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Analyzing Business Leadership Skills Under Uncertain Environment Using Fuzzy AHP Approach.

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Abstract: Over the years, leaders affect followers' success and inspiration. Up to this point, research has concentrated on leader characteristics, attitudes, or followers' self-concepts and the related consequences. Dynamic leadership attracts attention because it leads to promoting future business leadership. This study aims to analyze the influencing factors of business leadership. This study proposes the Fuzzy Analytical Hierarchy Process Method (FAHP) to achieve a systematic weighting of critical factors affecting business leadership to overcome human expectations' vagueness. Group of critical criteria basing on experts' opinions are identified: Creative Thinking (A), Cause-Effect Analysis (B), Forecasting (C), Planning (D), Visioning (E), Problem Defining (F), Idea Evaluation (G), Wisdom (H), and Constraint Analysis (I). The results revealed that Visioning (E) is the most critical skill at a weight of 0.138, Forecasting (C) is the second position and Creative Thinking (A) is placed third with the weight of 0.126. The remaining skills' rankings are Cause-Effect Analysis (B) > Planning (D)> Idea Evaluation (G) >Wisdom (H) Constraint Analysis (I)> Problem Defining(F), respectively**.** The implications of findings bearing on leader thinking skills for leader assessment and leader development are considered. Finally, sensitivity analysis is conducted to verify the robustness of the results.

Keywords: MCDM, Fuzzy AHP, Leadership, Leadership Skills.

INTRODUCTION

People's performance in leadership roles, roles calling for the effective exercise of interpersonal influence, is an exceptionally complex phenomenon (Mumford et al., 2017). As a result, leadership performance can be understood using a number of different meta-models. As studied by (Day et al., 2014), the development of influential leaders and leadership behaviour is a prominent concern in organizations of all types. Indeed, it appears that the study of charismatic leadership itself has taken on a larger-than-life and mysterious character in the organizational sciences. It is not easy to downplay the real or perceived importance of leadership in influencing important individual- and firm-level outcomes (Banks et al., 2017). This statement is particularly true when considering the almost romantic perceptions of charismatic leaders as "larger than life" characters with a "mysterious gift."

Regarding the study of (Reh et al., 2017), charismatic leaders have consistently been shown to affect followers' performance, motivation, and satisfaction. So far, research mainly focused on leader traits, leader behaviours, leader follower-relationship, and the subsequent consequences of each on followers' self-concepts. These approaches share the notion that leader charisma depends on direct interaction between leader and follower.

To be an effective and charismatic leader in today's competitive business environment, people need various characteristics such as intelligence, knowledge, and critical skills for working and performing complex tasks. Multi-criteria decision-making (MCDM) methods, referring to screening, prioritizing, ranking a set of criteria and alternatives, in which various variables cannot easily be translated into observable units and are usually under independent or conflicting attributes (Nguyen et al., 2020; Nguyen et al., 2020; Nguyen et al., 2020; Nguyen et al., 2020; Nguyen, 2021; Tsai et al., 2021). Because of lacking comprehensive research to determine a successful business leader's critical skills, by discussing literature and interviewing experts, this study aims to propose a Fuzzy Analytical Hierarchy Process (FAHP) to investigate the business leadership skills under uncertain environment from Vietnam.

This study is organized as follows: Section 2 is briefly presented the methodology of FAHP. The case analysis illustrated in Section 3. In section 4, conclusions are presented.

