Using Hybrid Method for Strategic Planning of Construction Contractor Companies

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Abstract: Construction contractor companies are affected by internal and external environments, an important part of strategic Planning process. Strategic environment analysis indicates SWOT analysis. SWOT analysis has some deficiencies in measurement and evaluation steps. Analytic hierarchy process dispels these deficiencies but does not consider the possible dependencies between factors. Analytic Network Process (ANP) is a new tool for Multi-Criteria Decision Making (MCDM) assuming relationships associated together, in this way it improves the analytic hierarchy process. In this paper, the hybrid method has been developed. Therefore, ANP has been applied in SWOT to consider interdependencies among factors rather than AHP which is based on independent factors in different groups. Finally, dependency measurement possibility among strategic factors becomes feasible. The research used a case study to validate Hybrid method and illustrate how the contractors and decision makers in construction companies can apply SWOT analysis as a main tool in strategic Planning process, make a decision and find the best alternative among the strategies. In this study, it has been concluded that dependencies among the SWOT factors have effect on sub factors weights; they can also change the strategy priorities.

1. Introduction

Each company faces various internal and external forces. These forces are considered either as potential drivers or potential constraints for company performance and achievement to its predefined scopes. As the first step in strategic planning, business managers identify and assess the strategic factors considered as assistance or obstacle for the company in achieving its potentials [1]. Since each company faces to dynamic environment, the relative importance of factors will change continuously. The strategic factors list can be applied as a starting point for companies' strategic planning. This list is a flexible tool and its most significant advantages are as follow:

- To help managers in studying and navigating of different management fields
- Acquiring insight about the importance of company's body
- Starting appropriate actions (representing the corrective actions)

Proper performance of a company is the result of right interaction with predominant environment which might have an internal or external nature. Main reason of success in strategic management and planning is collecting the industry information and understanding the competitive changes among different companies in corresponding industry [2].

2. Strategic planning

Strategic planning is a set of decisions and actions made by manager, consulting with all organization levels in order to determine long term activities of organization [1]. In other words, the strategic planning is the art and science of codifying, implementing and assessing of comprehensive decisions for empowering the organization to achieve its objectives [3]. The strategies are the tools that cause company to attain long term objectives. The company's strategies can be expanding activity in geographical aspect, varying activities, buying the other companies, producing and presenting products, transfusing in market, reducing costs, selling some items of assets, assigning many of authorities and private contributions [4]. Strategic management process is a method in which the strategists define objectives and decide strategically. This method consists of three basic elements of strategy development, strategy implementation and strategy control and evaluation [2].

Some of the strategic management basics in strategy development are such as determination of mission, vision, goal and value, recognition and analysis of internal and external environment, formulating and codifying the strategy (identifying strategic alternatives) and superior strategy selection [2]. Desirable performance of a company is gained by correct interaction between organization management

and environment which might be internal or external [1].

One of the applications of strategic management is in the project environment need the strategy basics development. For explanation of strategic management application in project environment, the basics of development such as vision, value and mission are defined [2,5]: by mission codifying, all of the activities and actions of the company are coordinated and rectified and stakeholders' attention and motivation increase about the subject. The project vision defines the general path of the project. Not only it acts the role of leadership and management improvement of project team but also provides tools for managing the project product. As the main characteristics of the vision, it should be future representative, realistic, feasible, attractive and motivating for organization, challenging and concentrating [6].

3. The position of SWOT in strategic management

As mentioned, strategic management includes three fundamental phases: strategy development, strategy implementation and strategy control and evaluation. Complete analysis of company's internal and external environments should be carried out before describing the strategic management phases. Numerous methods are used in strategic planning for the analysis of strategic cases. Among all of them, the analysis of strengths, weaknesses, opportunities and threats (SWOT) is the most common [2]. SWOT analysis is an important support and the most general tool for application in systematic analysis of organizations' internal and external environments [2,7,8,9]. The SWOT analysis collects the most significant internal and external factors affect on organization's future. These factors are called strategic factors [10]. Formulating the strategy is a process for development of long term programs in order to respond to the external opportunities and threats effectively regarding to company's strengths and weaknesses [4].

4. Scopes

Contractors encounter diverse situations in their different work steps such as:

- Company establishment at beginning of work period assuming various scopes and technical staff selection
- Deciding to participate in different bids and price offering for winning
- Evaluation of company performance at the end of each financial year
- Determination of new policies and strategies in critical status

For each of these situations, contractor companies assess the predominant internal and external

conditions unconsciously and decide proportionally. Therefore, it is important to make decision for survival of company and proceeding toward the scopes in different times and various internal and external conditions.

This research attempted to use strategic management basics in strategy development phase of a construction contractor company. So, a construction contractor company established in economically critical atmosphere at the last year of war between Iran and Iraq, wining projects by participating in governmental bids, has been considered for a case study. Besides the definition of company vision, the mission and value have been determined. After providing the steering bases for company, the SWOT analysis applied to recognize internal and external environment and codify the strategy.

