An Integrated Fuzzy ANP-SWOT Method and its Application in University

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ABSTRACT
Strategic management is a term used to describe a decision process. It relates to the strategy in which decisions are made and activities are performed in order to achieve company goals most effectively. Our previous research on strategic decision-making combined both SWOT and ANP within the same case study. Now, we propose to use another method of analysis, as the values of indicators and attributes that impact the decision making process are often vague and imprecise. Therefore in the current research design we aim to use both SWOT and the Fuzzy approach of ANP to measure weight priorities. In order to obtain higher certainty and accuracy across a number of criteria comparatively our results suggested that SWOT and Fuzzy methodology use an enhanced version of the previous SWOT and ANP analysis and is not only a more accurate guide for strategic management at IUH but also leads to improved effectiveness for related decision- making processes.

Keywords
MCDM, Strategic management, Fuzzy Analytic Network Process (Fuzzy-ANP), IUH (Industrial University of Ho Chi Minh city).

1. INTRODUCTION
During the period of industrialization and modernization and international integration of the country, Vietnam human resources become increasingly significant and decide the success of the country. Educational roles are increasingly important in building a new generation of Vietnam, to meet the requirements of socio-economic development. This requires the education must develop the right strategy, case law, trends and age worthy.

The forerunner of the IUH is Go Vap Industrial Training School by Salesian monks founded in 1956-Nov-11 at Hanh Thong, Go Vap District, Gia Dinh Province. By 1968, the School was renamed the School of Engineering Don Bosco. After the complete liberation of the South, the School was renamed the School of Engineering of the Ministry IV Engineering and Metallurgy. By 1994, the school merged with the School of Chemical Bien Hoa City II at the School of Industrial Engineering IV, under the Ministry of Industry.

March 1999, the College established IV Industrial School in December 2004 and was upgraded to IUH, is one of the educational institutions universities, and technical training large in Vietnam (www.iuh.edu.vn).

IUH University became the basis of multi-level training, advanced interdisciplinary direction, leading modern in Vietnam, at regional level, to meet the demand for high-quality human resources for career industrialization and modernization of the country. IUH is striving to achieve university quality program on a regional and national level. For example, innovative teaching methods, teacher team development, improving quality and efficiency of teaching methods and financial resources. IUH was listed among the top schools in the ASEAN region.

In this paper, we used the concept of Fuzzy set theory and linguistic values to overcome uncertainty and qualitative factors. Then we used quantitative SWOT analysis as a decision tool for strategic planning and salary increases for faculty to enhance their knowledge in a university. IUH is an example. Fuzzy pair-wise comparisons used in the model, make the obtained weights of criteria more precise. Fuzzy logic has been integrated with SWOT analysis to del with vagueness and imprecision of human thought. We use the SWOT analysis and the comparison of pairs, used in the Fuzzy-ANP models to make weight gain more precise criteria.

The remaining parts of this paper a structured as follow: Section 2 Literature review. In section 3 review the ANP, Fuzzy-AHP, Fuzzy-ANP. In section 4, Combining Fuzzy-ANP and SWOT methodology. Section 5, An Application of Strategic decision making by integration of Fuzzy-ANP method base quantitative SWOT in Industrial University of Ho Chi Minh city (IUH), multi-criteria decision making, group decision making with actual numbers used in this model. In section 6 testing results by Fuzzy-AHP method. Finally, section 7 concludes the paper.

2. LITERATURE REVIEW
Strategic management, is a term that is used to describe the decision making process. Thus, the strategic management is the decisions and activities that will result in a more effective strategy to achieve the company goals. Managers always look for comprehensive picture of present condition of the organization and analyze of its future situation considering internal and external environment [5]. Business organizations today deal with unprecedented challenges, opportunities and threats in carrying out their mission. Thus, they needed description of internal strengths and weaknesses, as well as external opportunities and threats, takes place on the basis of a well-known technique called SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis [8]. Moreover, SWOT analysis, these factors are grouped into four parts called SWOT groups: strengths, weaknesses, opportunities, and threats. SWOT involves systematic thinking and comprehensive diagnosis of factors relating to a new product, technology, management, or planning.

SWOT (Strengths, Weaknesses, Opportunities and Threats) is one of the most well-known techniques for conducting a strategic study [2]. SWOT analysis is a commonly used tool for analyzing internal and external environments in order to attain a systematic approach and support for a decision situation (e.g. [11], [12]). Reference [9] presented a hybrid method for improving the usability of SWOT analysis. AHP's connection to SWOT yields analytically determined priorities for the factors included in SWOT analysis and makes them commensurable. Reference [11] using Analytic Network

Process (ANP), demonstrated a process for quantitative SWOT analysis that can be performed when there is dependence among strategic factors.

