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Fuzzy Expert System for Marketing Decision Model using Development Knowledge-based System

Kayvan Ghaderi [1], Vafa Maihami [2 +]

[1]Department of Computer Engineering, University of Kurdistan, Iran

[2]Department of Computer Engineering, University of Kurdistan, Iran

Abstract. This paper describes fuzzy expert system for marketing decision model using knowledge based system. In this study uses a decision table for representation decision rule to construct a marketing decision model. The marketing decision model is used to determine the entrance time of a new product into market. Presentation of a new product to the market at the best time will provide an advantage to competing companies and will increase their market share.

Keywords: Decision table, Knowledge-base, Fuzzy expert system, Marketing decision model.

1. Introduction

The real-world decision-making is too much complex, uncertain and imprecise to lend itself to precise, prescriptive analysis. It is this realization that underlies the rapidly growing shift from conventional techniques of decision analysis to technologies based on fuzzy logic. It was originally proposed as a means for representing uncertainty and formalizing qualitative concepts that have no precise boundaries. So far, engineering applications of fuzzy logic have gained much more attention than business and finance applications, but an even larger potential exists in the latter fields. Fuzzy logic is an excellent means to combine Artificial Intelligence methods. Expert systems were designed to reason through knowledge to solve problems using methods that humans use. A FES is an expert system that utilizes fuzzy sets and fuzzy logic to overcome some of the problems, which occur when the data provided by the user are vague or incomplete. we illustrate that the fuzzy approach may be useful in industrial economics. In particular a FES is adapted for product life cycle. All products have certain life cycles. Product life cycle is one of the oldest concepts in analyzing and solving business problems [1]. Life cycle refers to the period from the product's first launch into the market until its final withdrawal. Although life cycle varies by product and sector base, usually there are usually four phases in the life cycle period as shown in Fig. 1 [3]. The first period is the entrance phase, the second period is the development phase, the third period is the maturity phase and the fourth period is the satisfaction phase. The entrance phase is the period when a product is introduced to the market and an effort is made for its acceptance. In general, this is the period of catching up at par point. The development phase is the best step; the product has been through the brightest period and reached its maximum profit. In the maturity phase, problems gradually occur and sales start to decrease. Despite this decrease, companies try to keep sales high by using other marketing techniques. Which are called other sales efforts? In that period increases in sales like jumping sales (comb tooth) occur. The satisfaction phase is the period that the companies least prefer to be in because they will start to lose in a while. Management The remaining paper is organized in the following sections. In the section 2 the fuzzy expert system design is briefly described. Section 3 marketing decision model described using fuzzy logic. Section 4 Factors affect on performance of

+ Kayvan Ghaderi. Tel.: + (98-9186572842).
E-mail address: (Kayvan.Ghaderi1987@gmail.com)

product described. Section 5 decision table construct for marketing model. Section 6 results. Section 7 conclusions.