Although the SWOT analysis is an appropriate structure for strategies development, it has some deficiencies in measurement and evaluation steps and is not able to determine the strategies' significance based on the importance of constitutive components of internal and external environments. A multi criteria decision-making method which has been used to eliminate the deficiencies mentioned in literature is analytic hierarchy process (AHP). According to the application of AHP in SWOT analysis, the possibility of prioritizing the strategies is provided based on the importance of constitutive factors and by assumption of factors independency in each level.

AHP method dispels aforementioned deficiencies but it cannot measure and assume the dependencies among the factors. In AHP the factors in each level are assumed independent whereas the hypothesis of dependencies among the factors is logical regarding to effectiveness of internal and external environments. For example, if the company utilizes proper abilities and assets (strengths), it will use acquired opportunities, else these opportunities will not be useful and the competitors might grab them. The cited example is a sample of interdependency between the company's internal and external environments (strengths and opportunities).

In this affair, the prioritizing and choosing the superior strategy were performed by application of ANP composed with SWOT analysis, attending to the interdependency among the factors. Finally, by comparison of the results attained from AHP-SWOP and ANP-SWOP combinations, the influence of considering interdependencies has been studied for choosing the most suitable strategy.

5. The application of AHP in SWOT analysis

Comprehensive analysis of environment is so important to identify the internal and external forces imposed to the company. These forces can be assumed

either drivers or obstacles for organization performance and achievement to the aims [1]. The obtained information are represented as a matrix and different combinations of matrix fourfold factors cause to determine the strategies for long term progress of organization [1,2].

SWOT analysis can be used as an appropriate base for strategy formulating by applying properly [11]. The common method of SWOT has debility in evaluation and measurement phases. In other words, the SWOT analysis is not convenient as an analytical tool for determination of factors' relative significance and assessment of decision alternatives based on these factors [11]. Despite the analysis can distinguish the factors, they are described concisely [8]. SWOT helps the decision maker to categorize the factors in internal and external and also provides the possibility of comparing the opportunities and threats with strengths and weaknesses [12]. However, the consequence of SWOT analysis is only the listing or qualitative analysis of internal and external factors [7]. SWOT as an analytical tool, is not a facility for assessment of factors' importance and the coordination between these factors and decision alternatives. The SWOT application is based on the qualitative analysis and individuals' expertise in planning process. Because the planning processes have been mixed with different criteria and dependencies, the utilization of SWOT is not sufficient singly. The factors expression is so ordinary and short and can conclude that SWOT analysis is a superficial and imprecise listing or incomplete qualitative analysis of internal and external factors. Kurttila et al. developed a compound model in order to remove the weaknesses in evaluation and measurement phases of SWOT analysis. The applied decision-making analysis tool is the analytic hierarchy process (AHP) which has been used as a mathematical tool for solving sophisticated decision-making problems with multiple criteria [8].

Recently, the application of AHP has been concentrated on integration and combination with the other tools. For example, AHP is used in combination with mathematical programming to contain not only qualitative and quantitative factors but also some resources constraints in actual world [13]. The AHP in combined state causes more promising and realistic decision than the other state uses AHP alone. Hence nowadays, much more focus is on hybrid AHP. Various tools are hybridized with AHP because of: being well-known, extensive application and success in decision-making. Of the 66 papers published from 1997 to 2006, 5 papers (8 percent) are related to the application of AHP integrating with SWOT [13]. Kurttila et al. innovated a method to dispel the weaknesses of evaluation and measurement phases of SWOT. This method which used AHP in SWOT analysis was referred in next researches as A'WOT [11,14]. Some instances of researchers who pursued Kurttila's method include: Stewart et al. [9], Kajanus et al. [11], Shrestha et al. [12], Leskinen et al. [14], Shinno et al. (2006) [15] and Masozera et al.[16]. Same as Kurttila's research mentioned studies have only prioritized the factors and sub-factors of SWOT and have not comprised the strategies and strategy alternatives in hierarchical structure based on the strategic factors. Although the AHP method eliminates the inherent incompetency of evaluation and measurement phases of SWOT analysis, it cannot measure the dependencies among the factors. So, a suitable method is required to measure the interdependencies.

6. Why ANP?

The AHP method applied as a multi criteria decision making model in integrating with SWOT for removing the mentioned deficiencies. By using A'WOT combination, the possibility of strategy alternatives assessment is provided based on the importance of SWOT's factors and sub-factors. Although the AHP method eliminates the inherent incompetency of evaluation and measurement phases of SWOT analysis, does not consider the dependencies among the factors. Therefore, the lack of a proper method measuring the interdependencies is appreciated. The analytic network process, the general state of AHP, can assume the dependencies among different groups and elements and converts the problem from hierarchical attitude to a network. AHP analysis deems that the represented factors in hierarchical structure are independent from each other, whereas this assumption is not always true and it is possible to be dependency among the factors regarding to the influence of internal and external factors.