METHODOLOGY

The fuzzy set theory has been developed to deal with the concept of partial truth values ranging from absolutely right to absolutely false. Fuzzy set theory has become the primary tool for handling imprecision or vagueness, aiming at tractability, robustness, and low-cost solutions for real-world problems. According to Zadeh (1975), it

is complicated for conventional quantification to reasonably express complex situations, and it is necessary to use linguistic variables whose values are words or sentences in a natural or artificial language.
The FAHP approach performs AHP (Saaty, 1988) in a fuzzy environment to address uncertain, imprecise experts' judgments through linguistic variables or fuzzy numbers. There are several FAHP methods proposed by various authors (Buckley, 1985; Chang, 1996; Mikhailov, 2004). The earliest work on FAHP was by Van Laarhoven and Pedrycz (1983), which compared fuzzy ratios described by fuzzy triangular numbers. In the method, fuzzy weights are derived from fuzzy comparison matrices via a fuzzy logarithmic least squares method. Buckley (1985) determined fuzzy weights of comparison ratios with trapezoidal fuzzy numbers using the geometric mean method. Chang (1996) proposed an extent analysis method for FAHP, using fuzzy triangular numbers for pairwise comparison matrices to derive crisp weights. After that, Mikhailov (2004) suggested a fuzzy prioritization method to obtain crisp weights from fuzzy comparison matrices via nonlinear optimization. The weights of the criteria proposed in this study were determined using the fuzzy AHP technique. This study is applied to the FAHP methods proposed by Chang (1996).
The steps applied until the criteria weights were determined in the method are given below:
Step 1: a hierarchy was developed to turn a complicated problem into a raw form.
Step 2: the relative importance of each criterion was determined from expert views, and a comparison matrix was constructed based on the membership function of linguistic scale and Fuzzy number **(Table 1).** The resulting pairwise comparison matrix is defined in equation (1).

Table 1: Proposed Membership Function of Linguistic Scale

Fuzzy Number	Linguistic	Scale of Fuzzy Number
9	Perfect	(8,9,10)
8	Absolute	(7,8,9_
7	Very Good	(6,7,8)
6	Fairly Good	(5,6,7)
5	Good	(4,5,6)
4	Preferable	(3,4,5)
3	Not Bad	(2,3,4)
2	Weak Advantage	(1,2,3)
1	Equal	(1,1,1)

$$Z = \begin{bmatrix} (1,1,1) & l_{21}m_{21}u_{21} & \cdots & l_{1n}m_{1n}u_{1n} \\ l_{21}m_{21}u_{21} & (1,1,1) & \cdots & l_{2n}m_{2n}u_{2n} \\ \vdots & \vdots & & \vdots \\ l_{n1}m_{n1}u_{n1} & l_{n2}m_{n2}u_{n2} & & (1,1,1) \end{bmatrix} \quad (1)$$

All elements of the matrix Z (l_{ij}, m_{ij}, u_{ij}) indicate the important values of the criteria. The importance of analyzing the ith data for the m target was found according to the following symbols. All of (j: 1,2, …, m) M_{gi}^{j} were fuzzy triangular numbers. Moreover, $X = (x_1\ x_2, \dots, x_n)$ was the decision set, and $T = (t_1, t_2, \dots t_n)$ was the target of matrix.

$$M_{gi}^{1}, M_{g2}^{2}, \dots, M_{g3}^{m}, i = 1,2, \dots, n \qquad (2)$$

Step 3: the fuzzy values in each criterion's whole target set were summed separately, and the $\sum_{i=1}^{m} M_{gi}^{i}$value was obtained.

$$\sum_{i=1}^{m} M_{gi}^{j} = \left(\sum_{j=1}^{m} l_j, \sum_{j=1}^{m} m_j, \sum_{j=1}^{m} u_j \right) \qquad (3)$$

Step 4: each fuzzy value in the decision set was summed, and $\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^{j}$ was obtained. The inverse vector of $\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^{j}$ was then calculated.