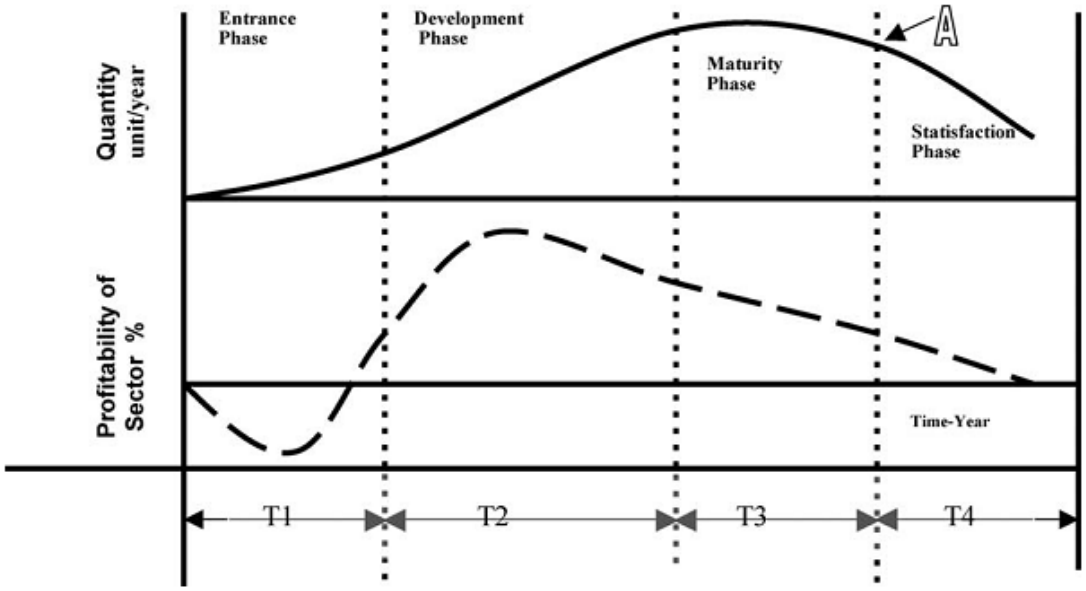


Fig.1 Life cycle period of a new product.

2. Fuzzy expert system design

A FES is an expert system that utilizes fuzzy sets and fuzzy logic to overcome some of the problems, which occur when the data provided by the user are vague or incomplete. The power of fuzzy set theory comes from the ability to describe linguistically a particular phenomenon or process, and then to represent that description with a small number of very flexible rules.

The fuzzy expert system design steps are shown as following:

1. Identification of the problem and choice of the type of fuzzy system, which best suits the problem requirement. A modular system can be designed consisting of several fuzzy modules linked together. A modular approach, if applicable, may greatly simplify the design of the whole system, dramatically reducing its complexity and making it more comprehensible.

2. Definition of input and output variables, their linguistic attributes (fuzzy values) and their membership function (fuzzification of input and output).

3. Definition of the set of heuristic fuzzy rules. (if–then rules).

4. Choice of the fuzzy inference method (selection of aggregation operators for precondition and conclusion).

5. Translation of the fuzzy output in a crisp value (defuzzification methods).

6. Test of the fuzzy system prototype, drawing of the goal function between input and output fuzzy variables, change of membership functions and fuzzy rules if necessary, tuning of the fuzzy system, validation of results.

3. Marketing decision model using fuzzy logic

The idea that marketing decisions can be supported with analytical, mathematical models took off in the sixties of the last century. Before that time, marketing decisions were mainly based on judgment and experience. This does not mean that there was no marketing analysis[4]. Marketing is a Planning and

executing a set of objectives to bring buyers and sellers together so that a sale can take place [4]. Marketing models is a core component of the marketing discipline. The recent developments in marketing models have been incredibly fast with information technology (e.g., the Internet), online marketing (e-commerce) and customer relationship management (CRM) creating radical changes in the way companies interact with their customers [4]. The system structure identifies the fuzzy logic inference flow from the input variables to the output variables. The fuzzification in the input interfaces translates analog inputs into fuzzy values.

4. Factors effect on performance of product

Presentation of a product to the market is caused by the opinion of innovation or requirements [2]. The criteria of existence of a product in the market are listed below:

4.1. Effect of economic changes

Changes in the economic structure affect the introduction of a product to the market and, the withdrawal of a product from the market; therefore, it is a major factor affecting on the performance of product [2].

4.2. Effect of political, social and cultural structure changes

Political, social and cultural changes that occur in society will change market conditions [2].

4.3. Effect of quality

As a common opinion in literature quality and cost are directly proportional. Higher quality in production increases costs. Unqualified production means doing a job more that once and wasting machine hours, labor hours and raw material [2].

4.4. Effect of technological changes

Technology is the knowledge, which is used or can be used for production of goods and services and capability of production and use of that knowledge. Technological capability can be the only or main reason of increase or decrease of major market share between competitors. Technological renewal has brought about new products new techniques of technology treatment new production methods and new organization structures [2].

4.5. Effect of competition

The main principle of competition is to be powerful and to survive. Competition which is done by means of information in our present day is an individual's or group's desire to race for the same purpose and to excel each other. From a company's point of view, competition is the entire activity of the companies trying to provide goods or services to the market directly or indirectly [2].