A company can properly utilize the opportunities if has the suitable facilities and assets, else the benefits due to the opportunity lose easily or is acquired by the competitors. This relationship is originally the internal connection between company's strengths and opportunities and demonstrated that the hypothesis of independency of strengths and opportunities is not correct (S-O). The relation between company's strengths and weaknesses is so that, the company with more strengths has fewer weaknesses and can encounter with positions due to the weaknesses (S-W). The same relationship exists between the threats and strengths. Originally, the ability of overcoming or resisting against threats is referred to company's strengths. Thus, a strong company can use strengths to eliminate or reduce the threats effects (S-T). The other possible dependency is the relationship between weaknesses and threats: the companies with more weaknesses are subjected under the threats more than the rivals (W-T). Also, for the companies with more

weaknesses, using the opportunities is more difficult. The company can conveniently utilize opportunities advantages by having proper abilities and assets. Otherwise, these opportunities will not be useful for the company. With regard to the mentioned issues, the companies should consider diverse interdependencies for the strategy development and selection (the indicated interdependencies have been illustrated in figure 1).

The factors of SWOT are dependent to each other. The factors' weights are calculated by assuming independency. So, the weights might vary if the dependencies among the factors are considered. Then the priority of strategies changes and affects on superior strategy selection. Therefore, adopting an analysis which can consider the dependency of assessment factors is necessary. The reason of using ANP analysis is the consideration of interdependency among the criteria because assuming these dependencies is not practicable in all of the aforementioned models. By applying the ANP analysis not only the interdependency among the factors and the feedback between the groups are attended but also the choices can be ranked.
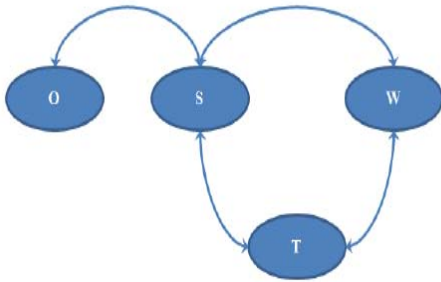

Figure 1. Interdependencies among the SWOT factors

7. Analytic network process

The initial study indicates that the most appropriate method for multi criteria decision-making is the analytic hierarchy process which is applied to solve complicated problems [17]. AHP was suggested by Satty [18] in 1980, as a method to solve the socioeconomically decision-making problems. This method has been applied for solving broad range of problems up to now [19,20,21].

Satty offered the AHP to solve the problems in which interdependency is remained between the alternatives and criteria. It was also recommended for the problems with dependency between the alternatives and criteria (Figure 2) [17]. ANP is the more general state of AHP. The AHP represents the hierarchically unidirectional relationship, whereas the ANP assumes dependencies between the levels and decision characteristics. The ANP feedback method replaced

hierarchical structure with the networks in the way that relationships among the levels are not defined as the higher and lower, dominant and non-dominant, direct and indirect [22,23]. For example, same as the hierarchical state, the alternatives' importance not only is determined by the criteria's significance but also may affect on them. So, representing a hierarchy with up-to-down linear structure is not suitable for a complicated system [22]. A system with feedback can be shown by a network. The structural difference between hierarchy and network processes is displayed in figure 2. The ANP has been applied as a comprehensive multi purpose decision-making method to solve numerous sophisticated problems [17,24,25]. As the application fields of AHP and ANP in construction engineering and management can indicate to the determination of contractors' pre-qualification [26,27], multi criteria evaluation of winning probability in competitive bid process [28], decision-making supporting system for choosing the appropriate method of project implementation using analytic hierarchy process [29], contractor selection using analytic network process (ANP) [30] and utilizing ANP in construction performance measurement [31].
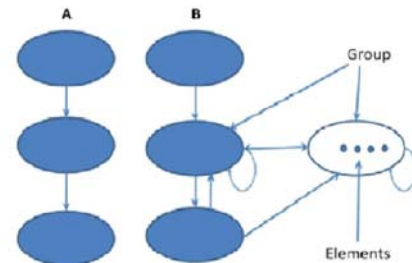

Figure 2. Structural difference between hierarchy and network processes (A:Hierarchy, B:Network)

ANP comprises four main steps [22]:
1- Creating the model and problem structure
2- Pair wise comparison matrices and priority vectors
3- Developing super matrix
4- Choosing the best alternative

1-Creating the model and problem structure

The problem must be expressed clearly and decomposed to a logical system such a network. This network can be acquired by decision makers using brainstorming or the other proper forms.

2- Pair wise comparison matrices and priority vectors

Similar to the conducted comparisons in AHP, some couples of decision making elements in each group are compared attending to their importance. The groups are also compared in pairs regarding to their

contributions in scope. The decision makers were asked to respond to a series of pair wise comparisons between the elements or groups to be evaluated by their contributions in a specific criterion at higher level. In addition the above, the interdependency among the elements of a group must be analogized in couples. The influence of each element on the other is indicted by the eigenvector. The values of relative importance are determined by the Satty's scales table. In this table, the score 1 represents identical significance of two elements and the score 9 indicates so much importance of an element (row group in matrix) than the other (column group in matrix). Reverse value is used for the reverse comparison ($a_{ij} = \dfrac{1}{a_{ji}}$). a_{ij} (c_{ji}) defines the importance of ith(jth) element. Same as the AHP, the pair wise comparisons in ANP are performed within a matrix. Local priority vector is derived by estimating the relative importance of the elements (nodes) and calculated as the following equation:

$$A \times W = \lambda_{max} \times W$$

In above equation, A, W and λ_{max} are the Pair wise comparison matrix, eigenvector and maximum eigen value of the matrix A. Satty has suggested various algorithms for estimating W. in this research; the Expert Choice Software [32] was applied to find eigenvectors of pair wise comparison matrices and determine the consistency rate.

