Creating Learning University through Integration of ANP and SWOT with fuzzy AHP Methodology (Case of University of Tehran)

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Abstract: The aim of this research is formulation and recognition of the priorities of transforming the University into dynamic learning organization. At first, the most influential internal and external elements were detected with the help of the techniques of strategy formulation. Then having used the Strengths, Weaknesses, Opportunities and Threats (SWOT) matrix, that is, the primary organizational strategies, we formulated the primary strategies. This research uses the analytic network process (ANP), which allows the quantitative analysis of SWOT and measurement of the dependency among the factors. Then using of fuzzy AHP technique, all of strategies will be prioritized. The research outcome is the formulation and recognition of the priorities of transforming the University into dynamic learning organization with the help of ANP and SWOT with FAHP techniques.

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1. Introduction

Learning organizations are not simply the most fashionable or current management trend, they can provide work environments that are open to creative thought, and embrace the concept that solutions to ongoing work-related problems are available inside each and every one of us. All we must do is tap into the knowledge base, which gives us the "ability to think critically and creatively, the ability to communicate ideas and concepts, and the ability to cooperate with other human beings in the process of inquiry and action (Navran Associates Newsletter 1993). The aim of the research is formulation and recognition of the priorities of Transforming the University into dynamic learning organization. The main techniques used in the research are ANP, SWOT, together with Fuzzy AHP technique.

2. Literature review

A learning organization is the term given to a company that facilitates the learning of its members and continuously transforms itself (Pedler and Burgogyne, 1997). Learning organizations develop as a result of the pressures facing modern organizations and enables them to remain competitive in the business environment (O'Keeffe, 2002). A learning organization has five main features; systems thinking, personal mastery, mental models, shared vision and team learning. Organizations do not organically develop into learning organizations; there are factors prompting their change. As organizations grow, they lose their capacity to learn as company structures and individual thinking becomes rigid (Pedler and Boydell, 1997). When problems arise, the proposed solutions often turn out to be only short term (single loop learning) and re-emerge in the future (Senge, 1990). To remain competitive, many organizations have restructured, with fewer people in the company (Pedler and Boydell, 1997) This means those who remain need to work more effectively (O'Keeffe, T. 2002). To create a competitive advantage, companies need to learn faster than their competitors and to develop a customer responsive culture (O'Keeffe, T. 2002). Argyris (1999) identified that organizations need to maintain knowledge about new products and processes, understand what is happening in the outside environment and produce creative solutions using the knowledge and skills of all within the organization. This requires co-operation between individuals and groups, free and reliable communication, and a culture of trust (Argyris, 1999). A learning organization exhibits five main characteristics: systems thinking, personal mastery, mental models, a shared vision, and team learning (Senge, 1990).

Systems thinking: The idea of the learning organization developed from a body of work called Systems thinking (Argyris, 1999). This is a conceptual framework that allows people to study businesses as bounded objects (Senge, 1990). Learning organizations use this method of thinking when assessing their company and have information systems that measure the performance of the organization as a whole and of its various components (Argyris, 1999). Systems thinking state that all the characteristics must be apparent at once in an organization for it to be a learning organization (Senge, 1990). If some of these characteristics is missing then the organization will fall short of its goal. However O'Keeffe (2002) believes that the characteristics of a learning organization are factors that are gradually acquired, rather than developed simultaneously.

Personal mastery: The commitment by an individual to the process of learning is known as personal mastery (Senge, 1990). There is a competitive advantage for an organization whose workforce can learn quicker than the workforce of other organizations (Wang and Ahmed, 2003). Individual learning is acquired through staff training and development (McHugh and Alker, 1998), however learning cannot be forced upon an individual who is not receptive to learning (Senge, 1990). Research shows that most learning in the workplace is incidental, rather than the product of formal training (O'Keeffe, T. 2002) therefore it is important to develop a culture where personal mastery is practiced in daily life (Senge, 1990). A learning organization has been described as the sum of individual learning, but there must be mechanisms for individual learning to be transferred into organizational learning (Wang and Ahmed, 2003).

Mental models: The assumptions held by individuals and organizations are called mental models (Senge, 1990). To become a learning organization, these models must be challenged. Individuals tend to espouse theories, which are what they intend to follow, and theories-in-use, which are what they actually do (Argyris, 1999). Similarly, organizations tend to have 'memories' which preserve certain behaviors, norms and values (Easterby-Smith, Crossan and Nicolini, 2000). In creating a learning environment it is important to replace confrontational attitudes with an open culture (McHugh and Alker, 1998) that promotes inquiry and trust (O'Keeffe, 2002). To achieve this, the learning organization needs mechanisms for locating and assessing organizational theories of action (Argyris, 1999). Unwanted values need to be discarded in a process called 'unlearning' (Easterby-Smith, Crossan and Nicolini, 2000). Wang and Ahmed (2003) refer to this as 'triple loop learning.'

Shared vision: The development of a shared vision is important in motivating the staff to learn, as it creates a common identity that provides focus and energy for learning (Senge, 1990). The most successful visions build on the individual visions of the employees at all levels of the organization (McHugh and Alker, 1998), thus the creation of a shared vision can be hindered by traditional structures where the company vision is imposed from above (O'Keeffe, 2002). Therefore, learning organizations tend to have flat, decentralized organizational structures (Argyris, 1999). The shared vision is often to succeed against a competitor (Wang and Ahmed, 2003), however Senge (1990) states that these are transitory goals and suggests that there should also be long term goals that are intrinsic within the company.

Team learning: The accumulation of individual learning constitutes Team learning (O'Keeffe, 2002). The benefit of team or shared learning is that staff grows more quickly (O'Keeffe, 2002) and the problem solving capacity of the organization is improved through better access to knowledge and expertise (McHugh, and Groves, 1998). Learning organizations have structures that facilitate team learning with features such as boundary crossing and openness (Argyris, 1999). Team learning requires individuals to engage in dialogue and discussion (O'Keeffe, 2002); therefore team members must develop open communication, shared meaning, and shared understanding (O'Keeffe, 2002).Learning organizations typically have excellent knowledge management structures, allowing creation, acquisition, dissemination, and implementation of this knowledge in the organization (Senge, 1990).

3. Research methodology

This research in terms of objective is a practical and in terms of methods is descriptive. For gathering data, both library and field methods are used. For writing literature, library techniques, including the survey of scientific journals and databases are used. But the main data has been gathered by field methods and through interview with teachers, experts and students of Tehran University. To measure the validity, the opinions of lecturers and experts were used. Various stages of research and data analysis are shown in Fig. 1.