Reference [10] presented a Quantified SWOT analytical method which provides more detailed and quantified data for SWOT analysis. The Quantified SWOT analytical method adopts the concept of Multiple-Attribute Decision Making (MADM), which uses a multi-layer scheme to simplify complicated problems, and thus is able to perform SWOT analysis on several enterprises simultaneously.

SWOT analysis and ANP integrated model to select an alternative strategy for a textile firm [2] Applied the ANP embedding into SWOT to analyze of the cumulative effect of pollution in the atmospheric environment management [3] proposed an integrated model for prioritizing the strategies of Iranian mining sector. They used ANP to obtain the weight of SWOT factors [5] structured ANP based SWOT approach to minimize environmental impacts due mining activities [6]. 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 [9]. 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 [12] The SWOT - ANP model is to prescribes policy recommendations both for the government and management, if adopted, could facilitate improved environmental performance [6].

Strategic planning in organizations has attracted much attention and a comprehensive plan is to allocate resources for long-term goals for the organization. Our previous study, Multi-criteria decision making (MCDM) method should be used to solve this problem. The Analytic Network Process (ANP) method [2], which is capable of handling interdependence among the evaluation criteria, has been applied widely recently. Besides one of the tools in the strategy formulation process, which is used in strategic issues for internal and external analysis, is SWOT analysis. Our previous study explains how to use the method ANP priorities of SWOT factors.

Although these approaches have brought new insights into the scene and deserve merit in terms of analytical foundation to determine the importance ranking of SWOT factors, still have a major limitation: ignoring the imprecision in human decision making processes. To simultaneously overcome these limitations, we propose an integrated SWOT Fuzzy ANP methodology, which would hypothetically handle the interactions, interdependences, and feedbacks amongst the SWOT matrix factors and also the vagueness in multi-criteria decision making.

3. METHODOLOGY

A. Analytic Network Process (ANP).

The ANP is generalization of the AHP [11]. The AHP also developed by Saaty [10], is one of the most widely used MCDM methods. ANP enables decision makers to assign a relative priority to each factor through pair-wise comparison [6]. The ANP allows complex interdependence relationships among elements [1], with utilizing the supper matrix.

ANP approach comprises four steps [11],[12] :

Step 1: Model construction and problem structuring: The problem should be stated clearly and decomposed into a rational system like a network.

Step 2: Pair-wise comparisons and priority vectors: In ANP, pairs of decision elements at each cluster are compared with respect to their importance towards their control criteria. In addition, interdependencies among criteria of a cluster must also be examined pair-wise; the influence of each element on other elements can be represented by an eigenvector. The relative importance values are determined with Saaty's scale.

Step 3: Super-matrix formation: The supe-rmatrix concept is similar to the Markov chain process. To obtain global priorities in a system with interdependent influences, the local priority vectors are entered in the appropriate columns of a matrix. As a result, a super-matrix is actually a partitioned matrix, where each matrix segment represents a relationship between two clusters in a system.

Step 4: Synthesis of the criteria and alternatives' priorities and selection of the best alternatives: The priority weights of the criteria and alternatives can be found in the normalized super-matrix.

B. The Fuzzy theory and Fuzzy-AHP method.

Zadeh (1965) introduced the Fuzzy set theory to deal with the uncertainty due to imprecision and vagueness. A major contribution of Fuzzy set theory is its capability of representing vague data. The theory also allows mathematical operators and programming to apply to the Fuzzy domain [12]. Generally, a Fuzzy set is defined by a membership function, which represents the grade of any element x of X that have the partial membership to M . The degree to which an element belongs to a set is defined by the value between zero and one. If an element x really belongs to M, $\mu M(x)=1$ and clearly not, $\mu M(x)=0$.

A triangular Fuzzy number is defined as (l,m,u), where $l \le m \le u$ .The parameters l,m and u respectively, denote the smallest possible value, the most promising value, and the largest possible value that describe a Fuzzy event. (l,m,u) has the following triangular type membership function.

$$\mu_M(x) = \begin{cases} \frac{x-1}{m-1} & l \le x \le m \\ \frac{u-x}{u-m} & m \le x \le u \\ 0 & \text{otherwise} \end{cases}$$

A triangular Fuzzy number can be show in fig 1.

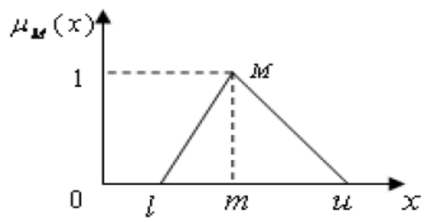

Fig 1. A triangular Fuzzy number Chang's extent analysis method [13]

Chang's extent analysis method is one of Fuzzy AHP methods, the steps of which are as follows:

Let $X=\{x_1,x_2,\ldots n\}$ be an object set, and $G=\{g_1,g_2,\ldots g_m\}$ be a goal set. According to the method of Chang's extent analysis, each object is taken and extent analysis for each goal, g_i , is performed respectively.

