

Fuzzy MCDM Application for Strategy Evaluation

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Abstract—The essence of strategy formulation is coping with competition. Therefore, the nature and degree of competition in an industry hinge on four basic forces: Production, Technology, Marketing and R&D are defined. To establish a strategic agenda for dealing with these contending currents and to grow despite them, a company must understand how they work in its industry and how they affect the company in its particular situation. This study adopt Fuzzy MCDM methods and details how these forces operate and suggests ways of adjusting to them, and, where possible of evaluation, of taking advantage of them. Knowledge of these underlying sources of competitive pressure provides the groundwork for a strategic agenda of action. The result highlights the critical strategies distance of the company, animate the positioning of the company in its industry, clarify the areas where strategic changes may yield the greatest payoff, and highlight the places where industry trends promise to hold the greatest significance as either opportunities or threats.

Keywords—fuzzy multiple criteria decision making (FMCDM); fuzzy analytic network process (FANP); DEMATEL; strategy evaluation

I. INTRODUCTION

Every industry has an underlying structure, or a set of fundamental economic and technical characteristics, that gives rise to these competitive forces. Decision maker, wanting to position his company to cope best with its industry environment or to influence that environment in the company's favor, must learn what makes the environment tick. The essence of strategy formulation is coping with competition. Yet it is easy to view competition too narrowly and too pessimistically. Awareness of these forces can help a company stake out a position in its industry that is less vulnerable to attack.

The nature and degree of competition in an industry hinge on four forces: Production, Technology, Marketing and R&D [1]. To establish a strategic agenda for dealing with these contending currents and to grow despite them, a company must understand how they work in its industry and how they affect the company in its particular situation. This study details how these forces operate and suggests ways of adjusting to them, and, where possible, of taking advantage of them. Knowledge of these underlying sources of competitive pressure provides the groundwork for a strategic agenda of action [2]. They highlight the critical strengths and weaknesses

of the company, animate the positioning of the company in its industry, clarify the areas where strategic changes may yield the greatest payoff, and highlight the places where industry trends promise to hold the greatest significance as either opportunities or threats. Understanding these sources also proves to be of help in considering areas for diversification.

The remainder of this paper is organized as follows. In Section 2, about strategy forces for business development is reviewed and the framework of dynamic strategy forces for efficiency business is built. In Section 3, the methodology of fuzzy hybrid MCDM model based on dynamic strategy is proposed for applying strategy forces. An empirical case and result are illustrated in Section 4. Discussions and implications are presented in Section 5. Finally conclusion is offered in Section 6.

II. ABOUT STRATEGY FORCES TO EVALUATION

The essence of strategy formulation is coping with competition. For a company in the fight for market share, competition is not manifested only in the other players. Rather, a competitive strategy in an industry is rooted in its underlying economics, and competitive forces exist not only from internal considerations but also that go well beyond the established combatants in the high-tech industry. The forces sources may gestate from customers, suppliers, potential entrants, and substitute products which are all competitors that may be more or less prominent or active depending on a particular industry.

The nature and degree of competition in the companies within the high-tech industry hinge on strategy forces [1][3], such as Production Capability (PC), Technology Competence (TC), R&D (RD), Marketing & Service (MS).

- Production Capability (PC)
- Technology Competence (TC)
- R&D (RD)
- Marketing & Service (MS)

Strategy-Forces based on answers to four generic questions about the strategy to be pursued by the organization which also assume the financial support and organizational deployment is available for high-tech competition game. Therefore, as Figure 1 these four questions, one about production, one about marketing, one about Technology, and one about R&D evolved quickly into a standard set of

"perspectives". The weaker the forces is to be collectively, however, the greater the opportunity can be for superior performance. Whatever their collective strength, the corporate strategist's goal is to find a position between company and industry where can best defend itself against these forces or can influence them in its favor [4].