4.6. Effect of other selling efforts

As mentioned above, in the maturity phase problems arise gradually and sales begin to decrease. Despite this sales decrease, companies try to keep sales high by using other marketing activities, which are called other sales efforts. If other selling efforts show an increase, it can be said that the sale of the manufacture is decreased [2].

5. Fuzzy block and decision table for marketing decision model based on performance of product

5.1. Fuzzy System

The fuzzy inference takes place in rule blocks, which contain the linguistic control rules. The outputs of these rule blocks are linguistic variables. The defuzzification in the output interfaces translates them into analog variables (see Fig. 2).

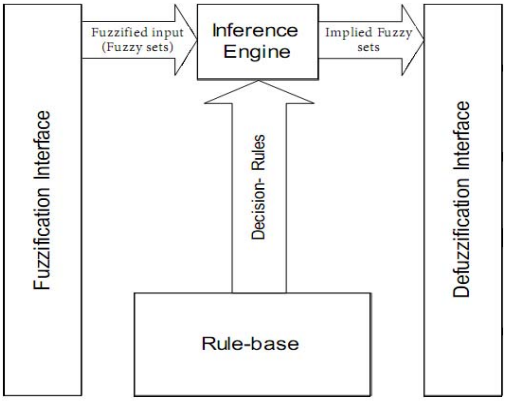


Fig.2. Fuzzy System

5.2. Decision Table

Marketing decision model based on performance constructed in below:

$$Performance\_of\_product \begin{cases} Global\_Market \begin{cases} Economic\_conditions \\ Political\_Circumstances \end{cases} \\ Manufacture \begin{cases} Competition \\ Other\_Selling\_Efforts \\ Proportional\_Increase\_in\_Sells \end{cases} \\ Target\_Market \begin{cases} Manufacture\_Point \\ Renewal \end{cases} \end{cases}$$

The decision table [5] is used as a means of representing a set of decision rules to construct a developed marketing decision model and is used as a technique to model the diagnostic and strategic knowledge involved. Decision table for component of performance of product show in fig.3.

The following Fig.4 shows the whole structure of this fuzzy system including input interfaces, rule blocks and output interfaces. The connecting lines symbolize the data flow. The fuzzification method, "Compute MBF," is the standard fuzzification method used in almost all applications. This method only stores the definition points of the membership functions in the generated code and computes the fuzzification at runtime.

For output variables, different defuzzification methods exist as well. The most often used method is CoM, which delivers the best compromise of the firing rules.

In Fig.3, rule block of the structure of the fuzzy logic system is shown. This block contains the rules of the system describing the control strategy. The rule blocks contain the control strategy of a fuzzy logic system.

GLOBAL MARKET

1. ECONOMIC CONDITIONS	negative	ineffective or positive	
2. POLITICAL CIRCUMSTANCES	-	negative	ineffective or positive
1. GLOBALMARKET = pessimistic	x	x	-
2. GLOBALMARKET = optimistic	-	-	x
	1	2	3

(a)

TARGET MARKET

1. MANUFACTURE POINT	m.p.<c.m.p.	m.p.=c.m.p.		m.p.>c.m.p.	
2. RENEWAL	-	not_ok	ok	not_ok	ok
1. TARGETMARKET = wait	-	-	-	x	-
2. TARGETMARKET = medium	-	x	-	-	x
3. TARGETMARKET = impulsive	x	-	x	-	-
	1	2	3	4	5

(b)

MANUFACTURE

1. COMPETITION	decreased		increased	
2. OTHER SELLING EFFORTS	decreased	increased	-	
3. PROP. INCREASE IN SELLS	-	-	decreased	increased
1. MANUFACTURE = poor	-	x	x	-
2. MANUFACTURE = good	x	-	-	-
3. MANUFACTURE = very good	-	-	-	x
	1	2	3	4

(c)