3.1. SWOT analysis

SWOT analysis is an important support tool for decision-making, and is commonly used as a means to systematically analyze an organization's internal and external environments (Kangas, Kurtila and Kajanus, 2003). By identifying its strengths, weaknesses, opportunities, and threats, the organization can build strategies upon its strengths, eliminate its weaknesses, and exploit its opportunities or use them to counter the threats. The strengths and weaknesses are identified by an internal environment appraisal while the opportunities and threats are identified by an external environment appraisal

(Dyson, 2004).SWOT analysis summarizes the most important internal and external factors that may affect the organization's future, which are referred to as strategic factors (Kangas and Kurtila, 2003). The external and internal environments consist of variables which are outside and inside the organization, respectively. The organization's management has no short-term effect on either type of variable (Houben and Lenie, 1999). Comprehensive environmental analysis is important in recognition of the variety of internal and external forces with which an organization is confronted. On the one hand these forces may comprise potential stimulants, and on the other hand, they may consist of potential limitations regarding the performance of the organization or the objectives that the organization wishes to achieve (Houben and Lenie, 1999). The obtained information can be systematically represented in a matrix; different combinations of the four factors from the matrix (Houben and Lenie, 1999) can aid in determination of strategies for long-term progress.

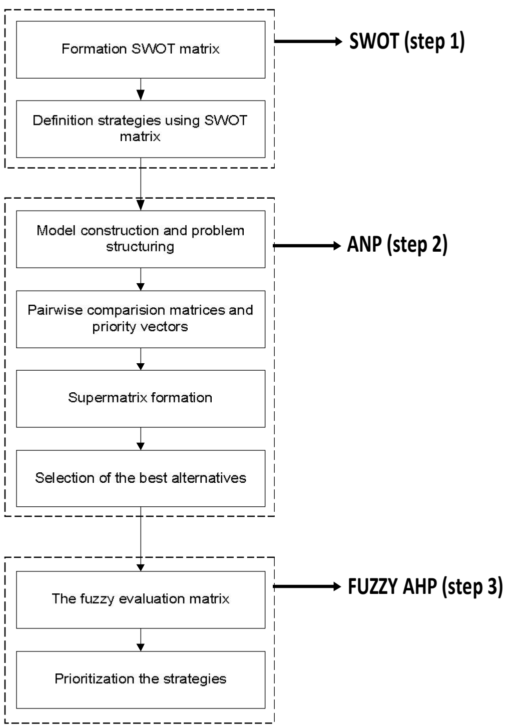

Fig 1. Schematic diagram of the proposed model

When used properly, SWOT can provide a good basis for strategy formulation (Kangas and Kurtila, 2003).However, SWOT analysis is not without weaknesses in the measurement and evaluation steps. In conventional SWOT analysis, the magnitude of the factors is not quantified to determine the effect of each factor on the proposed plan or strategy (Kuo-liang and Lin Shu-chen, 2008). In other words, SWOT analysis does not provide an analytical means to determine the relative importance of the factors, or the ability to assess the appropriateness of decision alternatives based on these factors (Kangas and Kurtila, 2003).While it does pinpoint the factors in the analysis, individual factors are usually described briefly and very generally (Hill and Westbrook, 1997).More specifically, SWOT allows analysts to categorize factors as being internal (Strengths, Weaknesses) or external (Opportunities, Threats) in relation to a given decision, and thus enables them to compare opportunities and threats with strengths and weaknesses (Shrestha and Alavalapati, 2004). However, the result of SWOT analysis is often merely a listing or an incomplete qualitative examination of the internal and external factors (Kangas and Kurtila, 2003). For this reason, SWOT analysis cannot comprehensively appraise the strategic decision-making process (Hill and Westbrook, 1997).

According to table 1, SWOT analysis matrix offers four types of strategies.

Table 1: SWOT matrix

Internal factors / External factors	Strengths (S)	Weaknesses (W)
Opportunities (O)	SO Strategies	WO Strategies
Threats (T)	ST Strategies	WT Strategies

SO strategies: Using the internal strengths and external opportunities will be determined.
WO strategies: Use of external opportunities, internal weaknesses can be reduced or eliminated.
ST strategies: Using internal strengths, external threats reduced or be removed.
WT strategies: Decreases the internal weaknesses and external threats are avoided.

For the preparation of SWOT Matrix, six steps must be passed:

1. Preparing a list of major opportunities and threats external environment organizations using PEST, Porter Five Forces Competitive models.
2. Prepare a list of the major strengths and weaknesses within the organization using the Porter value chain, EFQM, BSC models.
3. Compared to internal strengths with external opportunities and determining SO strategies
4. Compared to the internal weaknesses with external opportunities and determining WO strategies
5. Compared to internal strengths and external threats and determining ST strategies

6. Reducing internal weaknesses and avoiding external threats

3.2. Analytic network process

An initial study identified the multi-criteria decision technique, known as the AHP, to be the most appropriate for solving complicated problems (Saaty, 1978).AHP was proposed by Saaty in 1980 as a method of solving socio-economic decision-making problems, and has been used to solve a wide range of decision-making problems (Chang, 1992).

AHP is a comprehensive framework which is designed to cope with the intuitive, the rational, and the irrational when multi-objective, multi-criterion, and multi-actor decisions are made, with or without certainty, for any number of alternatives. The basic assumption of AHP is the condition of functional independence of the upper part, or cluster (see Fig. 3), of the hierarchy, from all its lower parts, and from the criteria or items in each level (Kulak and Kahraman, 2005).Many decision-making problems cannot be structured hierarchically because they involve interaction of various factors, with high-level factors occasionally depending on low-level factors (Saaty, 1978). Structuring a problem with functional dependencies that allows for feedback among clusters is considered to be a network system. Saaty suggested the use of AHP to solve the problem of independence among alternatives or criteria, and the use of ANP to solve the problem of dependence among alternatives or criteria (Saaty, 1978). The ANP, also introduced by Saaty, is a generalization of the AHP (Chang and Huang, 2006).While the AHP represents a framework with a un-directional hierarchical AHP relationship, the ANP allows for complex interrelationships among decision levels and attributes. The ANP feedback approach replaces hierarchies with networks in which the relationships between levels are not easily represented as higher or lower, dominant or subordinate, direct or indirect.

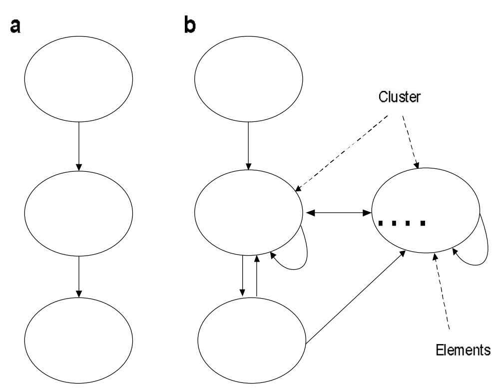

Fig 2. Structural difference between a hierarchy and a network: (a) a hierarchy; (b) a network

For instance, not only does the importance of the criteria determine the importance of the alternatives, as in a hierarchy, but the importance of the alternatives may also have an impact on the importance of the criteria (Kuo-liang and Lin Shu-chen, 2008). Therefore, a hierarchical representation with a linear top-to-bottom structure is not suitable for a complex system (Chang and Huang, 2006).