Understanding these sources also proves to be of help in considering areas for diversification. A strategy map is a diagram that is used to document the primary strategic goals being pursued by an organization or management team and to help managers focus their attention more closely on the interventions necessary to ensure the strategy is effectively and efficiently executed. By providing managers with the direct feedback on whether the required actions are being carried out, and whether they are working. A performance management system is deciding what activities and outcomes to monitor. By providing a simple visual representation of the strategic objectives to be focused on, along with additional visual cues in the form of the perspectives and causal arrows, the strategy map has been found useful in enabling discussion within a management team about what objectives to choose, and subsequently to support discussion of the actual performance achieved.

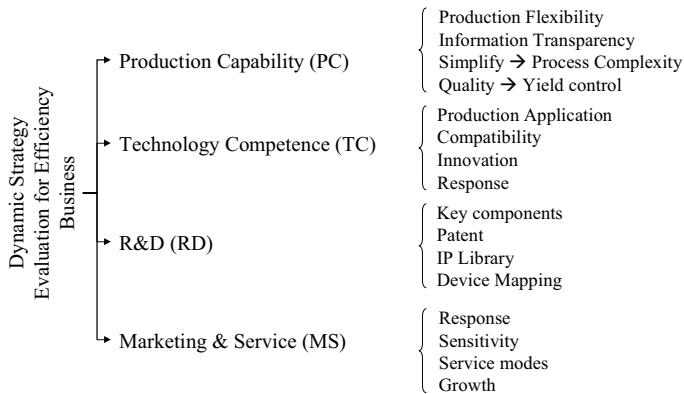


Figure 1. The Hierarchy Structure

III. MEASURING THE FORCES

This section is based on what factors the past scholars in the study of strategy forces considerations indicated and to further discuss the result of the study; hence, identify the flow of facts. This study uses the four main factors indicated by four-factor model as PC, TC, RD and MS factors to implement the strategies can be evaluated in dynamical considerations in time; identify the sub-factors that would affect the main factors, thus firmly develop evaluating criteria and its dynamic track of mapping.

A. Methodologies

The field of fuzzy multiple criteria decision making (FMCDM) concerns the problems that how decision makers should ideally do when facing multiple conflicting criteria.

Group decision-making solve problems through a group of experts form their specific knowledge domain and help on business strategies decision-making [5][6]. There are considerable methods and models have been proposed for various FMCDM problems (as Figure 2) with respect to different perspectives and theories.

