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An ANP and MULTIMOORA-Based SWOT Analysis for Strategy Formulation

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Abstract

Since no organization can have unlimited resources, strategists should decide on a strategy that can provide the greatest benefits to the organization. Decisions on strategy formulation commit the organization to produce specific products, work in specific markets, and exploit certain resources and technologies for a relatively long time. Strategies dictate the long-term competitive advantages of an organization. Either good or bad, strategic decisions have multifaceted results and long-lasting consequences for organizations. So, organizations should adopt optimal strategies to move in the right direction and avoid irreparable losses. This planning calls for an optimal model of strategy formulation so that the strategists of organizations can formulate a strategy for their respected organizations readily and accurately. The present study presents a composite approach to organizational strategy formulation.

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INTRODUCTION

Organizations are faced with diverse challenges and opportunities in their attempts to accomplish their goals and missions. To cope with the challenges and to take advantage of the environmental opportunities, they are growingly resorting to strategic management as an effective framework to improve their status despite rapid environmental changes (Porter, 1996; Bryson, 2015; Salas & Yepes, 2018). Strategic management refers to a set of decisions and actions taken by the management of an organization, after consulting with all organizational levels, to dictate the long-term activities of the organization (Wheelen & Hunger, 2010; David & David, 2016). Strategic management is an organized endeavor to take fundamental decisions and key actions that shape an organization and the orientation of the organizational activities with respect to other institutions in a legal framework (Vishnevskiy et al., 2016). Strategic management is not naturally static; rather, strategic models often contain a feedback chain to monitor the implementation and to be informed about the next round of planning (Hill & Jones, 2012). Organizations draw on different processes to develop and lead their strategic management activities (Bagheri, 2016). The organizations that were equipped with advanced planning have developed more detailed processes (Salas & Yepes, 2018). The process of strategic management aims to achieve a preliminary consensus on the shape and content of strategic management system so that it can provoke support and commitment among key decision-makers and main leaders of the industry in question (Rosenzweig, 2015). Overall, the strategic management process is composed of three essential levels: strategy formulation, strategy implementation, and strategy control and appraisal (Hax & Majhuf, 1991; David & David, 2016).

Strategy formulation, the first step of strategic management, is a targeted instrument to develop a competitive advantage for an organization and to improve its performance (Wang et al., 2014). Strategy formulation refers to a process by which an organization defines its working domain and its long-term orientation. This process is composed of planning a route by which an organization can shape its activities and resources in the environment in which it operates and thereby, it creates value (Porter, 1996; Bisbe & Malagueno, 2012). Strategy formulation is perceived as the process of strategy selection and prioritization. This process is vital for the viability of an organization because it provides a framework for the organization to achieve the predicted outcomes (Alinezhad, 2018).

Today, it is generally agreed upon that to guarantee patients' health, it is necessary to manage and use medical tools correctly and that the quality of healthcare services depends on the available technology (Balestra et al., 2012). Medical technology management is an important constituent of a healthcare system (Wang et al., 2006). Medical equipment management (MEM) is the most important dimension of this process (Jazani, 2006). MEM refers to the process that enables hospitals to develop, monitor, and manage their equipment so that they can make safer, more effective and more economical use of their equipment and the equipment are maintained in good working conditions (Dyro, 2004). The MEM process ensures that the risks of medical equipment use are minimized (MHRA, 2015). The effectiveness of an MEM system can be measured by the operational performance of the medical equipment that is managed by the system (Saleh, 2014). According to the lifecycle of MEM (Cheng & Dyro, 2004; Porter, 2010), the most important operational elements that need to be considered in decision-making include 'planning', 'ownership', 'maintenance', and 'replacement' (Porter, 2010).

Medical equipment replacement is a strategic decision made by manufacturing and service firms because the purchase of a new piece of equipment can often entail additional expenses and may influence the productivity and efficiency of both the equipment and the firm (Hartman & Tan, 2013). The process of removing equipment from organizations due to equipment obsolescence, its failure, high costs of its maintenance or other factors is called equipment replacement, which is aimed to select suitable equipment at right time with minimum cost and maximum productivity (Dyro, 2004; Fan et al., 2014). The main goal of equipment replacement is to lead the organization towards profit maximization or cost minimization (Kalavathy, 2016). The planned replacement of equipment will reduce maintenance cost and other overhead (Taghipour, 2011). In other words, the policy in medical equipment replacement is to determine a proper age for replacement, rather than the use of the equipment for a long time with higher maintenance costs (Sharma, 2012).