A system with feedback can be represented by a network. The structural differences between a hierarchy and a network are depicted in Fig. 2. The elements of a cluster may influence some or all the elements of any other cluster. A network can be organized to include source clusters, intermediate clusters and sink clusters. Relationships in a network are represented by arcs, where the directions of arcs signify directional dependence (Chang and Huang, 2006). Interdependency between two clusters, termed outer dependence, is represented by a two-way arrow. Inner dependencies among the elements of a cluster are represented by looped arcs (Chang and Huang, 2006).

The ANP is composed of four major steps (Chang and Huang, 2006):

Step 1: Model construction and problem structuring: The problem should be stated clearly and be decomposed into a rational system, like a network. This network structure can be obtained by decision-makers through brainstorming or other appropriate methods. An example of the format of a network is shown in Fig. 2b.

Step 2: Pairwise comparison matrices and priority vectors: Similar to the comparisons performed in AHP, pairs of decision elements at each cluster are compared with respect to their importance towards their control criteria. The clusters themselves are also compared pairwise with respect to their contribution to the objective. Decision-makers are asked to respond to a series of pairwise comparisons of two elements or two clusters to be evaluated in terms of their contribution to their particular upper level criteria. In addition, interdependencies among elements of a cluster must also be examined pairwise; the influence of each element on other elements can be represented by an eigenvector. The relative importance values are determined with Saaty's 1–9 scale (Table 2), where a score of 1 represents equal importance between the two elements and a score of 9 indicates the extreme importance of one element (row cluster in the matrix) compared to the other one (column cluster in the matrix) .A reciprocal value is assigned to the inverse comparison, that is, $a_{ij}=1/a_{ji}$, a_{ij} (a_{ji}) denotes the importance of the ith (jth) element. Like with AHP, pairwise comparison in ANP is performed in the framework of a matrix, and a local priority vector can be derived as an estimate of the relative importance associated with the elements (or clusters) being compared by solving the following equation:

$$A \times w = \lambda_{max} \times w \qquad (1)$$

Where A is the matrix of pairwise comparison, w is the eigenvector, and λ_{max} is the largest eigenvalue of A. Saaty (1986) proposes several algorithms to approximate w. In this paper, Expert Choice is used to compute the eigenvectors from the pairwise comparison matrices and to determine the consistency ratios.

Step 3: Supermatrix formation: The supermatrix concept is similar to the Markov chain process (Saaty, 1980) .To obtains global priorities in a system with interdependent influences, the local priority vectors are entered in the appropriate columns of a matrix.

Table 2: Saaty's 1–9 scale for AHP preference

Intensity of importance	Definition
1	Equal importance
3	Moderate importance
5	Strong importance
7	Very strong importance
9	Absolute importance

As a result, a supermatrix is actually a partitioned matrix, where each matrix segment represents a relationship between two clusters in a system. Let the clusters of a decision system be C_k , k=1,2,…,n, and each cluster K has m_k elements, denoted by e_{k1} ,e_{k2} ,…,e_{kmk}.

The local priority vectors obtained in Step 2 are grouped and placed in the appropriate positions in a supermatrix based on the flow of influence from one cluster to another, or from a cluster to itself, as in the loop. A standard form for a supermatrix is as shown in expression (2) (Saaty, 1980).

$$W = \begin{array}{c} \\ C_1 \\ \vdots \\ C_k \\ \vdots \\ C_n \end{array} \begin{array}{c} \begin{array}{ccccc} C_1 & \cdots & C_k & \cdots & C_n \end{array} \\ \begin{bmatrix} W_{11} & \cdots & W_{1k} & \cdots & W_{1n} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ W_{k1} & \cdots & W_{kk} & \cdots & W_{kn} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ W_{n1} & \cdots & W_{nk} & \cdots & W_{nn} \end{bmatrix} \end{array} \qquad (2)$$

As an example, the supermatrix representation for a hierarchy with three levels, as shown in Fig. 3a (Saaty, 1980), is as follows:

$$W_h = \begin{bmatrix} 0 & 0 & 0 \\ W_{21} & 0 & 0 \\ 0 & W_{32} & 1 \end{bmatrix} \qquad (3)$$

In this matrix, w_{21} is a vector which represents the impact of the goal on the criteria, W_{32} is a matrix that represents the impact of the criteria on each of the alternatives, I is the identity matrix, and zero entries correspond to those elements having no influence. For the example given above, if the criteria are interrelated, the hierarchy is replaced with the network shown in Fig. 2b. The interdependency is exhibited by the presence of the matrix element W_{22} of the supermatrix W_n, yielding (Saaty, 1980):

$$W_n = \begin{bmatrix} 0 & 0 & 0 \\ W_{21} & W_{22} & 0 \\ 0 & W_{32} & 1 \end{bmatrix} \qquad (4)$$

Note that any zero value in the supermatrix can be replaced by a matrix if there is an interrelationship of the elements within a cluster or between two clusters. Since there usually is interdependence among clusters in a network, the columns of a supermatrix may sum to more than one. However, the supermatrix must be modified so that each column of the matrix sums to unity. An approach recommended by Saaty (1980) involves determining the relative importance of the clusters in the supermatrix, using the column cluster (see Fig. 3) as the controlling cluster.

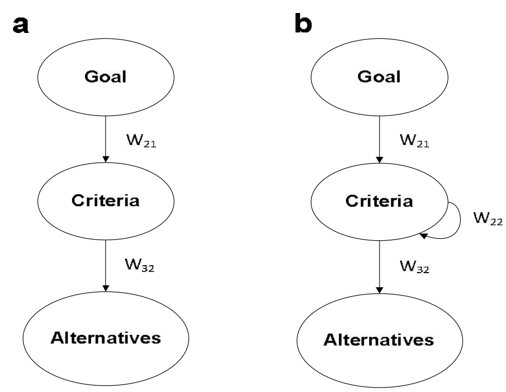

Fig 3. Hierarchy and network: (a) hierarchy; (b) network

That is, row clusters with non-zero entries in a given column cluster are compared according to their impact on the cluster of that column cluster. An eigenvector is obtained from the pairwise comparison matrix of the row clusters with respect to the column cluster, which in turn yields an eigenvector for each column cluster. The first entry of the respective eigenvector for each column cluster, is multiplied by all the elements in the first cluster of that column, the second by all the elements in the second cluster of that column and so on. In this way, the cluster in each column of the supermatrix is weighted, and the result, known as the weighted supermatrix, is stochastic.