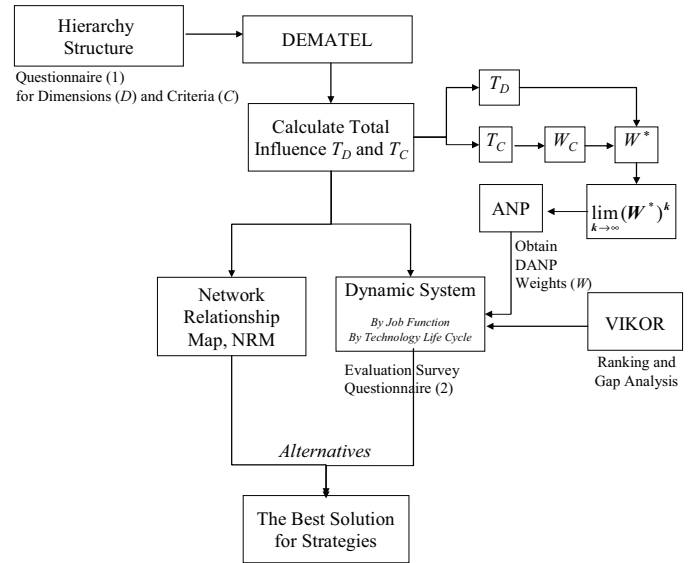


Figure 2. Framework of Hybrid Methodologies Application

B. Fuzzy Theory with AHP and ANP

Because of the subjective of the attributes used in the evaluation, AHP [7][8][9][10][11][12] is the most appropriate method for this problem. However, since the experts prefer natural language expressions rather than sharp numerical values in their assessments, the classical AHP may not yield with a satisfactory result. Expressions such as “not very clear”, “probably so”, and “very likely”, are used often in daily life, and more or less represent some degree of uncertainty of human thought. The fuzzy set theory proposed by Zadeh [13], an important concept applied in the scientific environment, has been available to other fields as well. Consequently, the fuzzy theory has become a useful tool for automating human activities with uncertainty-based information. This study proposes a fuzzy AHP framework to weigh the talent selection implementation factors. This study model helps organizations identify the differences between the desired and current situations, and then identify the improvement areas and develop the strategies for the talent selection implementation.

In addition, the company can also use the assessment results as a benchmark with competitors and other “best-in-class” organizations. To manage talent selection successfully, its measurement indicators must be defined and prioritized. Because of the subjective of the attributes used in the evaluation, AHP [10][12] is the most appropriate method for this problem. However, since the experts prefer natural language expressions rather than sharp numerical values in their assessments, the classical AHP may not yield with a

satisfactory result. This study proposes a fuzzy AHP framework to weigh the talent selection implementation factors.

C. Fuzzy Decision-making

When people encounter uncertain or vague decision-making problems in the real world, they often express their thinking and subjective perception in words instead of probability and statistics. But the problem with words is that their meanings are often vague. Furthermore, even when people use the same words, individual judgment of events is invariably subjective and may differ. Moreover, even if the meaning of a word is well defined (e.g., the linguistic comparison labels in the standard AHP questionnaire responses), when we use the word to define a set, the boundary that separates whether an object does or does not belong to the set is often fuzzy or vague. This is why fuzzy numbers and fuzzy sets have been introduced to characterize linguistic variables. The preferences in AHP are essentially human judgments based on one's perception (this is especially true for intangibles), and we believe the fuzzy approach allows for a more accurate description of the decision making process.

FANP approach has been presented to prioritize strategy implementation factors for a manufacturing business to implement one of its most critical parts used in management decision process and under multiple criteria's decision-making in the fuzzy environment [11][14]. The main criteria and attributes have been decided which are based on the current business scenario and experience of the experts in the respective fields. The large number of criteria and attributes demonstrated the complexities being involved in the strategy implementation factors. Each factor affecting [15] as strategy forces and implementation has been analyzed and discussed. This paper has made a significant contribution to identify the important criteria and paves the way to consider these practically relevant and interesting issues of strategy forces factors in the fuzzy environment.

We emphasize that the contribution of this study which build up and apply the theoretical model of strategy implementation priority. This study takes a step in the direction of setting priorities of clarifying, guiding and integrating terms and concepts relevant to strategy implementation and management aspects in the firm process.

D. Mapping tools

A network connects the components of a decision system. According to size, there will be a system that is made up of subsystems, with each subsystem made up of components, and each component made up of elements. The elements in each component interact or have an influence on some or all of the elements of another component with respect to a property governing the interactions of the entire system.

DEMATEL

The DEMATEL method is based upon graph theory, enabling us to plan and solve problems visually, so that we

may divide multiple criteria into a relationship of cause and effect group, in order to better understand causal relationships. Directed graphs (also called digraphs) are more useful than directionless graphs, because digraphs will demonstrate the directed relationships of sub-systems. A digraph typically represents a communication network, or a domination relationship between individuals, etc. The DEMATEL method can convert the relationship between the causes and effects of criteria into an intelligible structural model of the system [16][17].

A component of a decision network which was derived by the DEMATEL method is denoted by $C_h, h=1, \dots, m$, and assume that it has n_h elements (determinants), which we denote by $e_{h1}, e_{h2}, \dots, e_{hm}$. The influences of a given set of elements (determinants) in a component on any element in the decision system are represented by a ratio scale priority vector derived from paired comparisons of the comparative importance of one criterion and another criterion with respect to the interests or preferences of the decision makers. This relative importance value can be determined using a scale of 1–9 to represent equal importance to extreme importance.