3-developing super matrix

For attaining the general priorities in a system with the effects which are dependent to each other, the general priority vectors are entered in appropriate columns of matrix. So, the super matrix is originally a separated matrix that each part of it represents relationship between two groups in a system. The groups of a decision-making system have been shown as C_k (k=1, 2 …) and each group is made up of m_k elements denoted by $e_{k_1}, e_{k_2}, ..., e_{k_m}$. Local priority vectors acquired in second step are classified and fixed in suitable position based on the effect flow from a group to another or itself. The standard form of super matrix is displayed in equation 2:

$$
W = C_k
\begin{array}{c}
\\
\end{array}
\begin{bmatrix}
W_{11} & \cdots & W_{1k} & \cdots & W_{1n} \\
\vdots & & \vdots & & \vdots \\
W_{k1} & \cdots & W_{kk} & \cdots & W_{kn} \\
\vdots & & \vdots & & \vdots \\
W_{n1} & \cdots & W_{nk} & \cdots & W_{nn}
\end{bmatrix}
$$

It is notable that each zero number in super matrix is replaceable by a matrix if the elements of one or two groups have mutual relationship together. Since the mutual relationship always exists among the groups in a network, the super matrix's columns may result in a summation more than one. Nevertheless, the super matrix must be changed in a way that summation of each column becomes equal to one. The Satty's represented method includes the determination of relative importance in a super matrix using column group as a controller group. It means that row groups with nonzero values are compared in their corresponding column group regarding to the effect on that column group. The eigenvector is derived by pair wise comparison matrix of row clusters related to the column clusters; finally, an eigenvector is attained for each column group. The first input of eigenvector for each column group is multiplied by all elements in first group of that column, the second one by all elements in second group of that column and so on. Therefore the group in each column of super matrix is weighted and the weighted super matrix will be random and probabilistic.

Matrix exponentiation represents relative effects of elements on each other. To reach the importance weights convergence, the weighted super matrix is raised to 2k+1 power, where k is a great arbitrary number and generated matrix is the limit matrix. Limit matrix is in the form of weighted super matrix but all of its columns are identical. Final priorities of all elements in the matrix are derived by normalization of each group in super matrix. It is necessary to act precisely for wrapping up the priority vectors of relative scale derived by pair wise comparison matrix in a system with feedback. The interaction between the elements in a system with feedback can be either direct or indirect.

4- Choosing the best alternative

If the super matrix formed in third step covers the entire network, the priority weights of all (2) ves are specified in the column related to the n ... ced super matrix's alternatives. In the other words, if super matrix covers only the associated groups, the more calculations should be done in order to find the general priority of alternatives. The alternative with the greatest general priority must be chosen.

8. Hybrid method development by combination of ANP and SWOT analysis

Suggested hierarchy and network structure for SWOT analysis consists of four levels illustrated in figure 3. Scope of the problem (the best strategy), criteria (SWOT factors), sub-criteria (SWOT sub-factors) and alternatives (strategy alternatives) are the four levels from first to fourth, respectively. The super

matrix for combination of AHP with SWOT and the four levels are as below:

$$
W \quad
\begin{array}{l}
\text{Scope} \\
\text{SWOT factors} \\
\text{SWOT sub-factors} \\
\text{Alternatives}
\end{array}
\begin{bmatrix}
0 & 0 & 0 & 0 \\
W_{21} & 0 & 0 & 0 \\
0 & W_{32} & 0 & 0 \\
0 & 0 & W_{43} & I
\end{bmatrix}
$$

W_{21} : The vector that indicates the effect of scope on the criteria

W_{32} : The matrix which represents the influence of criteria on each of the sub-criteria

W_{43} : The matrix which represents the influence of criteria on each of the alternatives

I : Identity matrix

The hierarchical and network structure of SWOT analysis have been illustrated in figures 3-A and 3-B, respectively. The network structure is a form of hierarchy with dependency in nodes and without feedback. In this model, SWOT factors, SWOT sub-factors and alternatives have been applied instead of criteria, sub-criteria and alternatives respectively and SWOT factors are interdependent. The main phases of suggested model comprise: the first phase is investigation and identification of factors, sub-factors and alternative. The significance of SWOT factors are specified attending to the dependency among the SWOT factors, weights of SWOT sub-factors and priority vector for strategy alternatives. Represented letters in figure 3-B, are originally the matrices used to find the relative importance weights in super matrix.
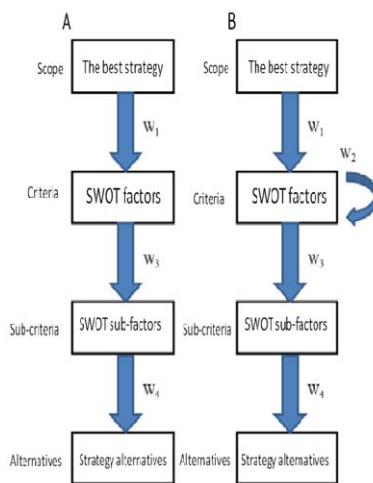