Equipment is mostly replaced when they fail at critical working conditions or when it is realized during their service period that the spare parts and manufacturer support are not available (Taghipour, 2011; Saleh, 2014). It is sometimes observed that equipment is replaced as soon as new technology is made available even if the existing equipment is still effective (Clark, 2008). As a result, the overall productivity of the healthcare system is severely impaired by unnecessary expenses of replacing equipment that can still work instead of focusing on equipment that needs replacement (Rajasekaran, 2005; Mkalaf, 2015). To avoid wastes and overhead costs in hospitals, it is imperative to ensure that medical equipment is replaced in a reasonable and preplanned manner. This process should be performed by optimal strategies (Chien et al., 2010). The planning of this procurement requires a decision-making system of medical equipment replacement by which we can make better use of the limited resources. The present study proposes an optimal approach to strategy development. This approach will contribute to filling the gap in the medical sector as to the development of strategies for optimal replacement of medical equipment in the studied hospitals.

Since an organization is faced with internal and external forces that can be potential stimulants or can be subject to potential constraints with respect to the performance of the organization and/or the goals that the organization is seeking (Houben et al., 1999), it is necessary to briefly analyze the internal and external environment of the organization as the first step of strategic management process (Yuan, 2013). Strategic management process can exploit many methods and techniques to analyze strategic issues (Yuksel & Dagdeviren, 2007). One of the tools used to analyze internal and external strategic issues in strategy development step is SWOT matrix or analysis. SWOT focuses on assessing the strengths, weaknesses, opportunities, and threats of an organization. The SWOT analysis is a major decision support tool and is often used as a technique of systematic analysis of the internal and external environment of an organization (Shafieyan et al., 2017). The SWOT analysis can be applied for any product, location, industry, or organization (Ghorbani et al., 2015). Despite the extensive applications of the SWOT analysis, this method is suffering from multiple limitations such as the inability to rank the criteria and strategies (Lin et al., 2008). So, the SWOT analysis is unable to assess the strategic decision-making process comprehensively (Yuksel & Dagdeviren, 2007) as it cannot rank the strategies and factors. Multi-attribute decision-making (MADM) techniques are perceived as useful tools to rank the options in complex multi-dimensional problems. Various methods have been already proposed to prioritize the options in the MADM models (Yuksel & Dagdeviren, 2007; Patil & Kant, 2014; Kilic et al., 2015; Arsic et al., 2017; Deveci et al., 2018; Wu et al., 2018). The present study used the ANP and MULTIMOORA techniques to prioritize the criteria and alternative options in order to present a comprehensive decision system for strategy development using a composite SWOT-ANP-MULTIMOORA approach.

The paper is organized as follows. Section 2 is a brief overview of the methods used as the constituents of our composite approach. Section 3 describes the proposed methodology that is scrutinized in Sections 4 and 5. Section 6 provides a numerical application of the proposed method. Finally, the paper is concluded in Section 7.

An overview of the methods employed

We employed the SWOT analysis to recognize all relevant factors. Then, these factors could be categorized into strengths (S), weaknesses (W), opportunities (O), and threats (T) according to internal and external perspectives. The ANP approach was applied to assign a weight to individual SWOT factors and sub-factors. Finally, the alternative strategies were ranked using the MULTIMOORA method. Next sub-sections provide a brief overview of these three methods.

SWOT analysis

In a SWOT matrix, strengths and weaknesses of an organization are regarded as internal factors, and threats and opportunities are considered external factors. These factors are exploited to identify and formulate strategies by matching the key internal and external factors. The SWOT analysis reveals the best composite strategies to maximize the strengths and opportunities and to minimize the threats and weaknesses (Hong & Chan, 2010). The matrix is applied to develop four types of strategies as presented in Table 1.

Strength-opportunity (SO) strategies take advantage of internal strengths of an organization to seize external opportunities; weakness-opportunity (WO) strategies seek improving internal weaknesses by using external opportunities; strength-threat (ST) strategies aim to exploit the strengths of an organization to hinder or minimize the impact of external threats; finally, weakness-threat (WT) strategies are defensive tactics to reduce internal weaknesses and avoid external threats. The present study used the ANP technique to quantify the results of the SWOT matrix.

Table 1: SWOT analysis matrix.

		Internal Factors	
		Strengths (S)	Weaknesses (W)
External Factors	Opportunities (O)	SO strategy	WO strategy
	Threats (T)	ST strategy	WT strategy

Analytic network process method

Analytical hierarchy process (AHP) is a vigorous technique that helps analysts choose the best decision out of multiple decisions by organizing a decision-making problem in a hierarchy structure with different levels (Saaty, 1996). AHP enables us to assess factors considered as criteria and to evaluate alternative strategies by assigning relative weights (Sevkli et al., 2012). The technique posits that the factors presented in the hierarchical structure are independent and there are only unilateral relationships between the elements of different decision levels in the hierarchy and the distinct elements within each cluster, as well as between the clusters (Chung et al., 2005). But, this is not always a reasonable assumption. The AHP method is not suitable for models in which there are mutual relationships between the clusters or interrelationships between the elements of a cluster (Lin et al., 2008). So, analytic network process (ANP) has been presented to cope with this problem.