Dynamical system

A dynamical system (DS) is a concept in mathematics where a fixed rule describes the time dependence of a point in a geometrical space [18]. DS is a manifold M called the phase (or state) space endowed with a family of smooth evolution functions Φ^t that for any element of $t \in T$, the time, map a point of the phase space back into the phase space. The notion of smoothness changes with applications and the type of manifold. There are several choices for the set T . When T is taken to be the reals, the dynamical system is called a *flow*; and if T is restricted to the non-negative reals, then the dynamical system is a *semi-flow*. When T is taken to be the integers, it is a *cascade* or a *map*; and the restriction to the non-negative integers is a *semi-cascade*. DS is a means of describing how one state develops into another state over the course of time [19]. Technically, a DS is a smooth action of the reals or the integers on another object (usually a manifold). When the reals are acting, the system is called a continuous dynamical system, and when the integers are acting, the system is called a discrete dynamical system.

E. VIKOR method

The compromise-ranking method (VIKOR method) determines the compromise solution [20][21][22]; the obtained compromise solution is acceptable to the decision-makers because it provides a maximum group utility of the majority (represented by $\min S$), and a minimum individual maximal regret of the opponent (represented by $\min Q$). The model uses the DEMATEL and ANP procedures to obtain the weights of criteria with dependence and feedback and uses the VIKOR method to obtain the compromise solution.

IV. EMPIRICAL CASE AND RESULTS

The example of High-Tech electronic company is illustrated to show the proposed method. Empirical findings these four factors have the relationship of mutually interactive and self-feedback. Therefore, this study provides set of patterns, and take major player of high-tech company, explained that manufacturer of using the way of business strategies in a dynamic industry nature. The result presents a comprehensive framework for making judgments to move forward about business strategies development is essential. The function is refers to completes this position or duty group of important abilities, therefore the application function examines whether matches is a very good concept.

Empirical case of high-tech company as the example is illustrated to show the proposed method. As for the numerical raw data was collected in fuzzy considerations and turned into the calculation in crisp numbers directly for further evaluation processes. The findings of these four factors have the relationship to mutually interactive and its self-feedback (as Table 1 and Table 2).

TABLE 1 The Distance of Influences by Aspects

Aspect	R	S	R+S	R-S	Rank
A PC	4.239	4.068	8.306	0.171	3
B TC	4.339	3.846	8.184	0.493	2
C RD	3.571	4.908	8.479	-1.337	4
D MS	4.485	3.813	8.298	0.673	1

Table 1 states “Market & Service” will be more important to fit the change of outside environment and close to real requirement and get the real necessity of customer needs. Besides, it shows the “Technology Competence” can be a potential to challenge and to complete rivals in a speedy growth industry nature.

TABLE 2 The Distance of Influences by Criteria

Criteria	R	S	R+S	R-S	Rank
a1 Production Flexibility	5.556	4.518	10.074	1.038	1
a2 Information Transparency	4.811	5.663	10.474	-0.852	14
a3 Simplify operation -- Process Complexity	4.499	6.029	10.528	-1.53	16
a4 Quality -- Yield control	5.445	4.584	10.029	0.861	3
b1 Production Application	4.676	5.469	10.145	-0.793	13
b2 Compatibility	5.43	4.622	10.052	0.808	5
b3 Innovation	5.429	4.591	10.02	0.838	4
b4 Response	5.553	4.515	10.068	1.038	2
c1 Key components	4.995	5.032	10.027	-0.037	10
c2 Patent	5.104	4.972	10.076	0.132	7
c3 IP Library	4.925	5.054	9.979	-0.129	11
c4 Device Mapping	4.507	5.733	10.24	-1.226	15
d1 Response	4.822	5.24	10.062	-0.418	12
d2 Sensitivity	5.033	4.996	10.029	0.037	8
d3 Service modes	5.08	5.105	10.185	-0.025	9
d4 Growth	5.13	4.872	10.002	0.258	6