Figure 3. A: Hierarchical representation of SWOT model , B: Network representation of SWOT model

According to the figure 3-B, the principal matrix that shows the SWOT model with internal relationship is as follow:

$$
W =
\begin{array}{l}
\text{Scope} \\
\text{AWOT factors} \\
\text{SWOT sub-factors} \\
\text{Alternatives}
\end{array}
\begin{bmatrix}
0 & 0 & 0 & 0 \\
W_1 & W_2 & 0 & 0 \\
0 & W_3 & 0 & 0 \\
0 & 0 & W_4 & I
\end{bmatrix}
$$

In this matrix, the vector W_1 indicates the effect of scope, choosing the best strategy according to the SWOT factors. W_2 represents the interdependency of SWOT factors. W_3 considers the influence of SWOT factors on each of the sub-factors and finally W_4 represents the effect of SWOT sub-factors on each of the alternatives.

Limit super matrix is created for exerting ANP in suggested matrix in order to find the identified strategies' priority by SWOT analysis and acquired by putting the weights in super matrix and exponentiation of super matrix to achieve convergence. Obtained weights in limit matrix are originally related to the strategy priorities. As mentioned, weighted matrices of $W_1, W_2, W_3,$ and W_4 are entered in super matrix and general priorities of strategy alternatives are determined by computing the limit matrix. The following notes must be considered for computing the general priority weights through the formation of super matrix:

• After developing the super matrix, the weighted super matrix is attained through the conversion of all the columns in a way that their summation becomes equal to one. (for example, normalizing the columns)

• Then the general priority vectors or the weights are acquired by exponentiation of weighted super matrix and converged to limit state. $\lim_{k \to \infty} W^k$

• If the super matrix is periodical, the limit super matrix will not be unique and two or more limit super matrices might be existed. In this situation, Cesaro summation is calculated to find the priorities. Cesaro summation is as following formula in which W_j represents the jth limit super matrix.

$$\lim_{k \to \infty} \left[\left(\frac{1}{N} \right) \sum_{j=1}^{N} W_j^k \right]$$

The ANP Super Decision Software [33] described in next section, has been utilized for calculating the limit matrix to find alternatives priority using super matrix concept.

9. Case study - strategic planning and application of Hybrid method

In this section, the basics of strategic management in strategy development phase are used as a tool for explanation of decision-making and

implementation process in a construction contractor company. This tool leads to develop one or more strategies to reach the scopes. At first, the mission, vision and company's value statements are determined in interaction with the members and then recognizing of internal and external environment and strategy development are performed. At the end, the multi criteria decision-making tools are employed for ranking and choosing superior strategy. For choosing the multi criteria decision-making method, the AHP method is applied in measurement and evaluation phases of SWOT analysis according to the aforementioned literature. Then, ranking and superior strategy selection are done using ANP analysis method which considers the possible interdependencies and finally acquired results of applying both methods in SWOT analysis are compared.

10. Study area

The studied case is DEZHPOL Contractor Company with grade 3 in construction field according to the contractors' evaluation criteria in Iran. This company has some complicated problems in decision making process because of three main reasons. So, using the SWOT combinatory analysis process with a method of multi criteria decision-making (ANP) is required. These reasons are as below:

a) **Founding at the last year of war between Iran and Iraq:** DEZHPOL Contractor Company started in 1988 – last year of war between Iran and Iraq. In that time, the economical difficulties due to the war, high inflation, lack of skilled human resources, priority of supplying cost of war than the other costs, reducing the oil sale and political difficulties with Arabic and western countries, lack of adequate security for investment and high current costs were so serious threats. Indeed, in those years, the construction business was so stagnant and numerous companies did not tend to invest in this industry. Despite mentioned threats, presence of this company in construction business as one of the first companies established in that unorganized situation could be treated as an opportunity for the company. Because it could own the large part of infrastructure projects in the country without serious competitor for many years to increase its credit.

b) **Participating in governmental bids:** this company has won most of its projects through the participating in governmental bids. Connection with the body of government and participating in bids which have specific constraints because of being governmental is considered as an external environmental factor with developing some opportunities and threats for aforesaid company. Lack of political stability of government, economical inflation of country which rises from the financial policies and affects on

financing contracts of governmental projects, strict rules and predominant bureaucracy of governmental organizations in Iran as a third-world country are the factors that expose the aforesaid company to threat. On the other hand, since the Iran's economy is associated to the government and huge amount of the country's incomes belong to the state, a particular assurance has been developed for the company because of the availability of sufficient budget to finance its contract. Also, the enhancement of Iran's development plans by the state, government's plans to increase housing because of Iran's youth population growth and approving the law that only engineering firms and qualified companies are permitted to construct buildings over 3000 m^2 have provided some opportunities for this company.

c) **Taking projects in different areas of the country:** this company does not consider any geographical limitation for participating in bids and taking projects. Providing skilled human resources in various areas, time consuming and cost affairs related to the consistence with geographical environment of the region which comprises new projects, costs due to the continuous transmission of machinery, constant human resource and management from a point to the other after finishing each project and starting new one, incidence of cultural problems with new region residents are the factors that can be assume as threats. Also, developing the communication with different people and implementing the projects which increase the reputation of company in diverse regions and acceptability of company among the competitors, can be assumed as opportunities in decision-making process of studied company.

