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FQSPM-SWOT FOR STRATEGIC ALLIANCE PLANNING AND PARTNER SELECTION; CASE STUDY IN A HOLDING CAR MANUFACTURER COMPANY

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Abstract. In today's competitive environment, holding companies are usually unable to successfully compete in production of goods and services due to technological sophistication. Therefore, for success of holding companies, selecting appropriate strategic alliance partner is a critical factor. Accordingly, the aim of the paper is to propose a systematic approach for an effective partner selection. Firstly, the underlying motivation and reasons for a strategic alliance building are presented using a SWOT analysis. Criteria of partners' evaluation are attained on the basis of combining strengths, weaknesses, opportunities and threats. Due to uncertainty of criteria, they are weighted using fuzzy quantitative strategic planning matrix (FQSPM). Because of a large number of criteria obtained from the SWOT-FQSPM analysis, criteria are diminished based on their weights using the Gap analysis with fuzzy data ranking. In the next step, it is proposed to apply four ranking algorithms including the Fuzzy Additive Ratio Assessment (ARAS-F), the Fuzzy Complex Proportional Assessment (COPRAS-F), the Fuzzy Multi-Objective Optimization by Ratio Analysis (Fuzzy MOORA), and the Fuzzy Technique for Order Preference by Similarity to Ideal solution (Fuzzy TOPSIS) to evaluate strategic partners. Finally, the results are combined with the help of the Borda method to choose the best alternative. To illustrate the efficiency of the proposed approach, a real partner selection problem at a holding industries factory in Iran is presented.

Keywords: partner selection, strategic alliance, SWOT, FQSPM, MCDM, ARAS-F, COPRAS-F, Fuzzy MOORA, Fuzzy TOPSIS.

JEL Classification: C44, C81, C82, D81.

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Introduction

Many manufacturer and service organisations depend on each other when producing goods and supplying services. If it is assumed that continuous progress of any organisation depends on the ratio of quality superiority of its products or services in comparison to competitors, it may be concluded that such advantage could not be gained without cooperation with an appropriate partner. For this reason, companies usually attempt to conclude an alliance contract with smaller companies as strategic alliance partners under companies' business brand. This type of business cooperation or acquisition is aimed at production of enhanced competitive products using more advanced technologies of smaller companies that would make the holding company more active and thriving in the competition against large rival companies (Cummings, Holmberg 2012). Accordingly, the most important factor is the selection of appropriate partners for holding companies to attain success in a dynamic business environment. Even the superior alliance management may be insufficient to overcome poor initial partner screening and selection efforts (Ashayeri *et al.* 2012). There are several reasons for the successful implementation of strategic alliances, but the importance of partner selection has been emphasised (Medcof 1997; Ding *et al.* 2013).

Based on existing approaches to cooperation and the use of capabilities and capacities of a company and its partners, a partner should be selected using systematic rules and viable criteria to ensure the minimal risk of outsourcing activities. As a systematic approach, many studies (Hoffmann, Schlosser 2001; Sampson 2004) advise companies to determine their motivation prior to selecting an appropriate alliance partner. This implies that the importance of selection criteria is affected by motivation. Nevertheless, almost all studies in this field also use expert ideas for determining motivation and determining or evaluating criteria of partners.

Therefore in the current research, based on the systematic approach, it is proposed to use a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis as a motivation definer for alliance strategy building with implementation of the quantitative strategic planning matrix, i.e. the QSPM-Gap analysis for weighting and determining the most important and feasible strategies as criteria for partner selection. It is important to note that in contrast with other studies, which use expert ideas only for identification of a strategic alliance, the current research seeks to achieve this aim with the help of the SWOT with QSPM analysis, combined with expert opinions. Then, the Gap analysis is used for selection of the most important criteria based on their feasibility score and QSPM weighted score.

Rather often, problems related to partner selection are examined using Multiple Criteria Decision Making (MCDM) approaches. There are some studies in this field that use new prioritisation methods. The relevant research review can be found in the following section of the article. It should also be noted that results can differ depending on the use of different MCDM methods (Antucheviciene *et al.* 2011, 2012). However, the use of a single prioritisation method cannot ensure the best result; besides, such a result would not be robust. Since we need a robust decision-making to choose the best partner (alternative), it is proposed to rank them using ARAS-F, COPRAS-F, Fuzzy MOORA, and Fuzzy TOPSIS methods. Then, the overall results can be found based on the Borda method. It should be mentioned, that this study was the first to use ARAS-F, COPRAS-F and Fuzzy MOORA methods for partner selection.

The rest of the paper is organised as follows: the first section presents the literature review; the proposed model is described in detail in the second section; in the third section, a case study is presented and the result obtained from the proposed algorithm is described; and the final section offers conclusions and future efforts.

1. Literature review

1.1. Partner selection

In this "co-competition" era, competitive advantages rely not only on internal capability and resources, but also on a close cooperation and solid relationships with external organisations (Claycomb, Frankwick 2004). Therefore, it is of vital importance to select the right partners for a strategic alliance that would result in minimisation of the total cost of produced goods as well as maximised profits and the quality of products.

Although policies on strategic alliances have been adopted by companies for decades, Gonzalez (2001) found that only 50% or less of alliance participants considered such integration a success. Some reports indicate that most of strategic alliance failures result from partner inability to perform the assigned function. When an enterprise decides to form a strategic alliance, it should select the partner with extreme caution in order to ensure success.

As a result, researchers use various methods to solve partner selection problem with respect to considerations mentioned above. Table 1 reviews partner selection studies, applied methods and considered problems.

The review indicates studies that use up-to-date Multiple Criteria Decisions Making approaches, such as ARAS (Zavadskas, Turskis 2010), COPRAS (Zavadskas, Kaklauskas 1996), Step-wise Weight Assessment Ratio Analysis (SWARA) (Keršuliene *et al*. 2010), Multi-Objective Optimization by Ratio Analysis (MOORA) (Brauers, Zavadskas 2006) and MULTIMOORA (Brauers, Zavadskas 2010), etc.