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

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

Step 5: Synthetic extent value (S_i) for each criterion was calculated by equation (6).

$$S_i = \sum_{j=1}^{m} M_{gi}^{j} * \left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1} \quad (6)$$

Step 6: Degree of possibility of $M_1(l_1, m_1, u_1) \geq M_2(l_2, m_2, u_2)$ was given in equation (7).

$$V(M_1 \geq M_2) = \sup_{x \geq y}[\min(\mu_{M_1}(x), \mu_{M_2}(y)] \quad (7)$$

Equation (8) was used to calculate the ordinate of the highest intersection point.

$$V(M_2 \geq M_1 = hgt(M_2 \cap M_1) = \left\{ \begin{matrix} 1 \\ 0 \\ \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} \end{matrix} \right\} \text{ if } m_2 \geq m_1, \quad \text{if } l_1 \geq u_2 \text{ otherwise} \quad (8)$$

Step 7: the degree possibility of a fuzzy convex point being greater than z convex fuzzy points $M_i (i = 1,2, \ldots, z)$ can be shown by equation (9).

$$V(M \geq M_1, M_2, \ldots, M_z) = V[(M \geq M_1); (M \geq M_2); \ldots; (M \geq M_z)] = \min V(M \geq M_\rho),\ p = 1,2, \ldots, z \quad (9)$$

Assuming that $z \neq \rho$ and z = 1,2, …, and n conditions are fulfilled, equation (10) applies.

$$d'(A_\rho) = \min V(S_\rho \geq S_z) \quad (10)$$

If $A_\rho (\rho = 1,2, \ldots, n)$ are n elements, then equation (11) applies

$$W = (d'(A_1), d'(A_2), \ldots, d'(A_n))^T \quad (11)$$

Step 8: normalized weight vectors were obtained.

$$W = (d(A_1), d(A_2), \ldots, d(A_n))^T \quad (12)$$

Geometric mean operations are commonly used within the application of the AHP for aggregating group decisions (Davies, 1994). The analytical step (II) mentioned above refers to the aggregation of the group evaluations. Fuzzy pairwise comparisons can be combined using the following algorithm (Chang & Wang, 2009) (equation 13). Where $(l_{ijk}, m_{ijk}, u_{ijk})$ is the fuzzy evaluation of sample members k (k= 1,2, …, K). However, min and max operations are not appropriate if the sample has a wide range of upper and lower bandwidths; in other words, if evaluations are inhomogeneous. We have to consider that if only one or a few decision-makers deliver extreme l_{ijk} and u_{ijk} the whole span of fuzzy numbers (l_{ij}, m_{ij}, u_{ij}) gets huge. Due to the required number of multiplication and addition operations, the aggregated fuzzy weights can even exceed the 0-1 borders or become irrational (Mikhailov, 2003), which is, of course, unsatisfactory. Therefore, we decided to use the geometric mean also for l_{ij} and u_{ij} Which delivers satisfying fuzzy group weightings (Equation 14):

$$l_{ij} = \min(l_{ijk}), m_{ij} = \left(\prod_{k=1}^{K} m_{ijk}\right)^{1/K}, u_{ij} = \max(u_{ijk}) \quad (13)$$

$$l_{ij} = \left(\prod_{k=1}^{K} l_{ijk}\right)^{1/K}, m_{ij} = \left(\prod_{k=1}^{K} m_{ijk}\right)^{1/K}, u_{ij} = \left(\prod_{k=1}^{K} u_{ijk}\right)^{1/K} \quad (14)$$