Raising a matrix to exponential powers gives the long-term relative influences of the elements on each other. To achieve convergence on the importance weights, the weighted supermatrix is raised to the power of 2k + 1, where k is an arbitrarily large number; the new matrix is called the limit supermatrix (Saaty, 1980). The limit supermatrix has the same form as the weighted supermatrix, but all the columns of the limit supermatrix are the same. The final priorities of all elements in the matrix can be obtained by normalizing each cluster of this supermatrix. Additionally, the final priorities can be calculated using matrix operations, especially where the number of elements in the model is relatively few. Matrix operations are used in order to easily convey the steps of the methodology and how the dependencies are worked out.

Step 4: Selection of the best alternatives: If the supermatrix formed in Step 3 covers the whole network, the priority weights of the alternatives can be found in the column of alternatives in the normalized supermatrix. On the other hand, if a supermatrix only comprises clusters that are interrelated, additional calculations must be made to obtain the overall priorities of the alternatives. The alternative with the largest overall priority should be selected, as it is the best alternative as determined by the calculations made using matrix operations.

3.3. Fuzzy AHP

Despite of its wide range of applications, the conventional AHP approach may not fully reflect a style of human thinking. One reason is that decision makers usually feel more confident to give interval judgments rather than expressing their judgments in the form of single numeric values. As a result, fuzzy AHP and its extensions are developed to solve alternative selection and justification problems. Although FAHP requires tedious computations, it is capable of capturing a human's appraisal of ambiguity when complex multi-attribute decision making problems are considered. In the literature, many FAHP methods have been proposed ever since the seminal paper by Van Laarhoven and Pedrycz (1983). In his earlier work, Saaty (1980) proposed a method to give meaning to both fuzziness in perception and fuzziness in meaning. This method measures the relativity of fuzziness by structuring the functions of a system hierarchically in a multiple attribute framework. Later on, Buckley (1985) extends Saaty's AHP method in which decision makers can express their preference using fuzzy ratios instead of crisp values. Chang (1996) developed a fuzzy extent analysis for AHP, which has similar steps as that of Saaty's crisp AHP. However, his approach is relatively easier in computation than the other fuzzy AHP approaches. In this paper, we make use of Chang's fuzzy extent analysis for AHP. Kahraman et al. (2003) and, Kulak and Kahraman (2005) applied Chang's (1996) fuzzy extent analysis in the selection of the best catering firm, facility layout and the best transportation company, respectively.

Let $O = \{o_1, o_2, . . ., o_n\}$ be an object set, and $U = \{g_1, g_2, . . ., g_m\}$ be a goal set. According to the Chang's extent analysis, each object is considered one by one, and for each object, the analysis is carried out for each of the possible goals, g_i. Therefore, m extent analysis values for each object are obtained and shown as follows:

$$\tilde{M}^1_{g_i}, \tilde{M}^2_{g_i}, \ldots, \tilde{M}^m_{g_i}, \quad i=1, 2, \ldots, n$$

Where $\tilde{M}^j_{g_i}$ (j=1,2,3,…, m) are all triangular fuzzy numbers. The membership function of the triangular fuzzy number is denoted by $M_{(x)}$. The steps of the Chang's extent analysis can be summarized as follows:

Step 1: The value of fuzzy synthetic extent with respect to the ith object is defined as:

$$S_i = \sum_{j=1}^{m} \tilde{M}^j_{g_i} \otimes \left[\sum_{i=1}^{n}\sum_{j=1}^{m} \tilde{M}^j_{g_i}\right]^{-1} \quad (5)$$

Where $\otimes$ denotes the extended multiplication of two fuzzy numbers. In order to obtain $\sum_{j=1}^{m} \tilde{M}^j_{g_i}$

We perform the addition of m extent analysis values for a particular matrix such that,

$$\sum_{j=1}^{m} \tilde{M}^j_{g_i} = \left(\sum_{j=1}^{m} l_j, \sum_{j=1}^{m} m_j, \sum_{j=1}^{m} u_j\right) \quad (6)$$

And to obtain $\left[\sum_{i=1}^{n}\sum_{j=1}^{m} \tilde{M}^j_{g_i}\right]^{-1}$, we perform the fuzzy addition operation of $\tilde{M}^j_{g_i}$ (j =1,2,…,m) values such that,

$$\sum_{i=1}^{n}\sum_{j=1}^{m} \tilde{M}^j_{g_i} = \left(\sum_{i=1}^{n} l_i, \sum_{i=1}^{n} m_i, \sum_{i=1}^{n} u_i\right) \quad (7)$$

Then, the inverse of the vector is computed as,

$$\left[\sum_{i=1}^{n}\sum_{j=1}^{m} \tilde{M}^j_{g_i}\right]^{-1} = \left(\frac{1}{\sum_{i=1}^{n} u_i}, \frac{1}{\sum_{i=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} l_i}\right) \quad (8)$$

Where $u_i, m_i, l_i > 0$

Finally, to obtain the S_j in Eq. (1), we perform the following multiplication:

$$S_i = \sum_{j=1}^{m} \tilde{M}^j_{g_i} \otimes \left[\sum_{i=1}^{n}\sum_{j=1}^{m} \tilde{M}^j_{g_i}\right]^{-1}$$
$$= \left(\sum_{j=1}^{m} l_j \otimes \sum_{i=1}^{n} l_i, \sum_{j=1}^{m} m_j \otimes \sum_{i=1}^{n} m_i,\right.$$

$\sum_{j=1}^{m} u_j \otimes \sum_{i=1}^{n} u_i)$ (9)

Step 2: The degree of possibility of $\tilde{M}_2 = (l_2, m_2, u_2) \geq \tilde{M}_1 = (l_1, m_1, u_1)$ is defined as

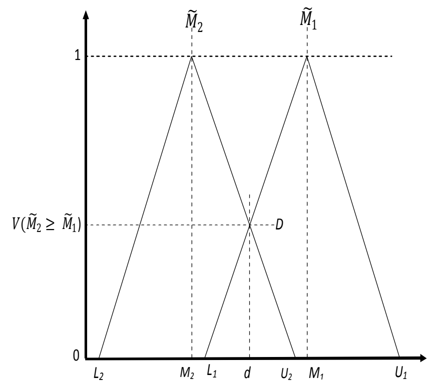

Fig 4. The degree of possibility of $\tilde{M}_1 \geq \tilde{M}_2$

$$V(\tilde{M}_2 \geq \tilde{M}_1) = \sup[\min(\tilde{M}_1(x), \tilde{M}_2(y))] \quad (10)$$

This can be equivalently expressed as,

$$V(\tilde{M}_2 \geq \tilde{M}_1) = hgt(\tilde{M}_1 \cap \tilde{M}_2) =$$

$$\tilde{M}_2(d) = \begin{cases} 1 & if\ m_2 \geq m_1 \\ 0 & if\ l_1 > u_2 \\ \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)}, & otherwise \end{cases} \quad (11)$$

Fig. 4 illustrates $V(\tilde{M}_2 \geq \tilde{M}_1)$ for the case d for the case $m_1 < l_1 < u_2 < m_1$, where d is the abscissa value corresponding to the highest crossover point D between $\tilde{M}_1$ and $\tilde{M}_2$, To compare $\tilde{M}_1$ and $\tilde{M}_2$, we need both of the values $V(\tilde{M}_1 \geq \tilde{M}_2)$ and $V(\tilde{M}_2 \geq \tilde{M}_1)$.