Therefore, *m* extent analysis values for each object can be obtained, with the following signs:

$$\widetilde{M}_{g_i}^{1}, \widetilde{M}_{g_i}^{2}, \ldots, \widetilde{M}_{g_i}^{m},\ i=1,2\ldots n \qquad (1)$$

where all the M_{gi}^{j} (j=1,2,…n) are triangular Fuzzy numbers.

The steps of Chang's extent analysis can be given as follows:

a: The value of Fuzzy synthetic extent with respect to the i th object is defined as:

$$S_i = \sum_{j=1}^{m} M_{g_i}^{j} \otimes \left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{g_i}^{j}\right]$$
(2)

$$\text{Where} \quad \sum_{j=1}^{m} M_{g_i}^{j} = \left(\sum_{j=1}^{m} l_j, \sum_{j=1}^{m} m_i, \sum_{j=1}^{m} u_j\right) \qquad (3)$$

$$\sum_{i=1}^{n}\sum_{j=1}^{m} M_{g_i}^{j} = \left(\sum_{i=1}^{n} l_i, \sum_{i=1}^{n} m_i, \sum_{i=1}^{n} u_i\right) \quad (4)$$

$$\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{g_i}^{j}\right]^{-1} = \left(\frac{1}{\sum_{i=1}^{n} u_i}, \frac{1}{\sum_{i=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} l_i}\right) \qquad (5)$$

b: The degree of possibility of

$M_2=(l_2,m_2,u_2) \geq M_1 = (l_1,m_2,u_1)$ is defined as :

$$V(M_2 \geq M_1) = \begin{cases} 1 & m_2 \geq m_1 \\ 0 & l_1 \geq u_2 \\ \frac{l_1-u_2}{(m_2-u_2)-(m_1-l_1)} & \text{otherwise} \end{cases} \qquad (6)$$

c: The degree possibility for a convex Fuzzy number to be greater than k convex Fuzzy numbers (M_i=1,2,…,k) can be defined by :

$$V(M \geq M_1, M_2, \ldots M_k) = \min V(M \geq M_i),\ i=1,2,\ldots,k \qquad (7)$$

Assume that

$$d'(A_i)=\min V(S_i \geq S_k) \text{ for } k=1,2,\ldots n,\ k \neq I \qquad (8)$$

Then weight vector is given by

$$W'=(d'(A_1),d'(A_2),\ldots d'(A_n))^T \qquad (9)$$

Where A_i(i=1,2,…n) are n elements.

d: Via normalization, the normalized weight vector are $W=(d(A_1),(A_2),\ldots d(A_n))^T$ (10)

where W is a nonFuzzy number

C. The Fuzzy-ANP method

Saaty's discrete scale shown in Table 1 is precise and explicit. However, human perceptions and judgments are mostly uncertain and vague, which requires incorporating fuzziness in modeling. In addition, matching and mapping of the perceptions and judgments to a number cannot be explained by definite numbers.. Instead of using the discrete scale of 1–9, a triangular Fuzzy number (TFN) scale $\tilde{1} - \tilde{9}$ then be described as in Table 2.

Table 1
Explanation of the pair-wise comparison scale.

Intensity of importance definition	Explanation
1 Equal importance	Two activities equally contribute to the object
3 Moderate importance	Experience and judgment slightly favour one activity over the other
5 Strong importance	Experience and judgment strongly favour one activity over the other
7 Very strong importance	An activity is very strongly favoured over the other, its dominance is demonstrated in practice
9 Extreme importance	The evidence favouring one activity over the other is of the highest possible order of affirmation
2, 4, 6, 8 For compromise between the above values	Sometimes one needs to interpolate a compromise judgment numerically because there is no good word to describe it

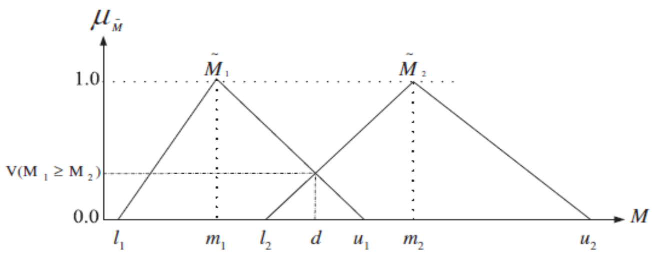

Fig. 4. Comparison of two triangular fuzzy numbers.