ANP method is an extension of the AHP (Saaty, 1996). It is almost impossible to depict very complex decision-making problems in a unidirectional hierarchical structure while it is vital to clarify the complicated and multi-dimensional relationships between alternatives and criteria, as is the case in ANP, where all elements and relationships are identified in one-way, two-way interactions and loops. ANP extends the pairwise comparison process to judge each component with respect to the priorities of criteria and alternatives. The ANP model is composed of four main parts (Chung et al., 2005). In the first part, the problem is defined comprehensively in a network model. In the second part, pairwise comparisons are built to estimate the relative importance of various elements at each level. The third part is related to the generation of a super matrix to display priorities of elements. The last part is to make decisions using the super matrix model. In the ANP analysis, after the relative importance of all components is obtained using the super matrix, a weighted super matrix is often employed to normalize the super matrix values, and also a limit matrix is constructed for each cluster. Then, the limit matrix is applied to find out the results of the decision problem (Yuksel & Dagdeviren, 2007). Fig. 1 compares the AHP and ANP methods.

As depicted in Fig. 2, the AHP and ANP models that were used for the SWOT analysis are given at four levels.

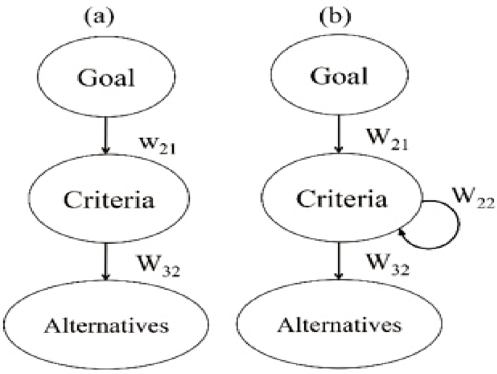

Fig. 1. Hierarchy and network: (a) Hierarchy; (b) Network.

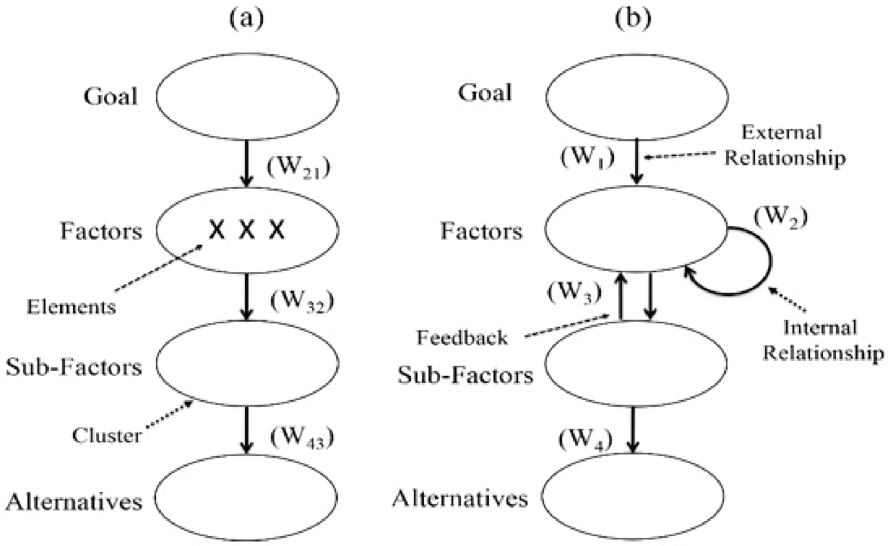

Fig. 2. A comparison of AHP and ANP methods (Sevkli et al., 2012)

To find the best strategy is the goal at the first level and it derives the rest of the hierarchy/network structure. The second and third levels are devoted to SWOT factors and SWOT sub-factors, which are used as criteria and sub-criteria, respectively. “Alternatives” which are composed of the alternative strategies come at the last level. Fig. 2a is a hierarchical illustration of the SWOT model and Fig. 2b displays its general network representation. The network model illustrates the case of a hierarchy with interdependence within clusters, but it lacks feedback. Here, SWOT factors, SWOT sub-factors, and alternative strategies are used instead of criteria, sub-criteria and alternatives respectively, and hence the SWOT factors can have interdependencies.