As the rank result (Table 2), “a1” and “b4” both locate higher position. Instantly, for pure foundry business, the “Production Flexibility” tasks have been always discussed by high-tech work environment. Due to the sensitivity of market and economic change, the globalized change may lead the change of corporate business strategies to fit the requirement of market (users) needs. Therefore, a continuous and

monitored “Response” is required for deployment of internal resources and providing a well mechanism to feedback to end-users in time.

The essential alternatives are provides for the problems solving. According to Table 3, “R7: Financial support/incentive program” and “R6: Competitiveness Evaluation System” are the most favor and satisfied issues while the performance evaluation to be measured. Not surprising that “R1: Innovation/Intelligent Property” reveals lowest credit which shows the importance of knowledge sharing and accumulation can possibly create a new hope of ideas generator toward a new challenge on the next business strategic move. As for the definition of those alternatives are showing as follows:

- R1. Innovation/Intelligent property: build an innovative environment for continuously technology development achievement.
- R2. Knowledge platform: provide a knowledge platform for knowledge accumulation, problem solving, lesson learned and information sharing.
- R3. Response system: external environmental change to cause Market/Operation strategies to be adjusted.
- R4. Communication system: a wide channel for customer services in viewing the progress of the on-line production and 24-hour on line service.
- R5. Efficiency evaluation system: Internal and external factors to move the operation work in effectively.
- R6. Competitiveness evaluation system: evaluate the way of technology adoption and shorten the time of technology development into production phase.
- R7. Financial support/ incentive program: budget plan and financial support.

This research involves several objects from Taiwan High-Tech manufacturing related leaders, experts from different function which includes top management, senior R&D, the senior administrative personnel and marketing functions. The questionnaire of evaluation mainly was composed of two parts: questions for evaluating the relative importance of criteria and company’s performance corresponding to each criterion.

The performance scores and gap (by VIKOR) are shown in Table 3. Using the performance values, relative results are obtained. We use the global weight in ANP to compare the performances of R1, R2, R3, R4, R5, R6, and R7 as the ANP provides significant feedback. The gap identified related needs-recognition and strategic behavior in sequence.

By integrating and calculating the investigated data, we determine the overall performance to guide the improvement of that $R7 \succ R6 \succ R4 \succ R5 \succ R2 \succ R3 \succ R1$. The overall performance value of R7 (28.613) and R6 (28.406) are close, whereas the range distance with R1 has the largest gap. Thus, R7, R6, R4, R5, R2, R3, and R1 have its sequence on enhancement of their business strategies or redefinition of management stages.