To evaluate the decision maker's judgments, pair-wise comparison matrices are created by using TFN in Table 2. This comparison Fuzzy matrix can be denoted as in (11) [12].

$$\tilde{A} = \begin{pmatrix} (a_{11}^{1}, a_{21}^{m}, a_{11}^{u}) & \cdots & (a_{1n}^{1}, a_{1n}^{m}, a_{1n}^{u}) \\ \vdots & \ddots & \vdots \\ (a_{m1}^{1}, a_{m1}^{m}, a_{m1}^{u}) & \cdots & (a_{mm}^{l}, a_{mm}^{l}, a_{mm}^{u}) \end{pmatrix} \qquad (11)$$

The element $\tilde{a}_{mn}$ which is given by$(a_{mn}^{l}, a_{mn}^{n}, a_{mn}^{u})$ represents the comparison of the component m with the component n. Due to the operational laws of Fuzzy numbers, the matrix $\tilde{A}$ can be rewritten as in Eq. (12) by replacing $\tilde{a}_{mn}$ with the corresponding reciprocal values (i.e. $1/a_{mn}$) [7].

$$\tilde{A} = \begin{pmatrix} (1,1,1) & \cdots & (a_{1n}^{1}, a_{1n}^{m}, a_{1n}^{u}) \\ \vdots & \ddots & \vdots \\ \left(\frac{1}{a_{m1}^{u}}, \frac{1}{a_{m1}^{m}}, \frac{1}{a_{m1}^{l}}\right) & \cdots & (1,1,1) \end{pmatrix} \qquad (12)$$

$\tilde{A}$ is a triangular Fuzzy comparison matrix. To compute the estimates of the Fuzzy priorities $\widetilde{W}_i$, where $\widetilde{w}_i = (w_i^{l}, w_i^{m}, w_i^{u})$ i=1,2; . . . ; n by means of the judgment matrix which approximates the Fuzzy ratios $\tilde{a}_{ij}$ so that $\tilde{a}_{ij} \approx \widetilde{w}_i/\widetilde{w}_j$. The logarithmic least squares method [8] is the most effective and efficient one and was used in our study. In this way, the triangular Fuzzy weights for the relative importance of the factors, the feedback of the factors, and alternatives according to the individual factors can be calculated [7] To compute the triangular Fuzzy numbers, the logarithmic least squares method is used as described in Eqs. (13) and (10), [11].

$$\widetilde{w}_k = (w_k^{l}, w_k^{m}, w_k^{u}),\ k = 1,2,\ldots n \qquad (13)$$

Where

$$w_k^{s} = \frac{\left(\prod_{j=1}^{n} a_{ij}^{s}\right)^{1/n}}{\sum_{k=1}^{n}\left(\prod_{j=1}^{n} a_{kj}^{m}\right)^{1/n}} \quad s \in \{l, m. u\} \qquad (14)$$

Following these steps the weights of the alternatives are to be converted to crisp numbers via the extent analysis as described in Section B.

Table 2
Definition of TFN-linguistic scale for importance.

TFN	Linguistic scale for importance	Triangular fuzzy scale
$\tilde{1}$	Equally preferred	(1,1,1)
$\tilde{2}$	Equally to moderately preferred	(1,3/2,3/2)
$\tilde{3}$	Moderately preferred	(1,2,2)
$\tilde{4}$	Moderately to strongly preferred	(3,7/2,4)
$\tilde{5}$	Strongly preferred	(3,4,9/2)
$\tilde{6}$	Strongly to very strongly preferred	(3,9/2,5)
$\tilde{7}$	Very strongly preferred	(5,11/2,6)
$\tilde{8}$	Very strongly to extremely preferred	(5,6,7)
$\tilde{9}$	Extremely preferred	(5,7,9)

Table 3
Definition of linguistic variables.

Linguistic variables	Bottom	Medium	Top
$\tilde{1}$ Equally preferred	1	1	1
$\tilde{2}$ Equally to moderately preferred	1	1, 5	1, 5
$\tilde{3}$ Moderately preferred	1	2	2
$\tilde{4}$ Moderately to strongly preferred	3	3, 5	4
$\tilde{5}$ Strongly preferred	3	4	4, 5
$\tilde{6}$ Strongly to very strongly preferred	3	4, 5	5
$\tilde{7}$ Very strongly preferred	5	5, 5	6
$\tilde{8}$ Very strongly to extremely preferred	5	6	7
$\tilde{9}$ Extremely preferred	5	7	9

4. COMBINING FUZZY-ANP AND SWOT METHODOLOGY

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. Then, according to the inner dependencies among the SWOT actors, 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 general sub-matrix notation for the SWOT model used in this study is as follows:

$$W = \begin{matrix} Goal \\ SWOT\ factors \\ SWOT\ sub\text{-}factors \\ alternatives \end{matrix} \begin{bmatrix} 0 & 0 & 0 & 0 \\ \widetilde{W}_1 & \widetilde{W}_2 & 0 & 0 \\ 0 & \widetilde{W}_3 & 0 & 0 \\ 0 & 0 & \widetilde{W}_4 & I \end{bmatrix}$$

Step 1: Identify SWOT sub-factors and determine the alternative strategies according to SWOT sub-factors.

Step 2: Assume that there is no dependence among the SWOT factors; determine the Fuzzy importance degrees of the SWOT factors with a $\tilde{1}-\tilde{9}$ scale ($\mathbf{w_1}$).