Based on Fig. 2a, the super matrix of a SWOT hierarchy with four levels can be represented as follows:

$$W= \begin{array}{l} \text{GOAL} \\ \text{SWOT factors} \\ \text{SWOT Sub-factors} \\ \text{Alternatives)} \end{array} \begin{bmatrix} 0 & 0 & 0 & 0 \\ w_{21} & 0 & 0 & 0 \\ 0 & w_{32} & 0 & 0 \\ 0 & 0 & w_{43} & I \end{bmatrix}$$

where W_{21} is a vector showing the effect of the goal on the criteria, W_{32} is a vector showing the effect of the criteria on individual sub-criteria, W_{43} is a vector showing the effect of the sub-criteria on each and every one of the alternatives, and I is the identity matrix. According to Fig. 2b, the general sub-matrix notation for the SWOT model used in this study can be shown as follows:

$$W=\begin{array}{l} \text{GOAL} \\ \text{SWOT factors} \\ \text{SWOT Sub-factors} \\ \text{Alternatives)} \end{array}\begin{bmatrix} 0 & 0 & 0 & 0 \\ w_1 & w_2 & 0 & 0 \\ 0 & w_3 & 0 & 0 \\ 0 & 0 & w_4 & I \end{bmatrix}$$

where W_1 denotes a vector representing the effect of the goal on the SWOT factors, W_2 represents a matrix representing the effect of the factors on individual sub-factors, W_3 is a matrix representing the effect of the sub-factors on individual alternatives, and I is the identity matrix.

This study preferred an ANP method to develop the multi-criteria structure that exists in the strategic formulation problem. Then, MULTIMOORA methodology could be employed to determine the most appropriate alternative in a comprehensive manner using the opinions of the case study experts.

MULTIMOORA

Multi-objective optimization by ratio analysis (MOORA) method was first presented by Brauers and Zavadskas (2006) drawing on previous research. In an attempt to make it more robust, they extended it to MULTIMOORA (MOORA plus the full multiplicative form) in their next work (Brauers & Zavadskas, 2010). These methods have been used in many studies (Siksnelyte et al., 2019; Hafezalkotob et al., 2018; Wang et al., 2018; Baležentis et al., 2012).

MOORA method commences with matrix X whose elements xij denote ith alternative of jth objective (i = 1,2,. . .,m & j = 1,2,. . .,n). MOORA consists of two parts: the ratio system and the reference point approach. MacCrimmon (1968) defines two stages of weighting, namely normalization and voting on the significance of objectives. Brauers and Zavadskas (2010) discussed weighting, and Brauers (2007) analyzed the problem of normalization. The MULTIMOORA method includes internal normalization and treats originally all the objectives equally important. By definition, all stakeholders that are interested in the issue could only give more importance to an objective. Therefore, they could either multiply the dimensionless number representing the response on an objective with a significance coefficient or they could decide beforehand to split an objective into different sub-objectives (Baležentis et al., 2012).

The ratio System of MOORA

Ratio system compares alternative of an objective to all values of the objective to define data normalization:

$$x_{ij}^{*} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^{2}}} \qquad (1)$$

where x_{ij}^{*} denotes ith alternative of *jth* objective. Usually these numbers belong to the interval [0;1]. These indicators are added (if desirable value of indicator is maximum) or subtracted (if desirable value is minimum), Thus, the summarizing index of each alternative is derived in this way:

$$y_i^{*} = \sum_{j=1}^{g} x_{ij}^{*} - \sum_{j=g+1}^{n} x_{ij}^{*} \qquad (3)$$

where g = 1,. . .,n denotes number of objectives to be maximized. Then, every ratio is given the rank: the higher the index, the higher the rank.

Reference point of MOORA

Reference point approach is based on the ratio system (previous section). The maximal objective reference point (vector) is found according to ratios found in Eq. 1. The jth coordinate of the reference point can be expressed as $r_j = \max_i x_{ij}^{*}$

in case of maximization. Every coordinate of this vector shows the maximum or minimum of certain objective (indicator). Then, every element of the normalized response matrix is calculated again and the final rank is assigned according to deviation from the reference point and the Min–Max Metric of Chebyshev:

$$\min_i \{\max_j |r_j - x_{ij}^{*}|\}$$

Full multiplicative form and MULTIMOORA

Brauers & Zavadskas (2010) proposed MOORA to be updated by the Full Multiplicative Form method embodying maximization as well as minimization of the purely multiplicative utility function. The overall utility of the ith alternative can be expressed as a dimensionless number:

$$U_i = \frac{\prod_{j=1}^{g}(x_{ij}^*)}{\prod_{j=g+1}^{n}(x_{ij}^*)} \quad (4)$$

where $\prod_{j=1}^{g}(x_{ij}^*)$. i=1, 2, …, m represents the product of objectives of the ith alternative that is supposed to be maximized with g = 1,. . .,n being the number of objectives to be maximized and where $\prod_{j=g+1}^{n}(x_{ij}^*)$ represents the product of objectives of the ith alternative to be minimized with n g being the number of objectives (indicators) to be minimized. Thus, MULTIMOORA summarizes MOORA (i.e. ratio system and reference point) and the full multiplicative form. The remaining subjectivity can also be reduced by ameliorated nominal group and Delphi techniques (Brauers & Zavadskas, 2010).

