
EI	LI	SLI	LI	VLI	ALI	LI	EI	VLI	VLI	EI	SLI
HI	AMI	HI	VHI	AMI	HI	AMI	SMI	HI	AMI	AMI	VHI
SMI	HI	SMI	EI	HI	EI	EI	SMI	EI	EI	HI	VHI

These judgments are aggregated using SWAM operator by considering the importance levels of DMs. Aggregated decision matrix is obtained in Table 3.

Table 3. Aggregated decision matrix

	C1		C2			C3			C4			
X1	0,60	0,40	0,40	0,65	0,35	0,35	0,74	0,26	0,27	0,65	0,35	0,35
X2	0,29	0,73	0,32	0,20	0,81	0,21	0,43	0,57	0,44	0,42	0,59	0,43
X3	0,79	0,22	0,23	0,86	0,14	0,15	0,88	0,12	0,14	0,76	0,25	0,26
X4	0,59	0,41	0,42	0,55	0,45	0,46	0,63	0,37	0,38	0,71	0,30	0,32

According to the best and worst scores, the corresponding Spherical Fuzzy Positive Ideal Solution (SF-PIS) and Spherical Fuzzy Negative Ideal Solution (SF-NIS) are given in Table 4.

Table 4. SF-PIS and SF-NIS values

	C1	C2	C3	C4
X ⁺	0,79 0,22 0,23	0,86 0,14 0,15	0,88 0,12 0,14	0,76 0,25 0,26
X ⁻	0,29 0,73 0,32	0,20 0,81 0,21	0,43 0,57 0,44	0,42 0,59 0,43

The ranking of alternatives in ascending order by Si, Ri and Qi based on Euclidean distance given in Table 5.

Table 5. The Si Ri Qi values

Si	Ri	Qi
0,365549	0,2150	0,3708
1	0,5717	1,0000
0	0,0000	0,0000
0,563674	0,3263	0,5672

According to SP-VIKOR the ranking of alternatives are x4>x1>x5>x2.

4. Conclusion

The main purpose of this study is to partners and to select the most suitable alternative for decision making process. Evaluation involves subjective and qualitative judgments and requires different complex factors. For this reason, evaluation problem needs MCDM methods to select the most appropriate alternative correctly. In this study SF-VIKOR –is used and the utilized model is implemented to a decision case.

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