Step 3: The degree of possibility for a convex fuzzy number to be greater than k convex fuzzy numbers M_i (I=1, 2… K) is defined as

$V(\tilde{M} \geq \tilde{M}_1, \tilde{M}_2, \ldots, \tilde{M}_k) = \min V(\tilde{M} \geq \tilde{M}_i)$, I =1,2,…,k

Step 4: Finally, W=(min V($s_1 \geq s_k$) min V($s_2 \geq s_k$),….,min V($s_n \geq s_k$))^T, is the weight vector for k = 1,. . .,n.

In order to perform a pairwise comparison among the parameters, a linguistic scale has been developed. Our scale is depicted in Fig.5and the corresponding explanations are provided in Table 3. Similar to the importance scale defined in Saaty's classical AHP (Saaty, 1980), we have used five main linguistic terms to compare the criteria: ‘‘equal importance’’, ‘‘moderate importance’’, ‘‘strong importance’’, ‘‘very strong importance’’ and ‘‘demonstrated importance’’. We have also considered their reciprocals: ‘‘equal unimportance’’, ‘‘moderate unimportance’’, ‘‘strong unimportance’’, ‘‘very strong unimportance’’ and ‘‘demonstrated unimportance’’. For instance, if criterion A is evaluated ‘‘strongly important’’ than criterion B, then this answer means that criterion B is ‘‘strongly unimportant’’ than criterion A.

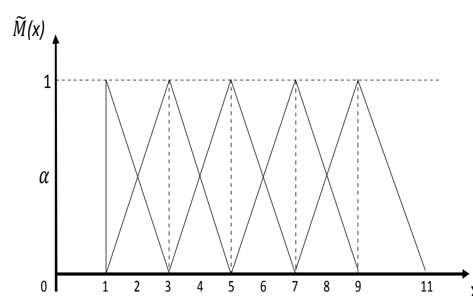

Fig 5. Membership functions of triangular fuzzy numbers corresponding to the linguistic scale

Table 3: The linguistic scale and corresponding triangular fuzzy numbers

Linguistic scale	Explanation	triangular fuzzy numbers	The inverse of triangular fuzzy numbers
Equal Importance	Two activities contribute equally to the objective	(1, 1, 1)	(1, 1, 1)
Moderate Importance	Experience and judgment slightly favor one activity over another	(1, 3, 5)	(1/5, 1/3, 1)
Strong importance	Experience and judgment strongly favor one activity over another	(3, 5, 7)	(1/7, 1/5, 1/3)
Very strong importance	An activity is favored very strongly over another; its dominance demonstrated in practice	(5, 7, 9)	(1/9, 1/7, 1/5)
Demonstrated importance	The evidence favoring one activity over another is highest possible order of affirmation	(7, 9, 11)	(1/11, 1/9, 1/7)

3.4. Integration of ANP with SWOT matrix

Although the AHP technique removes the deficiencies inherent in the measurement and evaluation steps of SWOT analysis, it does not measure the possible dependencies among factors. The AHP method assumes that the factors presented in the hierarchical structure are independent; however, this is not always a reasonable presumption. The possible dependency among factors can only be determined as a result of internal and external environmental analyses. An organization can make good use of its opportunities if it possesses assets and capabilities in which it can demonstrate superiority, otherwise opportunities are either lost before any benefit can be gained or are used by rivals. A similar relationship exists between threats and strengths. The ability to overcome or resist the effects of threats depends on one's strengths; a strong organization can use its strengths to either eliminate or minimize the effects of these threats. The relationship between the weaknesses and strengths of an organization are such that an organization with more strength would probably have fewer weaknesses, and therefore would be able to face situations arising from these weaknesses. Among the strategic factors, other two-variable combinations with possible interdependencies are threat-weakness and opportunity-weakness. It can be claimed that organizations with more weaknesses than their rivals are more susceptible to the threats. Thus, organizations should consider the relationship between their threats and weaknesses when establishing their strategies. Similarly, an organization with weaknesses may find it harder to make good use of its opportunities. It would be possible for an organization to benefit from the opportunities if it has sufficient assets and capabilities, but if not, such opportunities arising from the external environment may otherwise prove not useful (Dincer, 2004). As can be seen, the SWOT factors are not independent of each other, and moreover, there may even be a relationship among some factors. Since the factor weights are traditionally computed by assuming that the factors are independent, it is possible that the weights computed by including the dependent relations could be different. Possible changes in the factor weights can change the priorities of alternative strategies, and these changes, in turn, will affect the strategies chosen. Therefore, it is necessary to employ analyses which measure and take the possible dependencies among factors into account in SWOT analysis.

4. Analysis of data

The network model proposed in this study for SWOT analysis is composed of fiver levels, as shown in Fig. 4. The goal (best strategy) is indicated in the first level, the criteria (SWOT factors) and subcriteria (SWOT sub-factors) are found in the second and third levels respectively, and the last level is composed of the alternatives (alternative strategies). The supermatrix of a SWOT hierarchy with four levels is as follows:

$$W = \begin{array}{c} \text{goal} \\ \text{SWOT factors} \\ \text{SWOT subfactors} \\ \text{alternatives} \end{array} \begin{bmatrix} 0 & 0 & 0 & 0 \\ w_{21} & 0 & 0 & 0 \\ 0 & w_{32} & 0 & 0 \\ 0 & 0 & w_{43} & 1 \end{bmatrix} \quad (12)$$