Proposed methodology

The present work aimed to present a comprehensive approach to strategy formulation. The approach was used to formulate alternative strategies for medical equipment in the hospital sector. The case of the hospitals supervised by the Guilan University of Medical Science, Rasht, Iran was selected for the study. To find the internal factors (strengths and weaknesses) and external factors (opportunities and threats) affecting equipment replacement in the study region, we talked to the experts of the individual hospitals. After the key internal and external factors were identified, the SWOT matrix was built.

Then, the key factors were defined in the context of SWOT analysis, and the SWOT factors were incorporated into the integrated ANP weighted MULTIMOORA framework for the strategy formulation. The steps of the suggested approach can be briefly presented as follows, which is partially adapted from the best practices in the extant literature (Yuksel & Dagdeviren, 2007; Sevkli et al., 2012; Ervural et al., 2018)

Step 1. Referring to experts to identify the SWOT sub-factors (strengths, weaknesses, opportunities, and threats)

Step 2. Building the SWOT matrix and adopting strategies of medical equipment replacement

Step 3. Assuming that there is no dependence among the SWOT factors, determining the importance degrees of the SWOT factors on a 1–9 scale (i.e. calculate w_1)

Step 4. Determining, on a 1–9 scale, the interdependence matrix of each SWOT factor with respect to the other factors by using the schematic representation of the interdependence among the SWOT factors (i.e. calculating W_2)

Step 5. Determining the interdependent priorities of the SWOT factors (i.e. calculating $w_{factors} = W_2 \times w_1$)

Step 6. Determining the local importance degrees of the SWOT sub-factors on a 1–9 scale (i.e. calculating $w_{Sub\text{-}factor\ (local)}$)

Step 7. Determining the global importance degrees of the SWOT sub-factors (i.e. calculating $w_{Sub\text{-}factor\ (global)} = w_{factors} \times w_{Sub\text{-}factor\ (local)}$)

Step 8. Obtaining the evaluation matrix with regard to the identified alternatives and SWOT sub-factors on the Likert scale which was performed by expert teams

Step 9. Normalizing the decision matrix using Eq. 1

Step 10. Ranking the alternatives on the basis of the ratio system approach Eq. 2

Step 11. Ranking the criteria and alternatives by reference point approach

Step 12. Finally, ranking the alternatives by full multiplicative form Eq. 4

Application of the proposed methodology

Step 1. After consulting with the expert teams of the individual hospitals, a number of six key internal factors (three strengths and three weaknesses) and six key external factors (three opportunities and three threats) were identified as the factors affecting medical equipment replacement in the study site. The results are presented in Table 2.

Step 2. After the main internal and external factors were selected and assessed and the relationships of their attributes were identified, eight strategies that could be possibly used as effective ways of medical equipment replacement in the studied hospitals were developed. As the SWOT matrix in Table 2 shows, eight key strategies of medical equipment replacement in the hospitals of Guilan province were determined by pairwise matching of strengths, weaknesses, opportunities, and threats.

Table 2: The SWOT matrix of medical equipment replacement

		Strengths (S)	Weaknesses (W)
		S1: Executive regulation supporting optimal medical equipment replacement**S2**: Timely replacement of equipment according to the symptoms of the end of life**S3**: The existence of a comprehensive data system for medical equipment replacement in hospitals	**W1**: Old age of medical equipment**W2**: Surplus expenses of delayed replacement of medical equipment**W3**: The lack of budget allocation by hospital to medical equipment supply
Opportunities (O)	**O1**: The chance of increasing medical service value by enhancing medical equipment quality**O2**: The potential to produce and develop some medical equipment inside Iran**O3**: Exemptions and economic supports of equipment import by the government	**SO1**: Enhancement of existing medical equipment quality and their replacement with modern technologies**SO2**: Replacement of existing medical equipment at the end of its lifecycle with high-quality equipment supplied by reliable Iranian or foreign manufacturers	**WO1**: Attracting credit to purchase or replace medical equipment with respect to governmental supports**WO2**: Medical equipment supply by Iranian manufactures as much as possible to exploit special sale facilities
Threats (T)	**T1**: Unavailability of spare parts**T2**: High costs of medical equipment maintenance**T3**: Financial losses during the unavailability of broken equipment	**ST1**: The appealing to governmentally-supported technical and executive regulations and rules to attract local investors**ST2**: Formulation and implementation of optimal comprehensive plans for 'maintenance' and 'replacement' of hospital-specific medical equipment	**WT1**: Establishment of a special workgroup of medical equipment replacement in the hospitals**WT2**: Planning and implementation of an effective mechanism to reduce medical equipment replacement costs

Step 3. Step 3. Pairwise comparisons were made between SWOT factors using a nine-point scale according to the goal, assuming the lack of dependence between SWOT factors. The results are summarized in Table 3.