Step 3: Determine, with a Fuzzy $\tilde{1}-\tilde{9}$ scale, the inner dependence matrix of each SWOT factor with respect to the other factors by using the schematic representation of innerdependence among the SWOT factors: ($\widetilde{\mathbf{W}}_2$).

Step 4: Determine the interdependent priorities of the SWOT factors ($\widetilde{\mathbf{W}}_{\mathbf{factors}} = \widetilde{\mathbf{W}}_2 \mathbf{x} \widetilde{\mathbf{W}}_1$).

Step 5: Determine the local importance degrees of the SWOT sub-factors with $\tilde{1}-\tilde{9}$ scale ($\widetilde{\mathbf{W}}_{\mathbf{sub-factors(local)}}$).

Step 6: Determine the global importance degrees of the SWOT sub-factors ($\widetilde{\mathbf{W}}_{\mathbf{sub-factors(Global)}}$).

Step 7: Determine the importance degrees of the alternative strategies with respect to each SWOT sub-factor with a Fuzzy $\tilde{1}-\tilde{9}$ scale ($\widetilde{\mathbf{W}}_4$).

Step 8: Determine the overall priorities of the alternative strategies, reflecting the interrelationships within the SWOT factors ($\widetilde{\mathbf{W}}_{\mathbf{alternatives}} = \widetilde{\mathbf{W}}_4 \mathbf{x} \widetilde{\mathbf{W}}_{\mathbf{sub-factors(global)}}$).

5. ANALYZING THE SUGGESTED METHOD IN INDUSTRIAL UNIVERSITY OF HO CHI MINH CITY

Hierarchical model and network for the SWOT analysis is proposed here (and can be seen in Figure 3) consists of four levels.

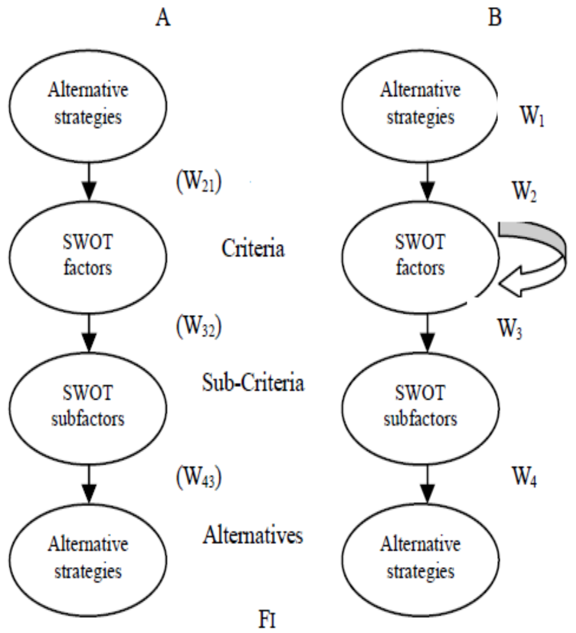

FIGURE. 3 (A) THE HIERARCHICAL REPRESENTATION OF THE SWOT MODEL. (B) THE NETWORK REPRESENTATION OF THE SWOT MODEL.

The goal is to become a university IUH multi-level training facilities, advanced interdisciplinary direction, leading modern in Vietnam, at regional level, to meet the demand for high-quality human resources for the industry industrialization and modernization. Consequently, The University focuses on developing high-quality education and stability. IUH university is one of the schools strive to become a prestigious school, trying to increase faculty salaries and purchase additional equipment for teaching. It is important to know that one of the main part of the school's faculty improve and increase their salaries. The overall goal how reassuring faculty teaching, research, working with the support of administrators help even if they improve their learning.