11. Development of mission, vision and value statements for company

A group of company's experts including direct manager(CEO), head of technical office, field superintendent, chairman of company and one of the researchers expressed their ideas in a meeting for development of mission, value and vision statements. The brain storming method was adopted for this affair.

12. Identifying and classifying the factors affecting on company's decision-making and determination of strategy alternatives

1- Identifying and classifying the factors

In this section, the company was evaluated by the experts group based on financial problems and tax office's rules, labor laws and social insurance, political problems, contractors' significant difficulties in last years, recent political boycotts,

current work capacity, technological status, experience in previous projects, experts in technical district and rivals' status in mentioned issues. The Delphi method was used in order to recognize the internal (strengths and weaknesses) and external (opportunities and threats) environments of company. At first, the experts were asked to list the strengths, weaknesses, opportunities and threats of company in questionnaires separately. After the first step of Delphi method, the questionnaires were collected and experts' ideas were wrapped up (in this paper, regarding to the emphasis on modeling, only the important factors are noted). In next step, the gathered ideas containing main internal and external factors were sent to the experts again to prioritize the factors approximately.

2- Assessment of factors identified in SWOT groups through the Delphi method and factors priority matrix

Since the importance of identified factors in previous step was diverse and the factors priorities were assessed for reducing the number of pair wise comparisons, it should be considered that the numbers of pair wise comparisons are exponentially increased by the number of factors. The factors assessment was performed in order to count factors with more importance and control the number of pair wise comparisons in manageable limit. After gathering the ideas in second step of Delphi method, the experts were asked to prioritize the factors. Then three main factors in each group were chosen to determine the strategy alternatives. The other method applied in this section was using the priority matrix of internal and external factors which was filled out by the company's boss.

3- Strategy alternatives determination

After specifying the strengths, weaknesses, opportunities and threats, the strategy and policy are determined in order to preserve the company's value, carry out the mission and reach the goals. These strategies are applied for resolving the company's weaknesses through the opportunities ahead (WO), utilizing the company's strengths to use the attained opportunities in an optimal way (SO), using the internal strengths to prevent the negative effect of external threats (ST), reducing the internal weaknesses and abstaining from the threats made by external environment (WT). In this step, the experts developed the strategy alternatives in each case using mutual interactions of SWOT groups (table-1).

Regarding to the participating of experts in developing the states of mission, goal, etc, the strategies development is also carried out attending to the company's mission, preserving the value and achieving the goals. The experts' efforts in development phase confirm this affair.

Table 1. SWOT matrix

Internal Factors		SWOT MATRIX	
Weaknesses: • ow liquidity • ow experience of great projects • ispersion of projects under construction	**Strengths:** • 8year successful background and resume • trong and resourceful technical office • xtensive and proper relations with owners, material vendors, banks…		
WO – Strategy Participating with reliable investors for housing in Tehran state in a mass and concentrated way	**SO – Strategy** Not participating in bid with low proposed percentage and entering among the great companies	**Opportunities:** • Increasing the budget of development plans • Youth population and high demand for housing • approving the law that only engineering firms and qualified companies are permitted to construct buildings over 3000 m²	External Factors
WT – Strategy Not participating in governmental bids, specially infrastructure contracts	**ST - Strategy** Moving toward the private and more specialized activities	**Threats:** • conomical inflation • ow management competency and dogmatizing of the owners • elays and shortcomings in proclaiming of price lists, adjustments and circulars of the organization of strategic planning and monitoring (low prices, mismatching of the adjustment indices and the facts…) • etting involved with different people and professions	

13. Application of ANP in SWOT analysis

For applying ANP in SWOT analysis, the desired problem was converted to hierarchical state in a way that each of sub factors and strategies became evaluable by ANP method. The interdependencies among the SWOT factors were considered in hierarchical structure (figures 3 and 4). By using ANP in SWOT analysis, the consideration of interdependencies among the SWOT factors becomes possible. As mentioned in section "the reason of using ANP", the factors of Strength, weakness, opportunity and threat have dependency in second level and are not independent from each other (the interdependency among the SWOT factors has been noted in "the reason of using ANP").

14. Finding the general priority of each strategy and choosing the superior strategy – application of Hybrid method (ANP in SWOT)

To find the alternatives priority using ANP analysis according to the figures 3 and 4, the weights were extracted in each level without assuming dependency between the factors and regarding to the former section. Then with assumption of dependency among the main SWOT factors (strength, weakness…), the weights were also extracted with internal

connections between the factors and the strategy alternatives' general priority was attained by forming the super matrix and computing the limit matrix. The Expert Choice Software and eigenvector method have been applied for calculating the weights in hierarchical structure condition.