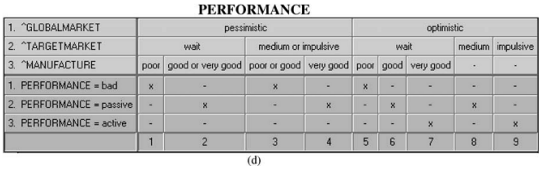


Fig. 3. Decision table representation

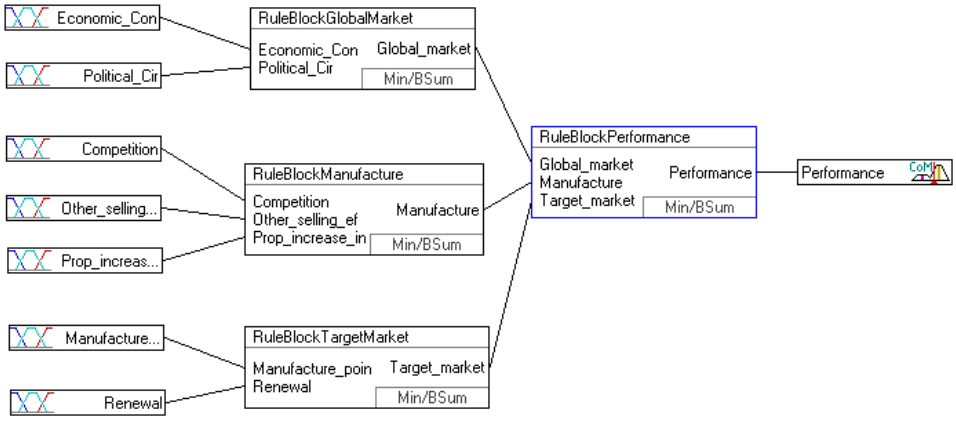


Fig.4. Structure of the fuzzy logic system

Each rule block confines all rules for the same context. A context is defined by the same input and output variables of the rules. The rules' "IF" part describes the situation, for which the rules are designed. The "THEN" part describes the response of the fuzzy system in this situation. The DoS is used to weigh each rule according to its importance. Factors named as global market indicators; overall economic situation and legal and political circumstances prevailing in the market are reviewed. The rules in DT of the Global Market can be summarized in production rules as following (see Table 1).

Factors named as target market indicators; combination of product is reviewed through comparison of performances of the product and its rival. Result of review reveals the probability that performance of the product can be lower or higher than or equal to that of the closest rival product. The condition of "manufacture point" has three condition domain factors: m.p. <c.m.p., m.p. =c.m.p. and m.p.>c.m.p.

Above, "m.p." as manufacture point of our product, "c.m.p." as manufacture point of competitor product. The Fuzzy expert rules in the target market can be summarized as following (see Table 2).

Factors of innovation in micromarket indicators; technological novelty significant in competitiveness is reviewed in the form of physical and functional production novelty, alternative usage and new markets. The fuzzy expert rules in the manufacture can be summarized in production rules as following (see Table 3).

As the result of sales rates' decrease, the company will initiate other sales efforts to increase sales. These efforts will escalate cost of other sales efforts. Thus, profit rate will drop as a big portion of the profit is used to finance other sales efforts. The fuzzy expert rules in the performance can be summarized in production rules in Table 4.

As the result of operating the expert system, three different deductions can be made, as preservation of the present status, introduction of new product to market and withdrawal of product from market, i.e.:

If PERFORMANCE = Active Then "Preserve the present status"
If PERFORMANCE = Passive Then "Introduce new product to market"
If PERFORMANCE = Bad Then "Withdraw the product from market"
MBF of Performance is represented in Fig.5.

Table 1: Rules of the Rule Block "RuleBlockGlobalMarket"

IF		THEN	
Economic_Con	**Political_Cir**	**DoS**	**Global_market**
Negative	Negative	1.00	Pessimistic
Negative	Ineffective	1.00	Pessimistic
Negative	Positive	1.00	Pessimistic
Inffective	Negative	1.00	Pessimistic
Inffective	Ineffective	1.00	Pessimistic
Inffective	Positive	1.00	Optimistic

IF		THEN	
Positive	Negative	1.00	Pessimistic
Positive	Ineffective	1.00	Optimistic
Positive	Positive	1.00	Optimistic

Table 2: Rules of the Rule Block "RuleBlockTargetMarket"