1.2. SWOT

In the partner selection process, the first step is devoted to a strategic analysis of internal organisational and external environmental driving forces, which act as the underlying motivation and reasons for alliance formation. This can be achieved using a systematic and simple method, such as a SWOT analysis.

A SWOT analysis is a generally used tool which examines strengths and weaknesses of an organisation or industry together with opportunities and threats of their marketplace environment (Azimi *et al*. 2011). Selection of important partners requires comprehensive information on circumstances of a market and a company; in addition, strategies of an organisation should be identified based on a scientific and systematic method. Thus, a SWOT analysis could be useful for determining important motivation of a company in partner selection. Having identified this motivation, strategies can be developed considering strengths, eliminating weaknesses, exploiting opportunities or countering threats (Kandakoglu *et al.* 2009) as well as using criteria that help companies evaluate their partners. It is important to note that there are hardly any SWOT analysis studies in partner selection. On the other hand, empirical studies show that the analysis is used successfully in designing real world problems (Yüksel, Dağdeviren 2007).

Table 1. Partner selection studies

References	Method	Considered problem
(Liou *et al.* 2011)	Fuzzy preference programming and Analytic Network Process (ANP)	To select partners for strategic alliances in the airline industry by considering effects of uncertainty and disagreement between decision-makers
(Huang *et al.* 2010)	Multi objective programming	To select optimal partners in the alliance and the corresponding resource allocations
(Chen *et al.* 2010)	Analytic hierarchy process (AHP) with linguistic variables	To select an R&D strategic alliance with closer levels of performance
(Ye 2010)	TOPSIS with interval-valued intuitionistic numbers	To select suitable partner for a virtual enterprise
(Wu *et al.* 2009)	ANP	Evaluate criteria and sub-criteria of partner in the LCD industry
(Liou 2012)	Hybrid DEMATEL and ANP	Helps to select suitable partners for a Taiwanese airline
(Yue 2013)	Projection technique	To select a partner with linguistic values and intuitionistic fuzzy information under a group decision-making environment
(Geum *et al.* 2013)	Index-based approach	Used index-based approach for patents and publications to identify and evaluate strategic partners for collaborative R&D
(Büyüközkan *et al.* 2008)	AHP and TOPSIS	Determine the most important criteria after calculating the criteria weights by AHP and finally ranking the strategic alliance partner in the logistics value chain by TOPSIS
(Chen *et al.* 2011)	Fuzzy PROMETHEE	To evaluate four potential vendors using seven criteria and four decision makers in the IS outsourcing
(Chen, Wang 2009)	Fuzzy VIKOR	Provides a rational and systematic process for developing the best alternative and compromise solution under each of the selection criteria for optimised partner in IT outsourcing
(Ashayeri *et al.* 2012)	Intuitionistic fuzzy Choquet integral operator	Development of the value chain concept from the perspective of partner selection. Outlines general similarities and differences of the value chain and the SCOR, and uses a simple V-form supply chain example to establish the proposed approach

1.3. QSPM with the Gap analysis

Although a SWOT analysis is a powerful tool, some experts believe that the number of quadruplet strategies resulting from the SWOT matrix are mostly too large. The number of these strategies should be reduced. Yet, a usual SWOT analysis cannot sort or weight strategies by using quantitative methods. Also, for having feasible criteria which are used as alliance strategies, a screening after criteria weighting is inevitable.

In order to solve these shortcomings particular to a SWOT analysis, the quantitative strategic planning matrix (QSPM) with the Gap analysis can be applied. It could be an effective tool when integrated with a SWOT analysis. The QSPM-Gap analysis evaluates, weights and reduces the number of criteria by examining feasibility and consistency of strategic alliance criteria in facing with environmental conditions and organisational situations. Accordingly, major criteria for the evaluation of partners will be formulated applying this approach.

Generally, studies in this field do not use any specific methods. Important criteria are only selected based on expert ideas and preferences. Moreover, in some cases when a number of strategies is large, decision makers can have different justification that causes inherent conflicts. Accordingly, it is proposed to use the Fuzzy QSPM-Gap analysis to adjust this condition and to decrease uncertainty and disagreement.

Recently, some researchers used the Fuzzy QSPM matrix to identify important strategies. Hosseini Nasab and Milani (2012) applied multiple criteria decision making and fuzzy numbers for improvement of a QSPM matrix. In their research, a FQSPM matrix is used for computing the sum of the total attractiveness score of alternatives. Yazdani *et al.* (2012) designed a strategic plan in an Iranian engineering company applying a SWOT analysis with reliable and achievable test by using QSPM.

2. The proposed model for partner selection

As mentioned before, since motivation to establish strategic alliances depends on different needs of an enterprise, attempts to identify universal criteria that enterprises should employ when seeking a proper partner are not productive (Chen *et al.* 2010). Accordingly, in the current research, the underlying motivation and reasons for strategic alliance building are elaborated with the help of a SWOT analysis and are determined according to exact wishes of a company. Then, criteria for evaluation of partners are attained on the basis of pair combining of four motivation groups of strengths, weaknesses, opportunities and threats. Figure 1 shows the proposed idea.

In the current research, criteria are obtained directly from motivation and do not require any reciprocal analysis as in studies of Liou *et al.* (2011) and Chen *et al.* (2010). Also, based on a direct linkage between criteria and motivation, inconsistency errors do not emerge. The criteria are extracted from external and internal motivation. If a partner does not satisfy such motivation, the alliance will break down.