Table 2. Strategies development based on SWOT matrix

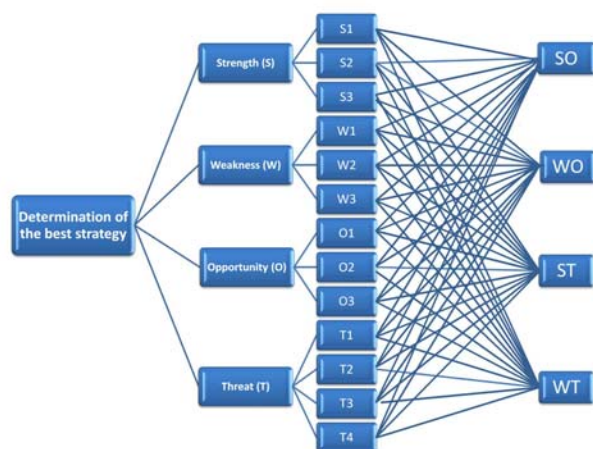| Strengths: S1 - 18year successful background and resume S2 - Strong and resourceful technical office S3 - Extensive and proper relations with owners, material vendors, banks…	Opportunities: O1 - Increasing the budget of development plans O2 - Youth population and high demand for housing O3 - approving the law that only engineering firms and qualified companies are permitted to construct buildings over 3000 m^2
Weaknesses: W1 - Low liquidity W2 - Low experience in great projects W3 - Dispersion of projects under construction	Threats: T1 - Economical inflation T2 - Low management competency and dogmatizing of the owners T3 - Delays and shortcomings in proclaiming of price lists, adjustments and circulars of the organization of strategic planning and monitoring (low prices, mismatching of the adjustment indices and the facts…) T4 - Getting involved with different people and professions
WO – Strategy Participating with reliable investors for housing in	SO – Strategy Not participating in bid with low proposed percentage and entering among the great
WT – Strategy Not participating in governmental bids, specially infrastructure contracts	ST – Strategy Moving toward the private and more specialized activities

Figure 4. ANP model for SWOT

The interdependency among the SWOT factors is acquired by analyzing the effect of each factor on the other using pair wise comparisons. As mentioned in previous section, assuming the independency of SWOT factors is not always feasible and more appropriate and realistic results are attained by utilizing SWOT analysis with ANP method. The interdependency among the SWOT factors is specified by analysis of company's internal and external environments. These interdependencies are as noted in the section "The reason of using ANP" and have been illustrated in figure 1. Attending to these interdependencies, the pair wise comparison matrices are formed according to table 3. In these tables, the factors are compared by answering the questions such

as follow: What is the relative importance of strengths in comparison with threats to control the weaknesses? For answering this question, the number 9 has been represented in pair wise comparison (table 3). Also, the eigenvector acquired by pair wise comparisons has been shown in the last column of each table. By computing the factors' relative importance weights, the SWOT factors' interdependency matrix is formed (W2). The general priorities of strategy alternatives can be attained by having W2 and W1, W3, W4 matrices formed in previous section. So, the weights and alternatives' general priorities are achieved by formation of limit matrix derived from super matrix. The SWOT analysis structure was formed in analytic network process by possessing the factors' interdependency matrix (W2) and using ANP-Super Decision Software. As shown in appendix (A), the input super matrix contains 22 rows and 22 columns. The local priority related to the comparison of each category of factors in rows than the predominant criterion or group in column has been represented in respective cells. For entering the pair wise comparisons among the factors, the ANP-Super Decision Software has been used.

Table 3. SWOT factors interdependency matrix regarding to strengths, weaknesses and threats

Strengths	W	O	T	Relative Importance Weights
Weaknesses(W)	1	1/9	1/4	0.068
Opportunities(O)		1	3	0.681
Threats(T)			1	0.249
CR=0.00				

Weaknesses	S	T		Relative Importance Weights
Strengths(S)	1	9		0.9
Threats(T)		1		0.1
CR=0.00				

Threats	S	W		Relative Importance Weights
Strengths(S)	1	6		0.857
Weaknesses(W)		1		0.142
CR=0.00				

15. Comparing the results of Hybrid method and Conventional method

According to the results acquired by combination of ANP analysis in SWOT, the company's superior strategy is SO strategy and strategies' prioritizing is as follow: SO-WO-WT-ST. The desired problem was studied through the integration of AHP and SWOT. Regarding to the assumption of factors independency in each level (figure 3-A), the strategies' priorities are obtained as follow: WO-WT-SO-ST that the superior strategy is WO strategy. In AHP analysis, the WO strategy with general priority of 0.287 was

chosen as the most appropriate strategy for the company and the strategies' prioritizing was changed. So, it can be found that the company's superior strategy and strategies' ranking vary by considering the dependency among the factors in the analysis. The obtained results of using AHP and ANP methods have been shown in table-4 for comparison:

Table 4. The strategies' weights and ranking due to the using of AHP and ANP

	SO	WO	ST	WT
Weights in AHP	0.258	0.287	0.194	0.261
Ranks in AHP	3	**1**	4	2
Weights in ANP	0.295	0.241	0.229	0.2345
Ranks in ANP	1	2	4	3

If dependencies among the SWOT factors and sub factors exist, the ANP analysis can be used to make decision correctly. This method is also used in cases that dependencies among the SWOT factors and sub factors do not exist or are negligible.