As it is evident in Table 3, the significance vector of the SWOT factors can be summarized as below:

$$w_1 = \begin{bmatrix} S \\ W \\ O \\ T \end{bmatrix} = \begin{bmatrix} 0.477 \\ 0.283 \\ 0.164 \\ 0.106 \end{bmatrix} \quad (5)$$

Step 4. The interdependence of the SWOT factors was determined by pairwise comparisons and the analysis of the impact of each factor on other factors. It was already mentioned that it is not always possible to deposit that the SWOT factors are independent. It is more likely to obtain more appropriate and realistic results by simultaneous use of the SWOT analysis and ANP. The analysis of the internal and external environments makes it possible to determine the dependence of the SWOT factor on one another as depicted in Fig. 3 schematically.

According to the interdependencies in Fig. 3, Tables 4-7 present the interdependence matrices of the SWOT factors with respect to each individual factor. This matrix (W2), which was calculated by relative significance weight, is displayed in Eq. 6.

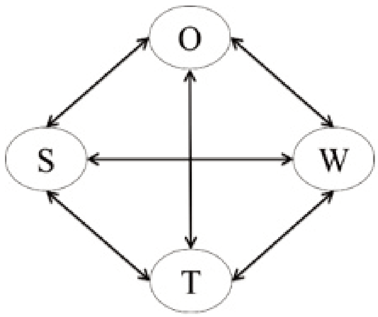

Fig. 3. Interdependencies among the SWOT factors.

$$W_2=\begin{bmatrix}1.000 & 0.570 & 0.634 & 0.429\\ 0.249 & 1.000 & 0.193 & 0.142\\ 0.594 & 0.594 & 1.000 & 0.429\\ 0.157 & 0.097 & 0.173 & 1.000\end{bmatrix} \quad (6)$$

Table 3: Pairwise comparison of the SWOT factors with respect to the goal assuming the lack of interdependence of the factors

SWOT factors	S	W	O	T	Importance degree
S	1	2	3	3	0.447
W		1	2	3	0.283
O			1	2	0.164
T				1	0.106

Table 4: Interdependency matrix of the SWOT factors with respect to strengths

Strengths	W	O	T	Relative importance weight
W	1	1/3	2	0.249
O		1	3	0.594
T			1	0.157

Table 5: Interdependency matrix of the SWOT factors with respect to weaknesses

Weaknesses	W	O	T	Relative importance weight
W	1	2	5	0.570
O		1	4	0.333
T			1	0.097

Table 6: Interdependency matrix of the SWOT factors with respect to opportunities

Opportunities	S	O	T	Relative importance weight
W	1	3	4	0.634
O		1	1	0.193
T			1	0.173

Table 7: Interdependency matrix of the SWOT factors with respect to threats

Threats	**S**	**W**	**O**	**Relative importance weight**
W	1	3	1	0.429
O		1	1.3	0.142
T			1	0.429

Step 5. In this step, the priorities of the SWOT factors were calculated by Eq. 7.

$$W_{factors} = W_2 \times w_1 \begin{bmatrix} 1.000 & 0.570 & 0.634 & 0.429 \\ 0.249 & 1.000 & 0.193 & 0.142 \\ 0.594 & 0.594 & 1.000 & 0.429 \\ 0.157 & 0.097 & 0.173 & 1.000 \end{bmatrix} \times \begin{bmatrix} 0.477 \\ 0.283 \\ 0.164 \\ 0.106 \end{bmatrix} = \begin{bmatrix} 0.379 \\ 0.221 \\ 0.285 \\ 0.115 \end{bmatrix} \quad (7)$$

Step 6. In this step, the relative priorities of the SWOT sub-factors were calculated by pairwise comparison matrices. The priority vectors that were derived from the analysis of pairwise comparison matrices are given in Eq. 8.

$$W_{(Strengths)sub\text{-}factors} = \begin{bmatrix} 0.196 \\ 0.493 \\ 0.311 \end{bmatrix} \quad W_{(Weaknesses)sub\text{-}factors} = \begin{bmatrix} 0.263 \\ 0.493 \\ 0.578 \end{bmatrix}$$

$$W_{(Opportunities)sub\text{-}factors} = \begin{bmatrix} 0.558 \\ 0.122 \\ 0.320 \end{bmatrix} \quad W_{(Threats)sub\text{-}factors} = \begin{bmatrix} 0.210 \\ 0.240 \\ 0.550 \end{bmatrix} \quad (8)$$

In this step, the overall priorities of the SWOT sub-factors were calculated by multiplying the interdependent priorities of the SWOT factors (given in Step 5) in the relative priorities of the SWOT sub-factors (derived in Step 6). Calculations are provided in Table 8. The vector w_(Sub-factor (global)) that was obtained from the values of overall priority of the sub-factors in the last column of Table 8 was given as Eq. 9.

$$W_{Sub\text{-}factor\ (global)} = \begin{bmatrix} 0.074 \\ 0.187 \\ 0.118 \\ 0.058 \\ 0.035 \\ 0.128 \\ 0.159 \\ 0.035 \\ 0.091 \\ 0.024 \\ 0.028 \\ 0.063 \end{bmatrix}$$

Step 8. In this step, we obtained the evaluation matrix with regards to the alternatives and SWOT sub-factors on the Likert scale provided by the expert teams (Table 9).