Once the criteria are investigated, the weighting and feasibility evaluation process is completed using the QSPM-Gap analysis. (Due to uncertainty of examined criteria, criteria are weighted using the FQSPM matrix.) The steps of analysis are as follow:

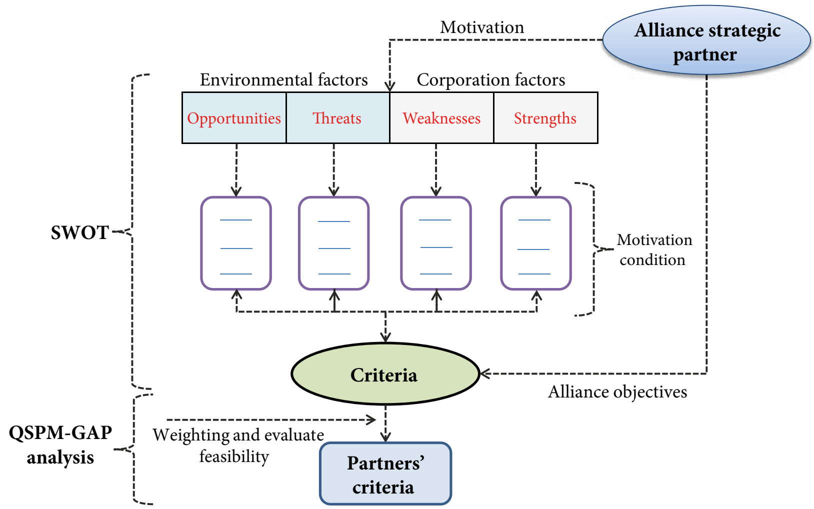

Fig. 1. The first step of the model

1. Create a table of alliance strategies (SO, WO, ST, WT) as criteria and motivations (S, O, W, T) based on the SWOT analysis output as in Table 2.

Table 2. Fuzzy SWOT-QSPM chart

	Att. score	SO_1–SO_m	WO_1–WO_m	ST_1–ST_m	WT_1–WT_m
S_1–S_n					
W_1–W_n					
O_1–O_n					
T_1–T_n					
Total criteria score					
Feasibility score					
Criteria weight					

2. Determine attractiveness scores of any of motivations (S, W, O, T) using fuzzy scores. These scores are determined in respect to environment and corporation factors.
3. Determine fuzzy scores of criteria (alliance strategies) in respect to motivations.
4. Compute normalised attractiveness score of any of motivations using the following equation:

$$\bar{A}_i^p = \frac{A_i^p}{\sum_{i=1}^{N} A_i^p}, \quad p \in (l,\ m,\ u), \quad i = 1, 2, \ldots, N, \tag{1}$$

where N is the number of motivations and A_i is fuzzy attractiveness scores of i^{th} motivation.

5. Calculate the normalised criteria score by using the following equation:

$$\hat{x}_{ij}^p = \bar{A}_i^p x_{ij}^p, \quad p \in (l,\ m,\ u), \quad i = 1, 2, \ldots, N, \quad j = 1, 2, \ldots, M, \tag{2}$$

where M is the number of criteria, x_{ij} represents fuzzy scores of i^{th} motivation of j^{th} criteria, and $\bar{A}_i^p$ is the normalised attractiveness score of i^{th} motivation.

6. Compute the total criteria score of any of criteria using the following equation:

$$TCS_j^p = \sqrt[1/N]{\prod_{i=1}^{N} \hat{x}_{ij}^p},\ p \in (l,\ m,\ u),\ i = 1, 2, \ldots, N,\ j = 1, 2, \ldots, M. \quad (3)$$

7. Determine the feasibility scores of criteria in facing with experts' idea about alliance condition and criteria situation. This score is the feasible degree of criteria regarding the alliance condition in the case study.
8. Multiplying the total score of each criterion TCS_j^p by the its feasibility degree, which makes fuzzy criteria weights:

$$W_j^p = TCS_j^p \times f_j,\ p \in (l,\ m,\ u),\ i = 1, 2, \ldots, N, \quad (4)$$

where W_j is weight of j^{th} criteria, TCS_j^p is the total score of j^{th} criteria and f_j is the feasibility degree of j^{th} criteria.

9. In this step, we use the Gap analysis based on fuzzy ranking as follows:
   9.1. The values of M_i (l_i, m_i, u_i) to M_j (l_j, m_j, u_j) criteria can be equivalently expressed as follows (Tavana *et al.* 2013):

$$V\left(M_i \le M_j\right) = hgt\left(M_j \cap M_j\right) = \mu M_i(d) = \begin{cases} 1, & if\ m_j \ge m_i, \\ 0, & if\ l_i \ge u_j, \\ \dfrac{u_i - l_j}{\left(m_j - u_j\right) - \left(m_i - u_i\right)} & otherwise, \end{cases} \quad (5)$$

where d is the ordinate of the highest intersection point D between μM_i and μM_j (see Fig. 2).

To compare M_i and M_j, both the values of $V\left(M_i \ge M_j\right)$ and $V\left(M_i \le M_j\right)$ are required.

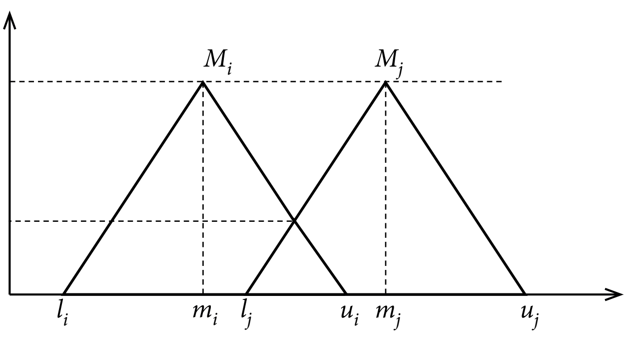

Fig. 2. Highest intersection point D between μM_i and μM_j

   9.2. The degree of possibility for a convex fuzzy number to be greater than N convex fuzzy numbers m_i (i =1, 2, …, N) can be defined by Eq. 6:

$$V\left(M \ge M_1, M_2, \ldots, M_N\right) = V\left[\left(M \ge M_1\right), \left(M \ge M_2\right), \ldots, \left(M \ge M_N\right)\right] = minV\left(M \ge M_i\right), \quad (6)$$

where i =1, 2, …, N.