IF		THEN	
Manufacture_poin	**Renewal**	**DoS**	**Target_market**
Mp<CMP	Not_OK	1.00	Wait
Mp<CMP	OK	1.00	medium
Mp=CPM	Not_OK	1.00	Wait
Mp=CPM	OK	1.00	Impulsive
Mp>CMP	Not_OK	1.00	Wait
Mp>CMP	OK	1.00	Impulsive

Table 3: Rules of the Rule Block "RuleBlockManufacture"

IF			THEN	
Competition	**Other_selling_ef**	**Prop_increase_in**	**DoS**	**Manufacture**
decreased	decreased	decreased	1.00	Poor
decreased	decreased	increased	1.00	Good
decreased	increased	decreased	1.00	Good
decreased	increased	increased	1.00	Very_Good
increased	decreased	decreased	1.00	Good
increased	decreased	increased	1.00	Very_Good
increased	increased	decreased	1.00	Very_Good
increased	increased	increased	1.00	Very_Good

Table 4: Rules of the Rule Block "RuleBlockPerformance"

IF			THEN	
Global_market	**Manufacture**	**Target_market**	**DoS**	**Performance**
Pessimistic	Poor	Wait	1.00	Bad
Pessimistic	Poor	medium	1.00	Bad
Pessimistic	Poor	Impulsive	1.00	Passive
Pessimistic	Good	Wait	1.00	Bad
Pessimistic	Good	medium	1.00	Passive
Pessimistic	Good	Impulsive	1.00	Passive
Pessimistic	Very_Good	Wait	1.00	Passive
Pessimistic	Very_Good	medium	1.00	Passive
Pessimistic	Very_Good	Impulsive	1.00	Active
Optimistic	Poor	Wait	1.00	Passive
Optimistic	Poor	medium	1.00	Passive
Optimistic	Poor	Impulsive	1.00	Active
Optimistic	Good	Wait	1.00	Passive
Optimistic	Good	medium	1.00	Active
Optimistic	Good	Impulsive	1.00	Active
Optimistic	Very_Good	Wait	1.00	Active
Optimistic	Very_Good	medium	1.00	Active
Optimistic	Very_Good	Impulsive	1.00	Active

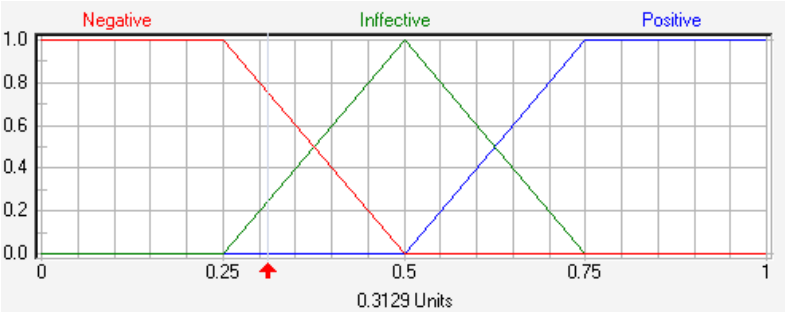


Fig.5. MBF of performance

6. Results

For the implementation, the fuzzy tech 5.54d software is used. By changing values of the DoS in rule blocks or using pattern generator in the File menu, we can that create different samples with not equal probability. So we can test our system with different situation. For example table 5 show the values of inputs and Fig.6 is 3D plot for them.