Step 9. The decision matrix was normalized using Eq. 1. The normalized decision matrix is shown in Table 10.

Step 10. In this step, the alternatives were ranked by the ratio system approach. In this approach, we first obtain the weighted matrix. Then, the sum of positive elements is subtracted from the sum of negative elements for each individual alternative. Thus, the ranking was performed by Eq. 2. according to the ratio system approach. The weighted matrix and the alternatives ranked by the ratio system are presented in Table 11.

Step 11. In this step, we ranked the alternatives on the basis of the reference point approach. So, we first obtained a reference point for the individual criteria. The reference point is the largest value of criteria $(r_i = \max_i w_j x_j^*)$ for positive criteria and the smallest value of criteria $(r_i = \min_i w_j x_j^*)$ for the negative criteria. Table 12 displays the values of reference point for performance assessment criteria. After the reference points were specified for individual criteria, the alternatives were ranked by the reference point approach using Equation. $\min_j \{\max_i |w_j r_i - w_j x_{ij}^*|$. The results are shown in Table 13.

Table 8: Overall priority of the SWOT factors

SWOT factors	Priority of factors	SWOT sub-factors	Sub-factor priorities	Final priority of sub-factors
Strengths	0.379	S_1	0.196	0.074
		S_2	0.493	0.187
		S_3	0.311	0.118
Weaknesses	0.221	W_1	0.263	0.058
		W_2	0.159	0.035
		W_3	0.578	0.128
Opportunities	0.285	O_1	0.558	0.159
		O_2	0.122	0.035
		O_3	0.320	0.091
Threats	0.115	T_1	0.210	0.024
		T_2	0.240	0.028
		T_3	0.550	0.063

Table 9: Evaluation matrix

	S_1	S_2	S_3	W_1	W_2	W_3	O_1	O_2	O_3	T_1	T_2	T_3
Strategy SO1	2.895	4.015	3.169	1.922	1.925	2.001	4.296	4.369	3.29	0.985	1.205	0.789
Strategy SO2	2.85	4.269	4.465	0.869	0.91	0.953	3.26	3.98	4.026	0.986	0.896	1.025
Strategy WO1	1.026	2.012	0.986	4.359	4.039	4.098	4.781	4.32	4.595	1.265	1.028	1.064
Strategy WO2	0.987	2.017	1.128	4.298	4.348	3.115	3.751	4.65	4.19	1.298	1.247	1.197
Strategy ST1	4.895	3.175	2.981	1.274	1.964	2.012	0.975	2.189	1.247	4.189	4.569	4.715
Strategy ST2	3.2	4.685	4.158	2.854	2.18	1.985	1.684	2.394	2.012	1.024	4.695	4.852
Strategy WT1	1.582	2.14	2.097	4.782	3.189	3.982	2.014	2.931	1.987	4.652	3.892	4.621
Strategy WT2	2.018	1.078	1.259	3.81	4.685	4.169	0.982	1.025	1.097	3.895	4.018	4.621

Table 10: Normalized decision matrix in MULTIMOORA method

	S_1	S_2	S_3	W_1	W_2	W_3	O_1	O_2	O_3	T_1	T_2	T_3
Strategy SO1	0.376	0.448	0.395	0.204	0.215	0.235	0.497	0.447	0.376	0.126	0.136	0.082
Strategy SO2	0.370	0.477	0.556	0.092	0.101	0.112	0.377	0.408	0.460	0.127	0.101	0.106
Strategy WO1	0.133	0.225	0.123	0.462	0.450	0.481	0.553	0.442	0.526	0.162	0.116	0.110
Strategy WO2	0.128	0.225	0.141	0.455	0.485	0.365	0.434	0.476	0.479	0.167	0.140	0.124
Strategy ST1	0.636	0.354	0.372	0.135	0.219	0.236	0.113	0.224	0.143	0.538	0.514	0.490
Strategy ST2	0.416	0.523	0.518	0.302	0.243	0.233	0.195	0.245	0.230	0.132	0.528	0.504
Strategy WT1	0.205	0.239	0.261	0.507	0.355	0.467	0.233	0.300	0.227	0.597	0.438	0.480
Strategy WT2	0.262	0.120	0.157	0.404	0.522	0.489	0.114	0.105	0.125	0.500	0.452	0.480