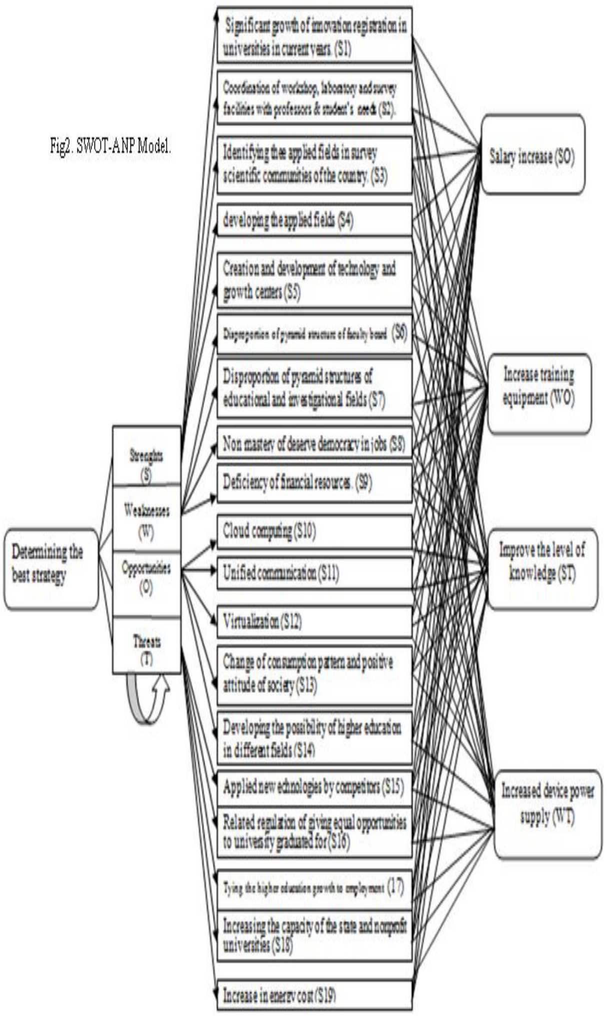

Fig2. SWOT-ANP Model.

Here you can employ the use of Fuzzy ANP on Matrix Analysis SWOT, Strategies of the Industrial University of Ho Chi Minh city (IUH). To enhance the quality of education and research, management has based its planning on the agenda also be adapted to identify strategies in line with the mission of the organization, and is suitable for internal and external factors.

Using Fuzzy-ANP priorities set for this purpose were the following:

Firstly: 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 Fuzzy ANP technique. The schematic structure established is shown in Fig2.

The aim of ''choosing the best strategy'' is placed in the first level of the Fuzzy ANP model and the SWOT factors (Strengths, Weaknesses, Opportunities, Threats) are in the second level. The SWOT sub-factors in the third level include four sub factors for every SWOT factor. Four alternative IUH strategies developed for this study are placed in the last level of the model. As presented in the SWOT matrix, these alternatives are as follows (Table 4).

Table 4 : Matrix SWOT in IUH

	External environment / Internal environment	Opportunities (O)	Threats (T)
		Cloud computing (S10) Unified communication (S11) Virtualization (S12) Change of consumption pattern and positive attitude of society (S13) Developing the possibility of higher education in different fields (S14)	Applied new echnologies by competitors (S15) Related regulation of giving equal opportunities to university graduated for (S16) Tying the higher education growth to employment (S17) Increasing the capacity of the state and nonprofit universities (S18) Increase in energy cost (S19)
STREGHT (S)	Significant growth of innovation registration in universities in current years. (S1) Coordination of workshop, laboratory and survey facilities with professors & student's needs (S2). Identifying thee applied fields in survey scientific communities of the country. (S3) developing the applied fields (S4) Creation and development of technology and growth centers (S5).	Salary increase (SO)	Improve the level of knowledge (ST)
WEAKNESES (W)	Disproportion of pyramid structure of faculty board (S6) Disproportion of pyramid structures of educational and investigational fields (S7) Non mastery of deserve democracy in jobs (S8) Deficiency of financial resources. (S9)	Increase training equipment (WO)	Increased device power supply (WT)

Second step: Assuming there is no dependency between SWOT factors, SWOT paired comparisons using a scale of $\tilde{1}-\tilde{9}$ and is done with attention to purpose. With the statistical data and synthesizing the experts' opinions directors, deputies, employees and took a University. The conflict comes in last 3 columns of the matrix is $\widetilde{W}_1$ of the matrix. Comparing the results are shown in Table 5.

Table 5. Comparison of paired matrix

SWOT Factors	S	W	O	T	Importance degrees of SWOT factors		
					Bottom	Medium	Top
Strengths (S)	$\tilde{1}$	$\tilde{2}$	$\tilde{3}$	$\tilde{3}$	0.250	0.370	0.370
Weaknesses (W)		$\tilde{1}$	$\tilde{2}$	$\tilde{3}$	0.250	0.280	0.280
Opportunities(O)			$\tilde{1}$	$\tilde{2}$	0.250	0.198	0.198
Threats(T)				$\tilde{1}$	0.250	0.152	0.152

Third step: Inner dependence among the SWOT factors is determined by analyzing the impact of each factor on every other factor using Fuzzy pair-wise comparisons. The introduction section mentioned that it is not always possible to assume the SWOT factors to be independent. More optimum results can likely be obtained by combining both SWOT analysis and the Fuzzy ANP technique. Using the analysis of both the internal and external environments of the organization, the dependencies among the SWOT factors, which are depicted schematically in Fig. 5, are determined. Based on the inner dependencies presented in Fig. 5, pair-wise 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 pair-wise comparisons and lead to a value of $\tilde{9}$ (very strong importance) as denoted in Table 7. The resulting eigenvectors are presented in the last column of Tables 6-9. Using the computed relative importance weights, the inner dependence matrix of the SWOT factors ($\widetilde{W}_2$) is formed. As opportunities are affected only by the Strengths, no pairwise comparison matrix is formed for opportunities.