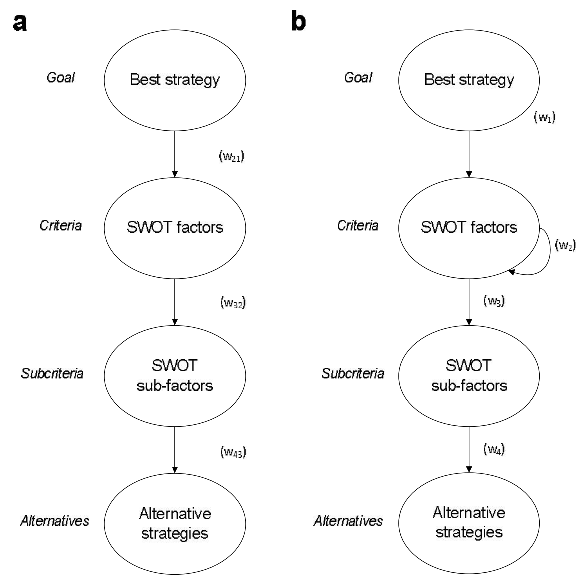

Fig 6. (a) The hierarchical representation of the SWOT model. (b) The network representation of the SWOT model

Where w_{21} is a vector which represents the impact of the goal on the criteria, W_{32} is a matrix that represents the impact of the criteria on each of the sub-criteria, W_{43} is a matrix that represents the impact of the sub-criteria on each of the alternatives, and I is the identity matrix. A hierarchical representation of the SWOT model is given in Fig. 6a and its general network representation is presented in Fig. 6b. The network model illustrates the case of a hierarchy with inner dependence within clusters but no feedback. Here, SWOT factors, SWOT sub-factors and strategies are used in place of criteria, sub-criteria and alternatives, respectively, and the SWOT factors have inner dependencies. The main steps of our proposed framework can be summarized as follows. The first step of the study is the identification of the SWOT factors, SWOT sub-factors and alternatives. The importance of the SWOT factor, which corresponds to the first step of the matrix manipulation concept of the ANP, is determined based on the works of Saaty

(1980).Then, according to the inner dependencies among the SWOT factors, the inner dependency matrix, weights of SWOT sub-factors and priority vectors for alternative strategies based on the SWOT sub-factors are determined in given order. The letters in parentheses in Fig. 6b represent the relationship that will be signified by sub-matrices for supermatrix evaluation of the relative importance weights. Based on the schematic representation of Fig. 6b, the general sub-matrix notation for the SWOT model used in this study is as follows:

$$W = \begin{matrix} \text{goal} \\ \text{SWOT factors} \\ \text{SWOT subfactors} \\ \text{alternatives} \end{matrix} \begin{bmatrix} 0 & 0 & 0 & 0 \\ w_1 & w_2 & 0 & 0 \\ 0 & w_3 & 0 & 0 \\ 0 & 0 & w_4 & 1 \end{bmatrix} \quad (13)$$

where w_1 is a vector that represents the impact of the goal, namely, selecting the best strategy according to SWOT factors, W_2 is a matrix that represents the inner dependence of the SWOT factors, W_3 is a matrix that denotes the impact of the SWOT factor on each of the SWOT sub-factors, and W_4 is a matrix that denotes the impact of the SWOT sub-factors on each of the alternatives. Using matrix operations is preferred in order to show the details of the calculations in this algorithm.

In this study, first an external environment analysis is performed by an expert team familiar with the operation of the organization. In this way, those SWOT sub-factors which affect the success of the organization but cannot be controlled by the organization are identified. In addition, an internal analysis is performed to determine the sub-factors which affect the success of the organization but can be controlled by the organization. In based on these analyses, the strategically important sub-factors, i.e. the sub-factors which have very significant effects on the success of the organization, are determined. Using the SWOT sub-factors, the SWOT matrix and alternative strategies based on these sub-factors are developed (Table 4).

Table 4: SWOT matrix for Tehran province Gas Company

Internal factors / External Factors	Strengths 1.Employment of graduates in different fields 2.Selection and deployment of systems using appropriate recruitment and staffing 3.Applying expert managers and supervisors from outside the organization 4.there are Service training centers in the organization 5.Using experienced teachers to train staff and increase productivity	Weaknesses 1.Lack of job promotion system based on productivity 2.Lack of needs assessment in education programs and the lack of sufficient attention to educational needs in educational programs 3.Lack of fair and appropriate payment Proportional with capabilities and expertise of human resources 4.Lack of integrated performance-based reward system 5.Lack of regulations for transport managers 6.Lack of adequate support systems of families of those died during service
Opportunities 1. there is graduated in our society and their possible deployment in the organization 2.there is intelligence platform communication (Internet, website, ...) in introducing the organization to individuals seeking work 3.Using technologies to increase employee productivity 4.Given a decent system of democracy in the country 5.Low job security in private sector	SO strategies 1.Make appropriate information and communication platform to introduce the organization and attract qualified human resources 2. Creating fitness between training and employment goals and job duties of the organization 3. Utilizing the principle, scientific and new recruits methods.	WO strategies 7.Training needs assessment system design and modification using modern technologies 8.Establishment of democratic procedures decent at managers various levels 9.Principled pay and reward system based on performance and productivity
Threats 1.Resistance the managers of organizations against employing modern technology 2.Lack of planning and discipline within the field of human resources 3.Disproportion wages and benefits payable to employees than the activities and revenues 4.Continually changing rules and regulations of human resources in government and Changing economic circumstances 5. Lack of appropriate human resource enforcement	ST strategies 4.Using specialized training necessary to modify negative beliefs and beliefs managers 5.Make appropriate notification to managers using new technologies in traditional employment 6.Development and diversity training programs to suit staff needs and developments in the country	WT strategies 10.Strengthen corporate culture to enhance the participation of employees and managers 11. Principled employee transfer process. 12.Design and implementation of mechanisms to support families of disabled employees and died

The proposed algorithm is as follows:

Step 1: The problem is converted into a hierarchical structure in order to transform the sub-factors and alternative strategies into a state in which they can be measured by the ANP and FAHP techniques. The schematic structure established is shown in Fig. 7. The aim of ''choosing the best strategy'' is placed in the first level of the ANP model and the SWOT factors (Strengths, Weaknesses, Opportunities, Threats) are in the second level. The SWOT sub-factors in the third level include: five sub-factors for the Strengths factor, six sub-factors for the Weaknesses factor, five sub-factors for the Opportunities factor, and five sub-factors for the Threats factor. In the fourth level, the overall weight strategies SO, WO, ST, WT using the ANP method obtains (The goal of this level is that to determine which one of the strategies are generally more important.) last level represents final strategies that using the FAHP method, we prioritize strategies .