Empirical Case
Proposed Critical Skills

Table 2: Proposed Skills

Skills	Explanation	Previous studies
Creative Thinking (A)	Creative thinking is the ability of one or more people to think, create, find out new options or topics about a certain research field.	(Nixon, Harrington and Parker, 2012)
Cause-Effect Analysis (B)	Skills to analyze the causes (rationale, reasoning and background reasons) along with the effects (consequences, effects, and outcome) for a particular event, happening, condition, or behaviour	(Wang et al., 2011)
Forecasting (C)	Forecasting uses information and data available in the past and present to make predictions about possible future trends. This is especially important in businesses doing business to effectively allocate human, financial resources or plan for the upcoming period.	(Xie et al., 2018)(Mumford et al., 2007, 2017)
Planning (D)	Planning in business is essential to success. When a company has a planning process and a plan to follow, leaders are better equipped to prepare for the future. A business plan creates a focus for the company, uniting employees toward common goals.	(Xie et al., 2018)
Visioning (E)	Vision is a prediction or imagination about an organization's future, clearly communicated and convincing is the orientation attached to all activities of the organization.	(Xie et al., 2018)
Problem Defining (F)	Defining a problem is a deceptively simple task – what at first seems to be the problem is often merely a symptom of a deeper problem.	(Mumford et al., 2007, 2017)
Idea Evaluation (G)	Evaluating new ideas is one of the most challenging parts of the job for any manager or executive. New ideas always have a lot of uncertainty involved and little data to back them up. evaluating ideas is also an essential factor in both successful idea management and innovation management	(Mumford et al., 2007, 2017)
Wisdom (H)	It is known as the ability to perceive, understand, interpret, think and process information, knowledge by generalization, inductive, discovering on the basis of deduced or summarized theorems and laws.	(Mumford et al., 2007, 2017)
Constraint Analysis (I)	**T**he constraint analysis process reasons about constraints at design time to help the designer understand the effects of constraints on object manipulation, identifying possible constraint violations as well as design alternatives for handling violations	(Mumford et al., 2007, 2017)

RESULTS AND DISCUSSIONS

Based on the weighting results of each proposed critical skills from Table 3 and **Figure 1**, the results showed that the critical skills' rankings are Visioning (E) > Forecasting (C) > Creative Thinking (A)>Cause-Effect Analysis (B) > Planning (D)> Constraint Analysis (I)> Wisdom (H), Idea Evaluation (G) > Problem Defining (F) respectively.

Visioning is the outcome of leader cognition that has the most direct impact on followers. Accordingly, it is not surprising to find that visioning skill is a mighty influence on leader performance. Visioning, however, requires framing problem solutions with respect to others and their needs.

Pant and Starbuck (1990) found that people are not good at making point forecasts – forecasts of specific outcomes. In contrast, Dailey and Mumford (2006) asked undergraduates to forecast the outcomes and resource requirements of project plans when serving as a proposal review committee.

Table 3: Fuzzy Weighting Results and Ranking

Fuzzy Geometric Mean			Fuzzy Weights			Bnp	Normalization	Weight	Ranking
0.8408	1.1531	1.5500	0.0685	0.1257	0.2271	0.140	0.1256	**0.126**	3
0.7798	1.0619	1.4244	0.0635	0.1158	0.2087	0.129	0.1156	**0.116**	4
0.9358	1.2809	1.6927	0.0762	0.1396	0.2480	0.155	0.1382	**0.138**	2
0.7756	1.0500	1.4134	0.0632	0.1145	0.2071	0.128	0.1147	**0.115**	5
0.9507	1.2730	1.6959	0.0774	0.1388	0.2485	0.155	0.1385	**0.138**	1
0.5355	0.7003	0.9613	0.0436	0.0763	0.1409	0.087	0.0777	**0.078**	9
0.5709	0.7551	1.0431	0.0465	0.0823	0.1528	0.094	0.0839	**0.084**	8
0.7046	0.9349	1.2412	0.0574	0.1019	0.1819	0.114	0.1017	**0.102**	7
0.7312	0.9650	1.2590	0.0595	0.1052	0.1845	0.116	0.1041	**0.104**	6

Creative thinking skills (A) are critical to leader performance throughout their careers. These findings broach the question as to whether creative thinking skills can be developed. A recent study by (Zaccaro et al., 2015) found that creative thinking skills predict leader performance, but that skill assessment should be within the performance domain. Another supporting analysis by (Scott et al., 2005) also indicated that educational programs are formulated to develop creative thinking skills.

Another prominent managerial skill would tend to be an interpretation of causes, priorities, and cause-goal linkages. Strange and Mumford (2005) offered some early support, emphasizing the importance of analyzing causes and goals.