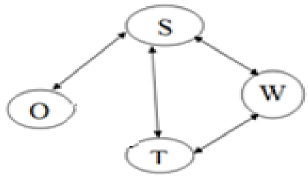

Fig 5. Inner dependence SWOT

Table 6. Inner dependence matrix of the SWOT factors with respect to "S"

Strengths	W	O	T	Relative importance weights		
				Bottom	Medium	Top
W	$\tilde{1}$	$1/\tilde{9}$	$1/\tilde{4}$	0.115	0.087	0.072
O		$\tilde{1}$	$\tilde{3}$	0.480	0.609	0.626
T			$\tilde{1}$	0.405	0.304	0.301

Table 7. Inner dependence matrix of the SWOT factors with respect to "W"

Weakness	S	T	Relative importance weights		
S	$\tilde{1}$	$\tilde{9}$	0.833	0.875	0.900
T		$\tilde{1}$	0.167	0.125	0.100

Table 8. Inner dependence matrix of the SWOT factors with respect to "T"

Threats	S	W	Relative importance weights		
S	$\tilde{1}$	$\tilde{5}$	0.655	0.706	0.733
W		$\tilde{1}$	0.345	0.204	0.267

$$\tilde{W}_2 = \begin{bmatrix} 1.000 & 1.000 & 1.000 & 0.833 & 0.875 & 0.900 & 1.000 & 1.000 & 1.000 & 0.655 & 0.706 & 0.733 \\ 0.115 & 0.087 & 0.072 & 1.000 & 1.000 & 1.000 & 0.000 & 0.000 & 0.000 & 0.345 & 0.204 & 0.267 \\ 0.480 & 0.609 & 0.626 & 0.000 & 0.000 & 0.000 & 1.000 & 1.000 & 1.000 & 0000 & 0000 & 0000 \\ 0.405 & 0.304 & 0.301 & 0.167 & 0.125 & 0.1000 & 0000 & 0000 & 0000 & 1.000 & 1.000 & 1.000 \end{bmatrix}$$

Step Four: At this point the interdependence Fuzzy priorities of SWOT factors are calculated as Follow:

The first Fuzzy priority of the strengths, weaknesses second Fuzzy priority, third priority is the fourth priority threats and opportunities.

$$\tilde{\mathbf{W}}_{\mathbf{factors}} = \tilde{\mathbf{W}}_{\mathbf{2}}\mathbf{x}\tilde{\mathbf{W}}_{\mathbf{1}} = \begin{bmatrix} 0.374 & 0.427 & 0.433 \\ 0.159 & 0.165 & 0.162 \\ 0.208 & 0.225 & 0.227 \\ 0.259 & 0.183 & 0.179 \end{bmatrix}$$

Step Five: In this step, local Fuzzy priorities of the SWOT sub-factors are calculated using the pair-wise comparison matrix.

$$\tilde{W}_{sub-factors(strengths)} = \begin{bmatrix} 0.374 & 0.476 & 0.456 \\ 0.182 & 0.327 & 0.212 \\ 0.138 & 0.174 & 0.118 \\ 0.148 & 0.113 & 0.102 \\ 0.158 & 0.111 & 0.112 \end{bmatrix}$$

$$\tilde{W}_{sub-factors(weakness)} = \begin{bmatrix} 0.123 & 0.095 & 0.091 \\ 0.419 & 0.492 & 0.501 \\ 0.162 & 0.142 & 0.138 \\ 0.296 & 0.270 & 0.270 \end{bmatrix}$$

$$\tilde{W}_{sub-factors(Theats)} = \begin{bmatrix} 0.306 & 0.366 & 0.380 \\ 0.165 & 0.129 & 0.124 \\ 0.145 & 0.093 & 0.090 \\ 0.182 & 0.208 & 0.205 \\ 0.202 & 0.204 & 0.201 \end{bmatrix}$$

Sixth step: In this step, the overall Fuzzy priorities of the SWOT sub-factors are calculated by multiplying the interdependent Fuzzy priorities of SWOT factors found in Step four with the Fuzzy local priorities of SWOT sub-factors obtained in Step five. The vector $\tilde{\mathbf{W}}_{\mathbf{sub-factors(Global)}}$ obtained by using the overall priority values of the subfactors in the last column of table 9.