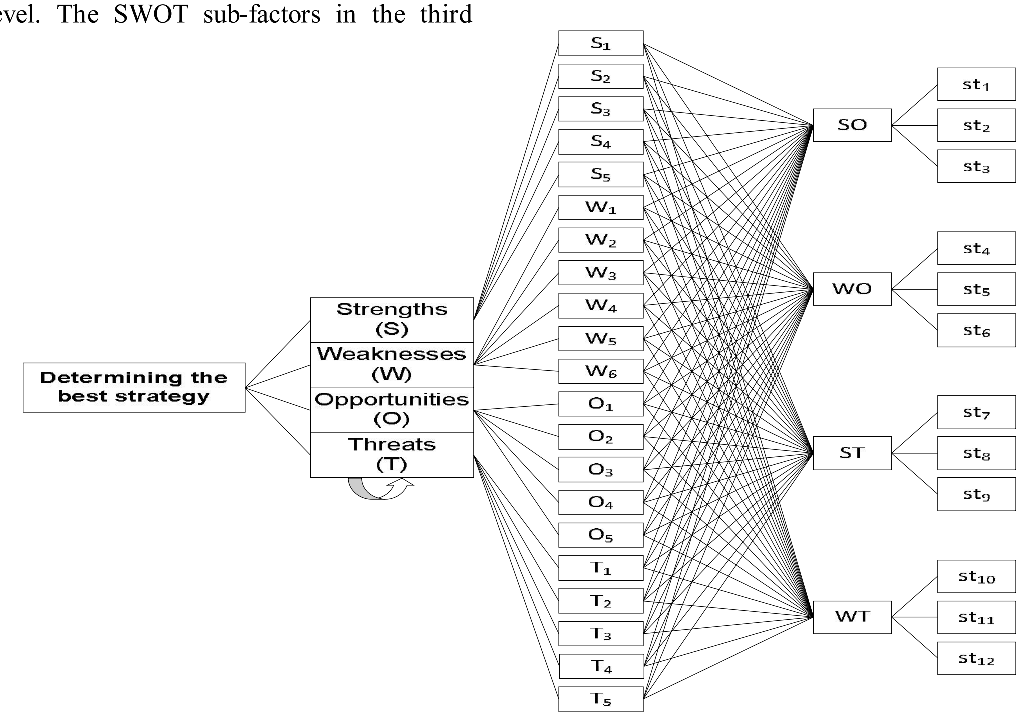

Fig 7. ANP and FAHP model for SWOT

Step 2: Assuming that there is no dependence among the SWOT factors, pairwise comparison of the SWOT factors using a 1–9 scale is made with respect to the goal. Paired comparisons matrix using Export Choice software, were analyzed and the weight vector is obtained. In paired comparisons, we should pay attention to the compatibility matrix. Matrix A = [aij] is consistent, if aik × akj = aij. Inconsistency rate of less than 0.1 in paired comparisons matrices is acceptable.

Table 5: Pairwise comparison of SWOT factors

SWOT factors	S	W	O	T	Importance degrees of SWOT factors
Strengths	1	5.5	0.55	5.45	0.372252
Weaknesses	0.183486	1	0.32	1	0.105026
Opportunities	1.818182	6.86	1	3.125	0.45813
Threats	0.181818	1	0.145773	1	0.064591

CR=0.042

Step 3: Inner dependence among the SWOT factors is determined by analyzing the impact of each factor on every other factor using pairwise comparisons. The introduction section mentioned that it is not always possible to assume the SWOT factors to be independent. More appropriate and realistic results can likely be obtained by using both SWOT analysis and the ANP technique. Using the analysis of both the internal and external environments of the organization, the dependencies among the SWOT factors, which are presented schematically in Fig. 8, are determined. Based on the inner dependencies presented in Fig. 8, pairwise comparison matrices are formed for the factors (Tables 6–8). The following question, ''what is the relative importance of strengths when compared with threats on controlling weaknesses?'' may arise in pairwise comparisons and lead to a value of 9 (absolute importance) as denoted in Table 7. The resulting eigenvectors are presented in the last column of Tables 6–8.Using the computed relative importance weights, the inner dependence matrix of the SWOT factors (W2) is formed. As opportunities are affected only by the Strengths, no pairwise comparison matrix is formed for opportunities.

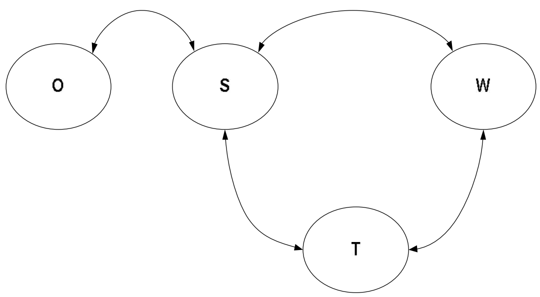

Fig 8. Inner dependence among SWOT factors

Table 6: The inner dependence matrix of the SWOT factors with respect to ''Strengths''

Strengths	W	O	T	Relative weights
W	1	0.18	1.35	0.139619
O	5.555556	1	6.9	0.754042
T	0.740741	0.144928	1	0.106339

CR=0.00

Table 7: The inner dependence matrix of the SWOT factors with respect to ''Weaknesses''

Weaknesses	S	T	Relative weights
S	1	5.42	0.844237
T	0.184502	1	0.155763

CR= 0.00

Table 8: The inner dependence matrix of the SWOT factors with respect to ''Threats''

Threats	S	W	Relative weights
S	1	5.8	0.852941
W	0.172414	1	0.147059

CR= 0.00

Step 4: In this step, Interdependence of the main weights multiplied by the main dependency matrix (relative weights obtained from the third stage) in the main relative weights after normalization is reached. The main factors of weight interdependence are calculated thus:

$$\begin{bmatrix} 1.000 & 0.8442 & 1.000 & 0.8529 \\ 0.1396 & 1.000 & 0 & 0.1471 \\ 0.7540 & 0 & 1.000 & 0 \\ 0.1063 & 0.1558 & 0 & 1.000 \end{bmatrix} \times \begin{bmatrix} 0.372252 \\ 0.105026 \\ 0.158130 \\ 0.064591 \end{bmatrix} = \begin{bmatrix} 0.487 \\ 0.003 \\ 0.37 \\ 0.06 \end{bmatrix}$$

Step 5: In this step, local priorities of the SWOT sub-factors are calculated using the pairwise comparison that their findings are in Table 10. For example, paired comparisons matrix for sub-agents strengths is given in Table 9.