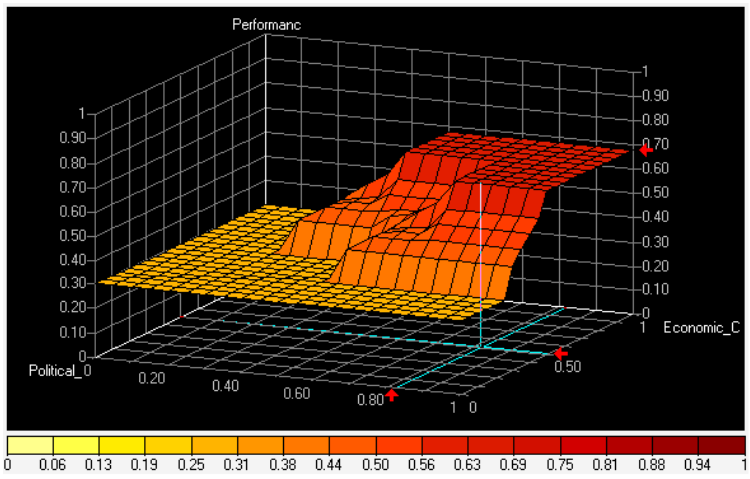
7. Conclusion

The DT technique was used to represent expert knowledge in terms of a set of DTs. Each DT represents in each problem area an exhaustive and exclusive set of decision rules to identify problems, analyze problems and formulate actions. Structuring the decision problem is the most important function of knowledge-based systems. In the context of knowledge-based systems, DTs are used efficiently and effectively during the verification and validation process, and in knowledge acquisition [6].

This section proposed an effort on the issue of the life cycle management. The idea, surely new, is to reproduce, in a structural way, what the experts do when have to decide a new product's market entering time. This study is applied on the decision tree and in the rule blocks [3]. As the result of the performed study, the most suitable time for introduction of the product to the market can be determined, instead of withstanding the costs of other sales efforts and losing profit as well as risking the loss of market share in the product's maturity period. When operating the expert system, three different deductions can be made, as preservation of the present status, introduction of new product to market and withdrawal of product from market. This structure, which has been designed solely for a liquid detergent producing company, can be conveniently used for different sectors too with new rule bases to be obtained from experts of the other sectors. The information about the variables, rules, membership functions for different parameters in the project is as shown in Table 6.

Table 5: Input's value

Economic_Con	05020
Political_Cir	0.8194
Competition	0.6627
Other_selling_ef	0.3036
Prop_increase_in	0.2817
Manufacture_poin	0.2817
Renewal	0.4901



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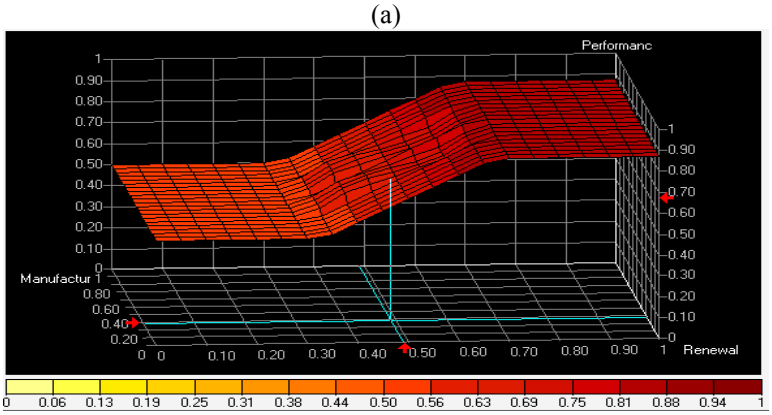

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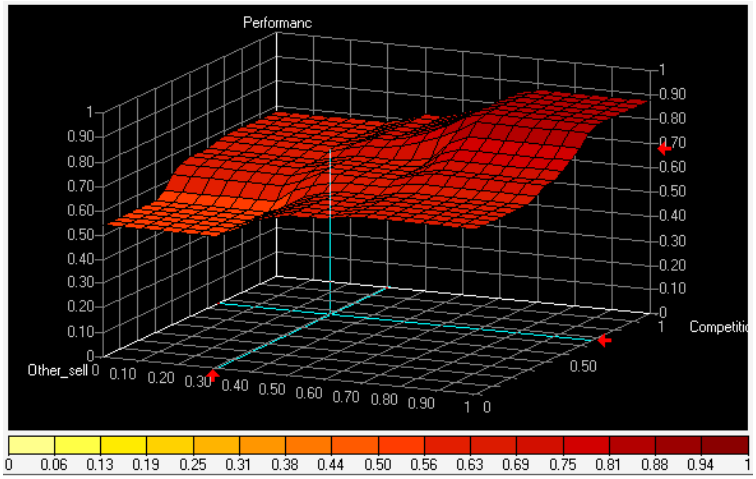

(c)

Fig .6. 3D plots of results

Table 6: Project Statistics

Input Variables	7
Output Variables	1
Intermediate Variables	3
Rule Blocks	4
Rules	41
Membership Functions	28

8. References

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