Table 9. Overall Fuzzy priorities of the SWOT sub-factors

SWOT Factors	Factors weight	Sub-factors SWOT	Sub factors weight	Main weight
Strength	(0.374,0.427,0.433)	S1	(0.374,0.476,0.456)	(0.146,0.192,0.203)
		S2	(0.182,0.327,0.212)	(0.062,0.097,0.086)
		S3	(0.138,0.174,0.118)	(0.045,0.073,0.051)
		S4	(0.148,0.113,0.102)	(0.055,0.048,0.047)
		S5	(0.158,0.111,0.112)	(0.065,0.047,0.048)
Weaknesses	(0.159,0.165,0.162)	S6	(0.123,0.095,0.091)	(0.018,0.012,0.011)
		S7	(0.419,0.492,0.501)	(0.051,0.065,0.065)
		S8	(0.162,0.142,0.138)	(0.024,0.019,0.017)
		S9	(0.296,0.270,0.270)	(0.030,0.028,0.027)
Opportunities	(0.208,0.225,0.227)	S10	(0.306,0.358,0.263)	(0.064,0.081,0.085)
		S11	(0.145,0.132,0.223)	(0.012,0.037,0.017)
		S12	(0.165,0.112,0.117)	(0.052,0.017,0.037)
		S13	(0.172,0.179,0.196)	(0.030,0.035,0.055)
		S14	(0.212,0.219,0.196)	(0.050,0.055,0.035)
Threats	(0.259,0.183,0.179)	S15	(0.306,0.366,0.380)	(0.079,0.067,0.068)
		S16	(0.165,0.129,0.124)	(0.040,0.024,0.022)
		S17	(0.145,0.093,0.090)	(0.040,0.017,0.016)
		S18	(0.182,0.208,0.205)	(0.048,0.039,0.037)
		S19	(0.202,0.204,0.201)	(0.052,0.037,0.035)

Step seven: At this stage of my strategy, the degree of importance according to the SWOT factors are calculated for each of them. Using expert choice software, special vectors and matrices by the analysis of this matrix is calculated $\widetilde{W}_4 = (W_4^{bottom}, W_4^{medium}, W_4^{top})$.

Step Eight: At this stage of my strategy, the overall priorities of the alternative strategies, reflecting the interrelationships within the SWOT factors calculate:

$$\tilde{\mathbf{W}}_{\mathbf{alternatives}} = \tilde{\mathbf{W}}_{\mathbf{4}}\mathbf{x}\tilde{\mathbf{W}}_{\mathbf{sub-factors(global)}}$$

$$= \begin{bmatrix} SO \\ WO \\ ST \\ WT \end{bmatrix} = \begin{bmatrix} 0.180 & 0.206 & 0.211 \\ 0.172 & 0.184 & 0.186 \\ 0.085 & 0.061 & 0.057 \\ 0.120 & 0.104 & 0.101 \end{bmatrix}$$

Normalizing :

$$W_{alternatives} = \begin{bmatrix} SO \\ WO \\ ST \\ WT \end{bmatrix} = \begin{bmatrix} 0.428 \\ 0.187 \\ 0.217 \\ 0.167 \end{bmatrix}$$

Table 10. The result of special vectors and matrices by the analysis of this matrix is calculated

$$\tilde{W}_4 = (W_4^{bottom}, W_4^{medium}, W_4^{top})$$

6. COMPARING THE FUZZY-AHP AND FUZZY-ANP RESULTS

The process of network analysis and prioritization of strategies through which we saw. The same example with the Fuzzy Analytical Hierarchy Process (Fuzzy-AHP) solution to answer the final question is as follows:

$$W_{alternatives} = \begin{bmatrix} SO \\ WO \\ ST \\ WT \end{bmatrix} = \begin{bmatrix} 0.426 \\ 0.170 \\ 0.245 \\ 0.159 \end{bmatrix}$$

Table 11. Weight And Ranking Of Strategies

	SO	WO	ST	WT
Weights in Fuzzy-ANP	0.428	0.187	0.217	0.167
Ranking in Fuzzy-ANP	1	3	2	4
Weights in Fuzzy-AHP	0.426	0.170	0.245	0.159
Ranking in Fuzzy-AHP	1	3	2	4

In Fuzzy-AHP methodology, SO strategy was found to be the best alternative, the overall priority value of 0.426. Priority ordering of alternative strategies is SO-ST-WO-WT. The results obtained from Fuzzy-AHP and Fuzzy-ANP methodology is comparatively listed in Table 11. This result was almost in line with the objectives of the university IUH given from the beginning. Raising the income base for faculty and improve the level them so that they feel secure teaching, working, studying.

7. CONCLUSTION

The overall goal is how to make the teaching staff keep their mind in working, researching with the supports of the administrators even when the teachers study to improve the knowledge. Fuzzy-ANP technique used in this work is to measure the dependence among the elements by converting all the elements of SWOT analysis and alternative strategies. Good results in the application of the SWOT solutions combined with Fuzzy-ANP in IUH are that the teachers get the better quality education and benefits, and the school attracts highly qualified professors.

The comparative results of the SWOT Fuzzy-ANP methodology showed that such an enhanced version of combining SWOT Fuzzy ANP method is capable of providing enriched insights for strategic management in University IUH as well as improved effectiveness for other related decision making processes. Our future research directions include applying this methodology to a variety of application areas (business settings that range from traditional manufacturing to service as well as E-commerce) to measure its effectiveness and usability. As per the results obtained from these application cases, we may to improve and generalize on this overall methodology.

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