Table 9: Pairwise comparison matrix for Strengths

Strengths	S_1	S_2	S_3	S_4	S_5	Local weights
S_1	1	0.49	0.35	1	0.54	0.112492
S_2	2.040816	1	0.48	2.18	2.11	0.241386
S_3	2.857143	2.083333	1	2.20	3.10	0.374111
S_4	1	0.458716	0.454545	1	1	0.130994
S_5	1.851852	0.473934	0.3222581	1	1	0.141018

CR= 0.02

Table 10: Overall priority of the SWOT sub-factors

SWOT factors	Priority of the factors	SWOT sub-factors	Priority of the sub-factors	Overall priority of the sub-factors
Strengths	0.487	Employment of graduates in different fields	0.112492	0.054783
		Selection and deployment of systems using appropriate recruitment and staffing	0.241386	0.117555
		Applying expert managers and supervisors from outside the organization	0.374111	0.182192
		there are Service training centers in the organization	0.130994	0.063794
		Using experienced teachers to train staff and increase productivity	0.141018	0.068676
Weakness	0.083	Lack of job promotion system based on productivity	0.116178	0.009643
		Lack of needs assessment in education programs and the lack of sufficient attention to educational needs in educational programs	0.059998	0.00498
		Lack of fair and appropriate payment systems Proportional with capabilities and expertise of human resources	0.274644	0.022795
		Lack of integrated performance-based reward system	0.120668	0.010015
		Lack of regulations for transport managers	0.14891	0.01236
		Lack of adequate support systems of families of those died during service	0.279602	0.023207
Opportunities	0.37	there is graduated in our society and their possible deployment in the organization	0.49629	0.183627
		there is intelligence platform communication (Internet, website, ...) in introducing the organization to individuals seeking work	0.043713	0.016174
		Using technologies to increase employee productivity	0.188864	0.06988
		Given a decent system of democracy in the country	0.110795	0.040994
		Low job security in private sector	0.160338	0.059325
Threats	0.06	Resistance the managers of organizations against employing modern technology	0.553868	0.033232
		Lack of planning and discipline within the field of human resources	0.065026	0.003902
		Disproportion wages and benefits payable to employees than the activities and revenues	0.233659	0.01402
		Continually changing rules and regulations of human resources in government and Changing economic circumstances	0.100305	0.006018
		Lack of appropriate human resource enforcement in organizations	0.047142	0.002829

Step 6: In this step, the overall priorities of the SWOT sub-factors are calculated by multiplying the interdependent priorities of SWOT factors found in Step 4 with the local priorities of SWOT sub-factors

obtained in Step 5. The computations are provided in Table 10.

Step 7: In this step we calculate the importance degrees of the alternative strategies with respect to each SWOT sub-factors. Because of many paired comparisons matrices, four paired comparison matrix is given as an example and the final results by using Expert Choice software is derived. There is just a table for comparing paired samples, but the final matrix shows the relative weights of these twenty one matrixes. Results using Export Choice software are calculated.

Table 11: Pairwise comparison matrices for the priorities of the alternative strategies for Strengths

Employment of graduates in different fields	SO	WO	ST	WT	Local weights
SO	1	4.1	3.1	7	0.57497
WO	0.243902	1	1.58	3.16	0.201286
ST	0.322581	0.632911	1	1.81	0.148336
WT	0.142857	0.316456	0.552486	1	0.075408

Step 8: Finally, the overall priorities of the alternative strategies are calculated as follows:

$$W_A = \begin{bmatrix} SO \\ WO \\ ST \\ WT \end{bmatrix} = W \times W_G = \begin{bmatrix} 0.4373 \\ 0.1850 \\ 0.2401 \\ 0.1368 \end{bmatrix}$$

The ANP analysis results indicate that SO is the best strategy with an overall priority value of 0/4373.

Step 9: At this stage, the final weight of each strategy (from St_1 to St_{12}) using FAHP method obtains and after that we prioritize them.

Table 12: The fuzzy evaluation matrix for SO strategies

SO	St_1	St_2	St_3	Local weights
St_1	(1,1,1)	(1,3,5)	(1/5,1/3,1)	0.347191
St_2	(1/5,1/3,1)	(1,1,1)	(5,7,9)	0.321097
St_3	(1,3,5)	(1/9,1/7,1/5)	(1,1,1)	0.331712

Table 13: The fuzzy evaluation matrix for ST strategies

ST	St_4	St_5	St_6	Local weights
St_4	(1,1,1)	(5,7,9)	(3,5,7)	0.261813
St_5	(1/9,1/7,1/5)	(1,1,1)	(1/9,1/7,1/5)	0.353827
St_6	(1/7,1/5,1/3)	(5,7,9)	(1,1,1)	0.384361

Table 14: The fuzzy evaluation matrix for WO strategies

WO	St_7	St_8	St_9	Local weights
St_7	(1,1,1)	(1/7,1/5,1/3)	(1,3,5)	0.754042
St_8	(3,5,7)	(1,1,1)	(7,9,11)	0.139619
St_9	(1/5,1/3,1)	(1/11,1/9,1/7)	(1,1,1)	0.106339

Table 15: The fuzzy evaluation matrix for WT strategies

WT	St_{10}	St_{11}	St_{12}	Local weights
St_{10}	(1,1,1)	(1/11,1/9,1/7)	(1/9,1/7,1/5)	0.150213
St_{11}	(7,9,11)	(1,1,1)	(1/7,1/5,1/3)	0.656518
St_{12}	(5,7,9)	(3,5,7)	(1,1,1)	0.193270

$W(st_1, st_2, st_3) = (0.13198, 0.13761, 0.16771)^T$
$W(st_4, st_5, st_6) = (0.0741, 0829965, 0.0829968)^T$
$W(st_7, st_8, st_9) = (0.02594, 0.140101, 0.01975)^T$
$W(st_{10}, st_{11}, st_{12}) = (0.02055, 0.02644, 0.08981)^T$

Finally, using techniques FAHP was evaluated, strategies to be prioritized as follow:

1- Increased support for creative solutions and innovative teaching method
2- Changes in training methods with regard to educational standards
3- Develop integrated information systems at University
4- Develop exchanges with other learning centers and learning from them
5- Motivate university through increased governmental support of the University
6- Develop effective and efficient communication with industry
7- Develop educational and research activities
8- Increased interaction with other universities to strengthen communication
9- Search and use new methods to do the work
10- Making money through supporting innovative activities
11- Reinforce and support learning teams
12- Attract financial support from outside of the University to support innovative activities

5. Conclusions

Organizations to survive in today's rapid and turbulent environment need to develop coherent long-term plans. So universities like other organizations should always adapt with these changes and try to be a dynamic learning organization. This study attempted to formulate strategies for transforming the University into a dynamic learning organization. At first, through the analysis of internal and external environment, strengths and weaknesses, opportunities and threats identified and SWOT matrix was formed. After formation of SWOT matrix, four general strategies, i.e., SO, WO, ST and WT were identified that each of the weights was obtained by the ANP method .Then, using FAHP, weight of each strategy was determined from st1 to st12 . This research unlike many other studies considers dependency among the strategic factors in its analysis. In this study, to measure the mutual dependence of factors ANP technique was used. Possible dependence among the factors through analysis of internal and external environments is identified. Strategies identified in SWOT matrix, using techniques FAHP and ANP were evaluated and strategies to be prioritized that best strategy is increasing support for creative solutions and innovative teaching method.

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