9.3. For $K \neq i$ and $K=1,2,\ldots,N$, $GW_j = minV(M_i \geq M_K)$, then, the Gap weight is as follows:

$$GW_j = (GW_1, GW_2, \ldots, GW_M),\ j=1,2,\ldots,M. \tag{7}$$

9.4. Compute the weighted normalised Gap of any criteria using the following equation:

$$NGW_j = \frac{GW_j}{\sum_{j=1}^{m} GW_j}. \tag{8}$$

Criteria with higher NWG_i have more priority than others. We select the most important criteria, based on expert ideas, which offer that roughly 80% of the cumulative weight of criteria can present all the most effective criteria.

Once the criteria are investigated, some choices of appropriate partners for strategic alliance formation are considered. Then, the evaluation of the alliance is fed back into the analytical phase. We seek to determine, which of several alternatives would best support the realisation of the ultimate goal. For these reasons, MCDM methods could be used.

Criteria determined in the previous stage and their fuzzy weights are used as input of ARAS-F, COPRAS-F, Fuzzy MOORA, and Fuzzy TOPSIS methods, and the Borda method is used to select the best partners as shown in Figure 3.

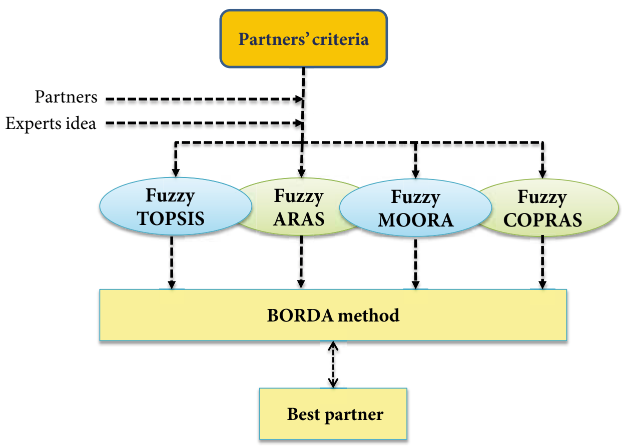

Fig. 3. The second step of the model

The proposed procedure for partner selection is summarised below.

Step 1: Set up an expert committee for this strategic decision problem.

Step 2: Set the fuzzy scale based on linguistic variables for SWOT, QSPM, ARAS, COPRAS, MOORA and TOPSIS methods.

Step 3: Get criteria based on the SWOT analysis and company motivation as follow:

1. Determine the key opportunities obtained as a result of partner selection;
2. Determine the key threats incurred by partner selection;

3. Determine the key weaknesses of the company;
4. Determine the key strengths of the company;
5. Compare internal strengths with external opportunities and determine the most effective SO alliance strategies;
6. Compare internal weaknesses and external opportunities and determine the most effective WO alliance strategies;
7. Compare internal strengths and external threats and determine the most effective ST alliance strategies;
8. Compare internal weaknesses and external threats and determine effective (defective) WT factors;
9. Determine SO, WO, ST and WT as alliance strategy criteria.

Step 4: Input criteria into the fuzzy QSPM matrix and weight them.

Step 5: Reduce the number of criteria by examining feasibility using the Gap analysis based on fuzzy ranking.

Step 6: Get partners' criteria.

Step 7: Evaluate the performance for each of the potential partners using ARAS-F, COPRAS-F, Fuzzy MOORA and Fuzzy TOPSIS methods based on partners' criteria.

Step 8: Compound results of the methods and get the final results based on the Borda method.

In summary, the proposed approach is divided into three sections: strategy building, alliance strategy weighting and decreasing, and partner evaluation and selection.

3. Case study: strategic alliance planning for partner selection in a holding car manufacturer company

With respect to the productive nature of car industries and the fact that they are aimed at achieving a greater product demand on the market, holding companies try to increase the profitability and reduce the production cost when entering into contracts with lucrative small and medium enterprises (SMEs) that satisfy required conditions under their own brand name. Also, establishing alliances with other companies may be a feasible way for SMEs to acquire necessary assistance for R&D. Because the size of SMEs, they have high focus on some specific technology and can be a proper partner for big companies. This study was completed at SH.KH Company that produces heavy machinery in Iran. This company works with casting units and production of cranks. SH.KH Company is attempting to acquire the Middle East market and concentrates on contracts with suitable SMEs. This contract is concluded under the name of SH.KH in the field of producing casting units and cranks.

Company strategies obtained from the SWOT analysis are introduced in Table 3. A group of experts answered questionnaires, which included open and close answers. The survey was conducted with three levels of managers. The result of the survey provided the basis for the SWOT analysis which was used to identify motivation and criteria of the company for cooperation with other companies (partners).