16. Model validation

Same as the other studies, this research has also encountered to some limits and problems in validation test of suggested model. The first problem is that the factors in ANP model do not have quantitative nature. ANP analysis is originally a method for multi criteria decision making with interdependent factors which are either quantitative or qualitative.

In addition, the problems modeled by ANP utilize the pair wise comparison matrices formed by the experts' judgment to determine the priority values. Therefore, changing the pair wise comparison matrices in different times is possible because they are formed based on subjective judgment of people. So, it is not feasible to reach the same results in studying various cases but there is an obvious fact that the people's taste and priority are different in diverse conditions. According to the above mentioned, it can be concluded that:

According to the expert's opinion, the variation of pair wise comparisons of factors is not a reason to refuse the validity of problems which uses suggested ANP model. The other problem in model validation test is that the model has not been experimented by the historical data and its main reason is the lack of historical data for the contractor company. Despite the mentioned problem, this lack is not significant and its prime reason is that: the pair wise comparison matrices in desired problem are inputs given to the model under the certain conditions. So, obtaining different results is possible regarding to the different pair wise comparison matrices in diverse time periods.

Relating to the aforementioned subject matters, the suggested model validation was evaluated in two ways. The first is the results attained by suggested model were compared with AHP model and the best strategy was introduced by considering the dependency among SWOT factors. Despite both methods used identical pair wise comparison matrices, different results were obtained by applying ANP and AHP (table 4). Such difference was predictable because the AHP could not consider dependencies assumed by ANP. Therefore, ANP is more appropriate for modeling actual situations in comparison with AHP. The second criterion for this research's model validation was the strategy managers' opinions. Favorable results were attained regarding to the application of AHP in SWOT analysis and choosing the acquired strategy in practice. Suggested model was applied in Contractor Company and it is better to be accommodated for utilizing in other companies and organizations. Two reasons for model accommodation are as follows:

• Sub factors and strategy alternatives in the model require changing because each management team should make its strategies based on strategic factors obtained by the internal and external analysis results.

• The dependency among SWOT factors and sub factors might vary according to the management style. For instance, in conducted research only the dependency among the factors was important. For different management, the dependency among the sub factors may be important in addition to dependency among the factors. So, the suggested model preserves its applicability for various management types.

The other index confirming the model validity is consistency rate (CR) of pair wise comparison matrices. Calculated CR due to the application of ANP and AHP must be lower than 0.1. The consistency rates of pair wise comparison matrices applied in this research have been calculated by Expert Choice and ANP-Super Decision Software and the values corresponding to each matrix have been represented in the main research's appendix. After achieving all consistency rates, it was observed that their values have been preserved less than 0.1. So, this affair certifies the propriety of applied pair wise comparison matrices.

17. Conclusion

The strategic management basics were exerted in strategy development phase in a contractor company as a case study. As the objectives of vision development can indicate to below cases:

- Motivating the company's practitioners in all the process
- using perspective in the future as a tool for prioritizing the needs and demands

Practitioners in management issues only tend to the constrained management such as time, cost and resources. However, the objective management and project choosing have the most importance in success of project and company. Right choosing of project as an organization's significant objective, is more important than implementing the project correctly. Exerting the strategic management basics in company, determination of company's policies and choosing the most proper strategy for the company lead to:

- Attract the projects in line with company's objectives and choose the projects in proportion with company's policies and optimized strategy
- More motivated participating of personnel in various phases (implementation…) regarding to the effectiveness level of company's perpetrators in identifying the strategic factors and codifying the strategy.
- More familiarity of factors with company's internal and external conditions and effort for moving toward the promotion of company.

In this paper, SWOT analysis was selected as a tool for recognizing the environment and codifying the strategy. In SWOT analysis, the strategy alternatives are formed according to the results of strengths, weaknesses, opportunities and threats acquired by analyzing the internal and external environments. SWOT analysis cannot quantitatively evaluate the strategy alternatives' importance according to the strategic factors' significance. So, some studies have been carried out for identifying strategies' importance based on factors' significance but in these researches, the SWOT factors were considered independent from each other that it is not correct assumption. This research tried to demonstrate that exerting SWOT analysis in quantitative state and considering the dependency among the factors are not possible. Applied method is ANP analysis which provides the possibility of measuring the dependency among the factors. The attained results of using ANP and AHP methods were compared to study the effect of dependency between the factors on strategies prioritizing and SWOT sub factors weights. It was observed that dependency among the SWOT factors affects on choosing and prioritizing the strategies and the order of strategies are different by application of ANP and AHP methods.

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Appendix A. SWOT analysis super matrix