Table 11: Weighted matrix and ranking of alternatives by ratio system approach

	S_1	S_2	S_3	W_1	W_2	W_3	O_1	O_2	O_3	T_1	T_2	T_3	y	Rank
Strategy SO1	0.005	0.004	0.003	0.034	0.016	0.079	0.030	0.008	0.012	0.047	0.084	0.028	0.348	2
Strategy SO2	0.007	0.003	0.003	0.042	0.014	0.060	0.014	0.004	0.005	0.066	0.089	0.027	0.334	4
Strategy WO1	0.007	0.003	0.004	0.048	0.015	0.088	0.062	0.016	0.027	0.015	0.042	0.010	0.336	3
Strategy WO2	0.008	0.004	0.004	0.044	0.017	0.069	0.047	0.017	0.026	0.017	0.042	0.009	0.303	**6**
Strategy ST1	0.031	0.014	0.013	0.013	0.008	0.018	0.030	0.008	0.008	0.044	0.066	0.047	0.300	**7**
Strategy ST2	0.032	0.015	0.003	0.021	0.009	0.031	0.030	0.009	0.018	0.061	0.098	0.031	0.356	**1**
Strategy WT1	0.030	0.012	0.014	0.021	0.011	0.037	0.060	0.012	0.029	0.031	0.045	0.015	0.317	**5**
Strategy WT2	0.030	0.013	0.012	0.011	0.004	0.018	0.063	0.018	0.023	0.019	0.023	0.019	0.253	**8**

Table 12: Reference point of criteria

Reference point	S_1	S_2	S_3	W_1	W_2	W_3	O_1	O_2	O_3	T_1	T_2	T_3
r	0.047	0.032	0.015	0.014	0.048	0.017	0.088	0.063	0.018	0.029	0.066	0.098

Table 13: Ranking of alternatives by reference point approach

	max	**Rank**
Strategy SO1	0.033	1
Strategy SO2	0.048	2
Strategy WO1	0.056	5
Strategy WO2	0.056	4
Strategy ST1	0.070	7
Strategy ST2	0.057	6
Strategy WT1	0.053	3
Strategy WT2	0.075	8

Step 12. The final step was related to the ranking of the alternatives by the full multiplicative form using Eq. 4. The full multiplicative sub-criterion was obtained from this Equation. and accordingly, the alternatives were ranked. The results are presented in Table 14.

Finally, the alternatives were ranked by the dominance theory approach. Given the principles of cardinal and ordinal numbers and Kendall and Gibbons (1990)'s theory, it is not possible to apply algebraic operations of cardinal numbers within the domain of ordinal numbers and these numbers can be only transformed to ordinal numbers of another type. The advantage of dominance theory is that all steps of problem-solving are performed within the domain of ordinal numbers. The absolute dominance occurs when the rank of an alternative dominates that of other alternatives. In the MULTIMOORA technique, the absolute dominance is observed under the 1-1-1 conditions. The general dominance happens when two ranks of three ranks of an alternative dominate the other alternatives. The final ranking of the strategies is presented in Table 15.

Table 14: Ranking of alternatives by full multiplicative approach

	U	Rank
Strategy SO1	8.017E-08	7
Strategy SO2	9.845E-09	8
Strategy WO1	9.804E-08	4
Strategy WO2	9.410E-08	5
Strategy ST1	2.848E-07	3
Strategy ST2	7.405E-07	2
Strategy WT1	2.151E-06	1
Strategy WT2	8.274E-08	6

Table 15: Final ranking of strategies by MULTIMOORA method

	Ratio System	Reference Point	Full Multiplicative Form	Rank
Strategy SO1	2	1	7	**2**
Strategy SO2	4	2	8	**4**
Strategy WO1	3	5	4	**3**
Strategy WO2	6	4	5	**6**
Strategy ST1	7	7	3	**7**
Strategy ST2	1	6	2	**1**
Strategy WT1	5	3	1	**5**
Strategy WT2	8	8	6	**8**

RESULTS

The present study presented a composite approach to facilitate strategy formulation process of the organizations. The approach drew on the SWOT matrix as one of the most famous analyzing tools of an organization's internal and external environments and the ANP technique used to quantify the results of the matrix. The ANP technique can be used to solve complex problems with a non-hierarchical structure. The main advantage of this technique is that it allows considering the interdependence of different decision levels with respect to one another as well as the interrelationships of decision criteria at the same level. Also, we made use of the MULTIMOORA technique that is the extended version of the MOORA technique. The composite techniques (e.g. MULTIMOORA) have turned out to be more successful in solving sensitive and complex problems and in making forecasts than their non-composite counterparts (Zavadskas et al., 2016). In the present changing environment, the only thing that has been left constant and stable has been the phenomenon of 'change' per se. Since the process of strategic management is a dynamic and continuous process, a change in one element of a strategy formulation model will entail a change in some or all other constituents of the model. Thus, the activities pertaining to strategy formulation are permanent in nature. Our proposed model of strategy formulation is clear and applied. The composite approach proposed here and in similar studies (Arsic et al., 2017; Shafieyan et al., 2017; Liu et al., 2018; Khan, 2018) can be used as a planning instrument for strategy formulation in future.

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