Table 3. SWOT Analysis

External factor	Internal factor	
	Weaknesses: 1. Lack of appropriate mechanism in order to prepare spare parts inside the country. 2. Lack of new production equipment. 3. Reliance on a customer and the lack of marketing in internal and international markets. 4. Shortage of delegation in all country. 5. Lack of information about updated price of spare parts. 6. Lack of mechanised logistic operations (such as a lift truck). 7. Space and technology restrictions to increase production capacity. 8. Low investing power due to high investment in preparing foreign spare parts. 9. Weakness in maintenance (lack of mechanised system and low competence of human resources). 10. Lack of coordination and complete information circulation between different departments.	Strengths: 1. Outsourced training of human resources. 2. Remarkable scientific capabilities in performing research and development projects. 3. Establishment of internal network system and its promotion capabilities. 4. A customer representative in the company. 5. Suitable equipment for staff training. 6. Flexibility of producing crank, assembling and spare parts making. 7. Certainty on dominance and on the quality of services and attempts to get quality management standard in services. 8. SH.KH Company is exempt from customs duties on imported spare parts.
Opportunities: 1. Supporting policies of the government on renovation and expansion of public transportation. 2. Preferential rate of customs duty on imported parts. 3. Using the existing and the new brand. 4. Government supporting policy for export. 5. Increasing attention to the environment and decreasing fuel consumption. 6. Increasing population and migration to cities. 7. The Iranian Government Decision of 2010 on phasing out old cars. 8. Privatisation approach used by the government. 9. Banking facilities and foreign exchange reserves. 10. Applying advanced technologies for engines.	WO criteria 1. Automated systems for high volumes of production. 2. Having guiding costs of major production processes in order to increase competing power. 3. Ability to reengineer after selling services. 4. Establishing up to date management methods. 5. Ability to replace new equipment with old equipment and mechanisation in order to increase the production capacity. 6. Ability to create a network, diversify and disperse sales centres in the country and abroad.	SO criteria 1. Ability to increase production capacity. 2. Diversify sales via expansion of export and new product development. 3. Help to increase marketing power to have effective representation in regional markets. 4. Expansion of productivity and incentive systems. 5. Relationships with other industries and expanding industrial marketing activities.

Continued Table 3

External factor	Internal factor	
Threats: 1. Restrictions for importing spare parts from foreign countries. 2. Rapid technological changes in car industry on the global scale. 3. Economic sanctions from countries of technology owners in the field of technology transfer. 4. Importing buses by government. 5. Strict environmental requirements. 6. Rapid emergence of competitors from advanced world technologies. 7. Administrative changes in customs related to car import. 8. Changing attitudes toward ownership of luxury and private cars. 9. Globalization.	WT criteria 1. Obtain new technologies to ensure their availability. 2. Utilising capacity of other manufacturers to expand services to suppliers. 3. Creating specialised production units with technologic flexibility capability for different industrial products. 4. Reengineering of organisational structures and relations.	ST criteria 1. Having diverse suppliers. 2. Supplying spare parts inside the country. 3. Partnership with the global network of suppliers. 4. Diverse production like special cars and public city transportation cars depending on the available technology in a company. 5. Optimised supply chain and management of human resources.

Linguistic variables for fuzzy scale of the expert idea are offered in Table 4.

Table 5 illustrates a part of the original QSPM matrix, which shows results of pairwise comparisons of criteria. Notice that quantitative calculations of the QSPM matrix and the SWOT analysis are performed using two methods:

1. Obtaining suggestions of seven experts through discreet interviews;
2. Gathering information from fifty experts filling-in the questionnaire.

Table 4. Linguistic variables for fuzzy scale

Condition	Very poor (VP)	Poor (P)	Fair (F)	Good (G)	Very good (VG)	Excellent (E)
Fuzzy scale	(0, 0.05, 0.1)	(0.1, 0.25, 0.3)	(0.3, 0.45, 0.5)	(0.5, 0.65, 0.7)	(0.7, 0.85, 0.9)	(0.9, 0.95, 1)

Table 5. A part of the original QSPM matrix

	Att.	SO1	SO2	SO3	SO4	SO5	WO1	WO2	WO3	WO4	…
O1	VG	G	VG	G	F	G	G	G	P	F	…
O2	VG	VG	VG	P	G	F	G	VG	F	P	…
O3	F	P	F	P	G	G	P	F	P	F	…
O4	VG	VG	VG	G	G	G	G	G	F	G	…
…	…	…	…	…	…	…	…	…	…	…	…

In this step, the normalised attractiveness score and the normalised criteria score are obtained by Eq. (1) and Eq. (2), respectively. Then, the total criteria score based on Eq. (3) is exerted and the feasibility number for each criterion is suggested by experts. Multiplying the total criteria score by the feasibility degree Eq. (4) of each criterion, weighted criteria are obtained. Table 6 illustrates the results of the step. In this step, criteria have been ranked with the fuzzy ranking model Eq. (5–6) and Gap weights (GW_j) as well as normalised Gap weights (NGW_j) have been received based on Eq. (7–8), see Table 7. NGW_j is a ratio and criteria with higher NGW_j have more priority than others. For example, we get the SO1 Gap weight as follows:

$$GW_{SO1} = \min(M_{SO1} \le M_{SO2}, M_{SO3}, M_{SO4}, M_{SO5}, M_{WO1}, M_{WO2}, M_{WO3}, M_{WO4}, M_{WO5}, M_{WO6}, M_{ST1}, M_{ST2}, M_{ST3}, M_{ST4}, M_{ST5}, M_{WT1}, M_{WT2}, M_{WT3}, M_{WT4}) = \min(0.237, 1, 0.0959, 0.285, 1, 1, 1, 0.2628, 1, 1, 1, 1, 1, 1, 0.427, 1, 1, 1, 0.4879) = 0.0959.$$

Table 6. Total criteria score, feasibility degree and weighted criteria

	Total criteria score			Feasibility	Weighted criteria		
	l	m	u		l	m	u
SO1	0.01013	0.01500	0.01625	3	0.03039	0.04501	0.04875
SO2	0.01002	0.01491	0.01647	4	0.04007	0.05963	0.06588
SO3	0.00701	0.01176	0.01324	1	0.00701	0.01176	0.01324
SO4	0.01165	0.01630	0.01777	4	0.04661	0.06520	0.07106
SO5	0.00829	0.01322	0.01473	5	0.04143	0.06608	0.07365
WO1	0.00607	0.01089	0.01238	2	0.01214	0.02177	0.02476
…	…	…	…	…	…	…	…

Like SO1, Gap weight of other criteria is calculated and normalised in Table 7.