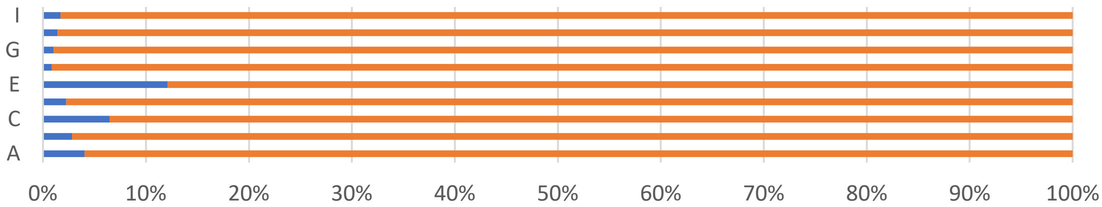
For a long time, planning has been overlooked as a critical factor in a leader's success. Hemlin (2009)found that research and development leaders were doubtful to delegate planning tasks, which corroborated this finding. However, planning inevitably requires mental simulations of potential actions. And this mental simulation of potential behaviour may be a key factor in determining a leader's success.

In fact, the significance of constraints may, in fact, explain why they are attended to in problem definition. However, constraints are not permanently fixed (Mumford et al., 2012). As a result, analysis of constraints, and their malleability, maybe a critical skill contributing to leader problem-solving.

Appraisal of the workability of ideas in context, in turn, suggests that wisdom may be a crucial skill needed by leaders. In fact, McKenna et al. (2009) have argued wise leaders use the experience to consider non-rational, subjective aspects of decisions using their wisdom to produce more practical and workable solutions appropriate for both followers and the organization.

Idea evaluation is another skill leaders must possess. In keeping with this observation, Watts et al.(2017) have argued that leader performance is often contingent on applying viable idea evaluation skills.

Somewhat more direct evidence bearing on the importance of active information gathering in problem definition and problem-solving has also been provided in a study by (Mumford et al., 1996). Leader performance in problem-solving improves when leaders actively search for information in the firm's external and internal environment, focusing in this search on crucial facts and incongruent, or inconsistent, information with respect to these facts. These information-gathering activities then provide a basis for problem definition where leaders define problems based on the approach to be taken and the key restrictions to be imposed – with leaders discounting goals in problem definition.



	A	B	C	D	E	F	G	H	I
W	0.126	0.116	0.138	0.115	0.138	0.078	0.084	0.102	0.104
Rank	3	4	2	5	1	9	8	7	6

W Rank

Fig.1: Weighting and Ranking Results

CONCLUSIONS

The main purpose of this study is to investigate the skills affecting business leaders in the fast- challenging business environment. The FAHP is employed to quantify the experts' opinions and determine and rank each proposed critical skills/ criteria' weighting. The findings showed that the critical skills' rankings are **Visioning** (E) > Forecasting (C) > Creative Thinking (A)>Cause-Effect Analysis (B) > Planning (D)> Constraint Analysis (I)> Wisdom (H), Idea Evaluation (G) > Problem Defining (F) respectively.

To begin, this study examined how essential abilities, intelligence influence the acquisition of the skills and the kind of experiences likely to promote the development of these skills. In addition, we comprehensively seek to identify other skills leaders might need, for example, attentional capacity and causal relationships among these skills.

Along somewhat different lines, this sudy evaluated how these skills influence leadership. Clearly, more research is needed on the skills leaders need to solve complex problems, inherently social problems. The value of understanding leader cognitive skills for both the assessment and development of leadership potential pointed to a broader conclusion of understanding leadership. Furthermore, this study as the present effort serves as an impetus for a new wave of research on the problem examining how leaders use knowledge to define problems, analyze causes/effect, analyze constraints, plan, forecast, think critically, evaluate ideas, pursue wise courses of action, and help followers make sense of problems through their vision.

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