TABLE 3 Performance Evaluation by VIKOR

Criteria \ Alternatives		Local weight	Global weight (ANP)	Aspired Level	R1	R2	R3	R4	R5	R6	R7
A.	Production capability (PC)	0.257			7.267	7.504	8.006	6.996	6.743	7.496	8.251
a1	Production Flexibility	0.251	0.064	10	8	7	9	8	7	8	9
a2	Information Transparency	0.253	0.065	10	9	8	8	5	4	7	8
a3	Simplify à Process Complexity	0.245	0.063	10	5	7	7	7	7	8	8
a4	Quality à Yield control	0.251	0.064	10	7	8	8	8	9	7	8
B.	Technology competence (TC)	0.257			4.765	5.214	5.509	5.692	5.481	5.959	6.226
b1	Production Application	0.239	0.061	10	5	6	6	8	7	9	8
b2	Compatibility	0.255	0.065	10	6	8	8	9	9	8	7
b3	Innovation	0.239	0.061	10	6	8	7	8	7	7	8
b4	Response	0.267	0.069	10	8	7	9	7	8	8	9
C.	R&D (RD)	0.257			5.852	5.756	5.726	8.000	7.364	7.480	7.852
c1	Key components	0.209	0.054	10	4	6	7	8	6	8	6
c2	Patent	0.271	0.069	10	7	6	5	8	9	8	9
c3	IP Library	0.276	0.071	10	6	6	7	8	8	7	8
c4	Device Mapping	0.244	0.063	10	6	5	4	8	6	7	8
D.	Marketing & service (MS)	0.257			7.202	7.735	6.786	6.743	6.980	7.471	6.284
d1	Response	0.265	0.068	10	7	7	8	7	7	6	7
d2	Sensitivity	0.276	0.071	10	6	8	7	6	7	8	6
d3	Service modes	0.239	0.061	10	9	8	5	8	6	8	7
d4	Growth	0.220	0.056	10	7	8	7	6	8	8	5
TOTAL		5.027	1.027	10	25.086	26.210	26.028	27.431	26.568	28.406	28.613
Performance Ranking for Alternative (Priority)					7	5	6	3	4	2	1

V. DISCUSSIONS AND IMPLICATIONS

There are most evidence of improvements in team performance attributed to management development, these typically related to process issues such as innovative activities, cost control, knowledge management, quality of service, better focus on customer needs, and improved customer relations etc. Managers in some organizations cited evidence of more strategic behavior and identified better procedures and monitoring of actions. Technology improvement from Cost reductions, efficiency gains and more effective quality control were also reported. To face external change and to fit the requirement of business opportunities, appropriate dynamical strategies give a challenged team performance arising from strategy.

Major difficulties of measurement of strategy forces and of attributing improvements to strategy in management development were encountered, especially where the same measures were used for function and business performance, or where the performance was regarded as a function of a manager's performance. Equally, business performance was difficult to separate from organizational performance and was affected by extraneous factors.

The alternatives which were ranked highest in terms of organizational performance improvements displayed quantified, written and corroborated evidence and respondents were unequivocal that strategic management development had contributed to all prime measures of business efficiency. The framework appears to be intuitive to managers and applicants who quickly adopt the terminology of the strategy forces. It offers a means of guiding easily recognized environmental components and provides a framework for combining these components to describe possible scenarios. In addition, it clearly distinguishes between the perspectives of different

industry nature and increases the likelihood that decision makers will incorporate these perspectives into their decisions.

The decision-making and influence processes operating in decision events are likely to be advanced through a closer alignment with the problem solving and decision-making in the real world.

VI. CONCLUSION

The conclusions and learning points to be drawn from the research outlined above relate both to the substantive findings, which contribute to the debate on the role of business in improving performance, and the procedural aspects of the methodology developed to undertake the study.

A case-study approach was necessary in order to capture qualitative information, including such 'soft' measures as perceptions of individuals, as well as exploring the relevant development and performance processes within organizations at different functions. In adopting such a methodology, however, there was a risk of marginalizing the findings because policy makers invariably seek 'hard' measures, with quantitative data that can be subject more easily to statistical tests. The challenge, therefore, was to devise a methodology that could permit hard conclusions from soft data.

The strategy force describes the structure of business systems and the industry nature of the influence mechanisms that determine outcomes. The strategy evaluation reliance on business decisions rather than operation activities as the key structural component of the framework provides a flexible and generalizable framework around which existing strategy force research can be arrayed. It also provides a means of aligning technology research with the problem solving and decision-making literatures. More work remains to be done to fully identify and understand influence mechanisms in strategy

evaluation systems. The dynamic strategy evaluation in considering the strategic forces can assist these efforts by offering a simple and easily recognizable structure for organizing research and practice in a complex field where a great deal is yet to be learned.

ACKNOWLEDGEMENT

This study is granted by National Science Council (NSC 099-2811-H-424-001) with 3-year Post Doctoral Research Program.

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