Based on expert ideas, which suggest that roughly 80% of cumulative weight of criteria can present all of the most effective criteria, we select them as feasible and effective partner criteria as follows:

$$NGW_{SO2} + NGW_{SO4} + NGW_{SO5} + NGW_{WO2} + NGW_{WO4} + NGW_{ST5} + +NGW_{WT4} = (0.1087 + 0.1361 + 0.1401 + 0.1227 + 0.1211 + 0.0980 + 0.0911) = 0.8223 > 0.80.$$

In Table 7, output of FQSPM-Gap analysis matrix is depicted. Criteria of SO4, SO2, SO5, WO2, WO4, ST5, and WT4 have more than 80% of cumulate weight of criteria (82.32%) and are selected as partner criteria (Table 8). Also, the decision matrix is normalised and the results are shown in Table 8.

In this step, we enter into the second phase of our paper and introduce alternatives. We introduce 5 alternatives as SMEs, which cooperate as an alliance in our partner selection model. Then, fuzzy triangular numbers are assigned from $\tilde{1}$ to $\tilde{9}$ by experts to evaluate these alternatives. Creating long-term commercial activities between a company and SMEs is the final aim of this expert scoring. Table 9 presents $\tilde{1}$ to $\tilde{9}$ linguistic variables, which are used in evaluation of alternatives by applying ARAS-F, COPRAS-F, Fuzzy MOORA,

Table 7. Gap analysis and fuzzy ranking

	SO1	SO2	SO3	SO4	SO5	WO1	WO2	WO3	WO4	WO5	WO6	ST1	ST2	ST3	ST4	ST5	WT1	WT2	WT3	WT4
SO1	–	1	–	1	1	–	1	–	1	0.5058	0.4415	–	–	–	–	1	–	–	–	1
SO2	0.3725	–	–	1	1	–	1	–	1	–	–	–	–	–	–	0.9300	–	–	–	0.8824
SO3	1	1	–	1	1	1	1	0.8735	1	1	1	1	1	1	1	1	1	1	1	1
SO4	0.0959	0.7758	–	–	1	–	0.8812	–	0.8663	–	–	–	–	–	–	0.6994	–	–	–	0.6504
SO5	0.2578	0.7913	–	0.9712	–	–	0.8760	–	0.8641	–	–	–	–	–	–	0.7303	–	–	–	0.6910
WO1	1	1	0.0985	1	1	–	1	0.0241	1	1	1	0.8924	0.1771	0.7839	0.7839	1	0.7027	0.8460	0.2215	1
WO2	1	1	1	1	1	1	–	1	1	1	1	1	1	1	1	1	1	1	1	1
WO3	1	1	1	1	1	1	1	–	1	1	1	1	1	1	1	1	1	1	1	1
WO4	0.2628	0.9101	–	1	1	–	1	–	–	–	–	–	–	–	–	0.8377	–	–	–	0.7895
WO5	1	1	–	1	1	0.2109	1	–	1	–	0.9365	0.1323	–	0.0523	0.0523	1	–	0.0988	–	1
WO6	1	1	–	1	1	0.2688	1	–	1	1	–	0.1891	–	0.1081	0.1081	1	0.0498	0.1552	–	1
ST1	1	1	0.2105	1	1	1	1	0.1357	1	1	1	–	0.2902	0.8906	0.8906	1	0.8082	0.9530	0.3351	1
ST2	1	1	0.8605	1	1	1	1	0.7334	1	1	1	1	–	1	1	1	1	1	1	1
ST3	1	1	0.3206	1	1	1	1	0.2447	1	1	1	1	0.4018	–	1	1	0.9158	1	0.4477	1
ST4	1	1	0.3206	1	1	1	1	0.2447	1	1	1	1	0.4018	1	–	1	0.9158	1	0.4477	1
ST5	0.4270	1	–	1	1	–	1	–	1	0.0379	–	–	–	–	–	–	–	–	–	0.9505
WT1	1	1	1.4443	1	1	1	1	1.3199	1	1	1	1	1.5854	1	1	1	–	1	1.6659	1
WT2	1	1	0.2636	1	1	1	1	0.1890	1	1	1	1	0.3432	0.9377	0.9377	1	0.8551	–	0.3882	1
WT3	1	1	–	1	1	1	1	–	1	1	1	1	–	1	1	1	1	1	–	1
WT4	0.4879	1	–	1	1	–	1	–	1	0.1015	0.0482	–	–	–	–	1	–	–	–	–
GW	0.0959	0.7758	0.0985	0.9712	1	0.2109	0.8760	0.0241	0.8641	0.0379	0.0482	0.1323	0.1771	0.0523	0.0523	0.6994	0.0498	0.0988	0.2215	0.6504
NGW	0.0134	0.1087	0.0138	0.1361	0.1401	0.0295	0.1227	0.0034	0.1211	0.0053	0.0068	0.0185	0.0248	0.0073	0.0073	0.0980	0.0070	0.0138	0.0310	0.0911
RANK	14	5	13	2	1	9	3	20	4	19	18	11	10	15	15	6	17	12	8	7

and Fuzzy TOPSIS methods. Table 10 also shows the fuzzy number value of alternatives in exchange for partner criteria by decision-makers.

Then, the alternative fuzzy numbers are normalised and normalised fuzzy decision matrix of five alternatives is obtained in Table 11.

In this stage, normalised-weighted values (normalised values multiplied by weights) of all the alternatives are calculated and normalised-weighted fuzzy decision making matrix is provided in Table 12.

Table 8. The fuzzy decision matrix and fuzzy weights of Partners' criteria

Criteria	Criteria weights	Normalised criteria weights		
		l	*m*	*u*
SO2	(0.04007, 0.05963, 0.06588)	0.138	0.139	0.139
SO4	(0.04661, 0.06520, 0.07106)	0.160	0.152	0.150
SO5	(0.04143, 0.06608, 0.07365)	0.142	0.154	0.156
WO2	(0.04341, 0.06229, 0.06820)	0.149	0.145	0.144
WO4	(0.04272, 0.06192, 0.06788)	0.147	0.144	0.144
ST5	(0.03918, 0.05785, 0.06371)	0.135	0.135	0.135
WT4	(0.03768, 0.05664, 0.06255)	0.129	0.132	0.132

Table 9. Linguistic variables of alternatives

TFN	Linguistic variables	Bottom	Medium	Top
1	Equally preferred	1	1	1
2	Equally to moderately preferred	1	1.5	1.5
3	Moderately preferred	1	2	2
4	Moderately to strongly preferred	3	3.5	4
5	Strongly preferred	3	4	4.5
6	Strongly to very strongly preferred	3	4.5	5
7	Very strongly preferred	5	5.5	6
8	Very strongly to extremely preferred	5	6	7
9	Extremely preferred	5	7	9

Table 10. The fuzzy number of alternatives by decision makers

	SO2	SO4	SO5	WO2	WO4	ST5	WT4
A1	9	9	2	2	4	3	7
A2	7	5	3	4	7	4	5
A3	6	9	2	3	3	5	6
A4	6	7	4	3	7	4	8
A5	9	4	3	4	4	3	9

Table 11. The normalised fuzzy decision matrix of five alternatives

	SO2			S04			SO5			WO2			WO4			ST5			WT4		
	l	*m*	*u*	*l*	*m*	*u*	*l*	*m*	*u*	*l*	*m*	*u*	*l*	*m*	*u*	*l*	*m*	*u*	*l*	*m*	*u*
A0	0.238	0.255	0.281	0.238	0.259	0.290	0.429	0.333	0.364	0.333	0.280	0.296	0.263	0.234	0.231	0.273	0.267	0.273	0.263	0.237	0.244
A1	0.238	0.200	0.188	0.143	0.167	0.161	0.143	0.143	0.136	0.111	0.120	0.111	0.158	0.191	0.192	0.091	0.133	0.121	0.158	0.194	0.203
A2	0.143	0.164	0.156	0.238	0.259	0.290	0.143	0.190	0.182	0.333	0.280	0.296	0.263	0.234	0.231	0.273	0.233	0.242	0.263	0.237	0.244
A3	0.143	0.164	0.156	0.238	0.204	0.194	0.143	0.143	0.136	0.111	0.160	0.148	0.158	0.149	0.154	0.273	0.267	0.273	0.263	0.237	0.244
A4	0.238	0.218	0.219	0.238	0.204	0.194	0.429	0.333	0.364	0.111	0.160	0.148	0.263	0.234	0.231	0.273	0.233	0.242	0.158	0.178	0.174
A5	0.238	0.255	0.281	0.143	0.167	0.161	0.143	0.190	0.182	0.333	0.280	0.296	0.158	0.191	0.192	0.091	0.133	0.121	0.158	0.153	0.135

Table 12. The normalised-weighted fuzzy decision making matrix

	SO2			S04			SO5			WO2			WO4			ST5			WT4		
	l	*m*	*u*	*l*	*m*	*u*	*l*	*m*	*u*	*l*	*m*	*u*	*l*	*m*	*u*	*l*	*m*	*u*	*l*	*m*	*u*
A0	0.033	0.035	0.039	0.038	0.039	0.044	0.061	0.051	0.057	0.050	0.041	0.043	0.039	0.034	0.033	0.037	0.036	0.037	0.034	0.031	0.032
A1	0.033	0.028	0.026	0.023	0.025	0.024	0.020	0.022	0.021	0.017	0.017	0.016	0.023	0.028	0.028	0.012	0.018	0.016	0.020	0.026	0.027
A2	0.020	0.023	0.022	0.038	0.039	0.044	0.020	0.029	0.028	0.050	0.041	0.043	0.039	0.034	0.033	0.037	0.031	0.033	0.034	0.031	0.032
A3	0.020	0.023	0.022	0.038	0.031	0.029	0.020	0.022	0.021	0.017	0.023	0.021	0.023	0.021	0.022	0.037	0.036	0.037	0.034	0.031	0.032
A4	0.033	0.030	0.030	0.038	0.031	0.029	0.061	0.051	0.057	0.017	0.023	0.021	0.039	0.034	0.033	0.037	0.031	0.033	0.020	0.023	0.023
A5	0.033	0.035	0.039	0.023	0.026	0.025	0.020	0.029	0.028	0.050	0.041	0.043	0.023	0.028	0.028	0.012	0.018	0.016	0.020	0.020	0.018

ARAS-F method results: One of the most effective recently developed method is ARAS (Additive Ratio Assessment) introduced by Zavadskas and Turskis (2010). Also, the same authors developed the ARAS-F method to solve different problems in fuzzy environment in transportation, construction, economics, technology and sustainable development (Zavadskas, Turskis 2010). The review by Zavadskas and Turskis (2011) provides a comprehensive comparison between the use of ARAS, COPRAS and other MCDM methods and their implementation in different fields. In the current case, the value of optimality function in the ARAS-F model for each criterion is determined and the results are shown in Table 13. Then, the centre-of-area algorithm is used for defuzzification of ARAS-F and the utility degree of an alternative (k_i) is calculated.

The first row of Table 14 is a crisp value of the optimality function (S_i), the next row is the degree of an alternative (k_i) and the last row is the rank of the alternative.

Table 13. The value of optimality function resulting from the ARAS-F method

	Value of optimality function		
	l	*m*	*u*
Partner 0	0.291	0.267	0.284
Partner 1	0.148	0.164	0.158
Partner 2	0.237	0.228	0.234
Partner 3	0.189	0.187	0.185
Partner 4	0.244	0.224	0.226
Partner 5	0.182	0.197	0.197

Table 14. The optimality function and the degree of an alternative value resulting from the ARAS-F method

	Partner 1	Partner 2	Partner 3	Partner 4	Partner 5
S_i	0.166	0.219	0.181	0.211	0.218
k_i	0.629	0.832	0.687	0.801	0.830
Rank	5	1	4	3	2

COPRAS-F method results: Calculations are made following Zavadskas and Antucheviciene (2007) and Safaei Ghadikolaei *et al.* (2014). In this method, based on Table 12, the total of weighted normalised value (p_i) is calculated and the relative significance or priority value (Q_i) for each partner alternative is computed (see Table 15). Finally, the utility degree (N_i) for each alternative is calculated and the complete ranking of partners is obtained.

Table 15. The relative weight, utility degree and rank of each alternative resulting from the COPRAS-F method

Partner	p_i			Q_i	N_i	Rank
	l	*m*	*u*			
Partner 1	0.160	0.165	0.157	0.166	73.92	5
Partner 2	0.221	0.219	0.224	0.219	97.64	2
Partner 3	0.173	0.178	0.174	0.181	80.66	4
Partner 4	0.252	0.227	0.229	0.211	94.10	3
Partner 5	0.193	0.211	0.217	0.224	100	1

Fuzzy TOPSIS method results: Calculations are made following Yurdakul and Iç (2009). In this method, based on Table 12, the negative and positive ideal solutions (D^+, D^-) are calculated and the ranking score (C) is obtained. The results of the Fuzzy TOPSIS method are summarised in Table 16, which indicates that the partner 5 and partner 4 obtain the first and the second ranks with C value of 0.595 and 0.587, respectively.

Table 16. The ideal solution and the rank of each alternative resulting from the Fuzzy TOPSIS method

Partner	D^+	D^-	C	Rank
Partner 1	0.061	0.004	0.063	5
Partner 2	0.037	0.043	0.535	3
Partner 3	0.054	0.023	0.298	4
Partner 4	0.027	0.038	0.587	2
Partner 5	0.033	0.049	0.595	1

Fuzzy MOORA method results: Calculations are made following Karande and Chakraborty (2012). In this method, based on Table 12, the beneficial criteria for each alternative (S_i) are calculated, then, the defuzzification using the centre-of-area method is performed and finally, the rank of alternatives is obtained. Partner 5 and partner 2 get the first and second ranks, respectively (see Table 17).

Table 17. The beneficial criteria and the rank of each alternative resulting from the MOORA-F method

Partner	S_i			S_i^*	Rank
	l	m	u		
Partner 1	0.148	0.170	0.169	0.046	5
Partner 2	0.219	0.222	0.227	0.060	2
Partner 3	0.172	0.187	0.189	0.056	4
Partner 4	0.227	0.224	0.231	0.055	3
Partner 5	0.178	0.199	0.203	0.071	1

Comparative analysis: In order to validate the applicability and suitability of the four considered preference ranking methods to solve this partner selection problem, their ranking performance (see Table 18) is compared using the BORDA method.

Table 18. The ranking of alternatives with four methods

Partner	ARAS-F	COPRAS-F	Fuzzy TOPSIS	Fuzzy MOORA
Partner 1	5	5	5	5
Partner 2	1	2	3	2
Partner 3	4	4	4	3
Partner 4	3	3	2	4
Partner 5	2	1	1	1

Borda is one of consolidation methods that are based on the majority voting rule. In this research, the achieved rankings are consolidated by four methods of ARAS-F, COPRAS-F, Fuzzy TOPSIS, and Fuzzy MOORA. The results are presented in Table 19. For example, in Table 18, Partner 4 in ARAS-F, COPRAS-F and Fuzzy TOPSIS is better than Partner 3 and just in Fuzzy MOORA the results are inverse. Therefore, based on the majority voting, the 4th row of the 3rd column is equal to 1 in Table 19. Then, we aggregate the results and the final alternative ranking is $A5 \succ A2 \succ A4 \succ A3 \succ A1$.

Table 19. Borda method for five alternatives

	Partner 1	Partner 2	Partner 3	Partner 4	Partner 5	BORDA	Rank
Partner 1	–	0	0	0	0	0	5
Partner 2	1	–	1	1	0	3	2
Partner 3	1	0	–	0	0	1	4
Partner 4	1	0	1	–	0	2	3
Partner 5	1	1	1	1	–	4	1

Conclusions and future efforts

Seeking for a better alliance partner for a strategic partnership, continuous controlling of their efficacy and helping them to expand efficacy of related activities to perform successful outsourcing is essential.

Therefore, the current research proposed to use SWOT, FQSPM-Gap, and combination of four fuzzy MCDM methods as an integrated methodology for solving partner selection problem. The SWOT analysis was used for determining motivation and criteria. Because the method is unable to identify the importance of each criterion, the QSPM-Gap analysis method under fuzzy environment was applied. By applying this method, the total weights of criteria obtained and the Gap analysis for decreasing the criteria was done using fuzzy ranking models. The weights of decreased criteria represent the real importance of each criterion in selecting the best partner.

In stage of ranking of alternatives based on weights of criteria, four methods, namely ARAS-F, COPRAS-F, Fuzzy TOPSIS and Fuzzy MOORA, together with the Borda algorithm were integrated to prioritise the alternatives.

The empirical results indicate that Partner 5 is the best selection from the car manufacturer's viewpoint. However, joining an alliance does not only depend on the company's "willingness", but also on "acceptance" of the alliance. Therefore, a tool is provided to help the car manufacturer to select an optimised strategic alliance.

This hybrid decision making process is performed as a possible appropriate form. It is obvious that the presented framework for ranking partners with respect to their total performance and considering dependence of criteria is a practical model.

Also, researchers can use other MCDM methods or develop hybrid approaches to solve the same problem and to compare with the proposed approach.

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