Quality Festival 2019
ISBN 2620-2832

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DECISION MAKING IN INDUSTRIAL ENTERPRISES IN CONDITIONS OF UNCERTAINTY

Abstract: *In this paper analysed the way of the the decision making "produce or purchase" under conditions of uncertainty in the industry enterprises applying the fuzzy sets theory.*
Keywords: *Decision making, Industrial enterprises, Uncertainty, Fuzzy sets.*

1. Introduction

Most decisions in industrial enterprises shall be made under conditions of uncertainty and risk. According to some authors [1, 8], the reasons are:

- relatively large number of relevant variables,
- inability to control relevant variables,
- their instability and nonlinearity,
- random character of the relevant variables,
- difficult quantification and measurement of activity of the relevant variables,
- insufficiency of information.

Consequently, the final effects of decisions are vital expertise to the decision-maker and correct assessment of the allowed level of risk (subjective factor). The example below illustrates one such situation.
In the field of industrial production, there are no companies that at least once during their business did not find a dilemma: whether a certain part/semiproduct/product is produced or purchased from a supplier. The three basic variants of this problem are [4, 5]:
1. the company has not produced or purchased a part/semiproduct/product;
2. to produce a part/semiproduct/product that the company so far bought from suppliers;
3. to purchase part/semiproduct/product that has so far produced in the company.

2. Ways of problem solving

Solving a defined problem can be accessed in three different ways:
1. Classical way,
2. The use of an expert system,
3. The application of the fuzzy sets theory.

A classical way in problem solving [6]. The basic characteristic of the classic way of solving this problem consists in the exclusive reliance on the comparison of the economic effects of the two decisions mentioned. In other words, the total cost of production of the observed part/subproduct/product is compared with the cost of its purchase (assuming there are suppliers from whom it can be procured) and after that the decision maker defines a

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cheaper variant. Only in rare cases, depending on the expertise of the decision-makers, some additional criteria are taken into account.

Application of the expert system in problem solving [6]. Because of the above mentioned additional criteria developed prototype expert system. As can be seen from the economic model (Figure 1), a number of attributes that are taken into consideration is significantly higher than in the classical manner of decision-making. The decision maker communicates with the expert system by selecting the domain values for the attributes of the last sheet of the decision tree. Based on these data, the built in algorithm, an expert system provides a draft decision with an explanation. Thus, the risk of making a wrong decision is reduced in many ways, which is the main goal of developing an expert system.

Application of the fuzzy sets theory in problem solving [3]. To solve a defined problem by applying the fuzzy sets theory for the economic model (Figure 1), it is possible to join oriented graph (Figure 2).

3. Application of the fuzzy sets theory

Input variables appear at the first and second levels. The second level already contains 4 functions of two arguments, the third level contains 3 also functions of two arguments, but that some of the arguments in the previous level defined function, that is, it is a complex function. The fourth level is a function of the argument 3, which are defined on the third level, ie. the fourth-level function obtained is multi-complex, and its value represent solution of the problem.

If necessary, this model can be developed to a higher number of levels, or narrowed to a smaller number of levels. However, the functions in the classical mathematical form can not be said, since the input variables (arguments) are so called. linguistic variables (for example, the high costs for material, the mean quantity of product suppliers aggressive appearance, etc.). The same applies to the output variable (function), which until the last level are the input parameters for the complex functions (eg production costs, purchase price, anticipated changes in technology, production constraints, etc.). This nature of the input and output values or domain values for which there is no possibility of accurate quantification, as well as criteria for making decisions in industrial enterprises, make it extremely convenient fuzzy sets theory to solve a defined problem. For the modeling of problems in which the interdependencies between the individual variable sizes are very complex, fuzzy logic is very often applied successfully. The solution of a defined problem is accessed precisely in this way. Input and output values are defined as different fuzzy sets, continuous and discontinuous [7] . Defining the fuzzy sets contains the fact that the corresponding possible values are associated with the corresponding degree of belonging, and then the rules of the conclusion are defined, which necessarily involves the implications of implication with the input conjuction and/or disjunction. After considering the degree of membership for each rule are selected value output variables with minimum or guaranteed levels of membership, taking into account all input parameters. After this procedure observed output size is not yet clearly defined, because all points depending on the number of rules used has different levels with varying degrees of affiliation. In the next step, at every point they can choose the output size values whose degrees of belonging to the maximum. In this way, the resulting output size is defazified, ie a specific output value is determined, which is either input variable at the next higher level or a decision (problem solving) at the last level. In this way, by applying a large number of steps, a final decision is made taking into account all possible circumstances and all possible values of the values that appear in it.

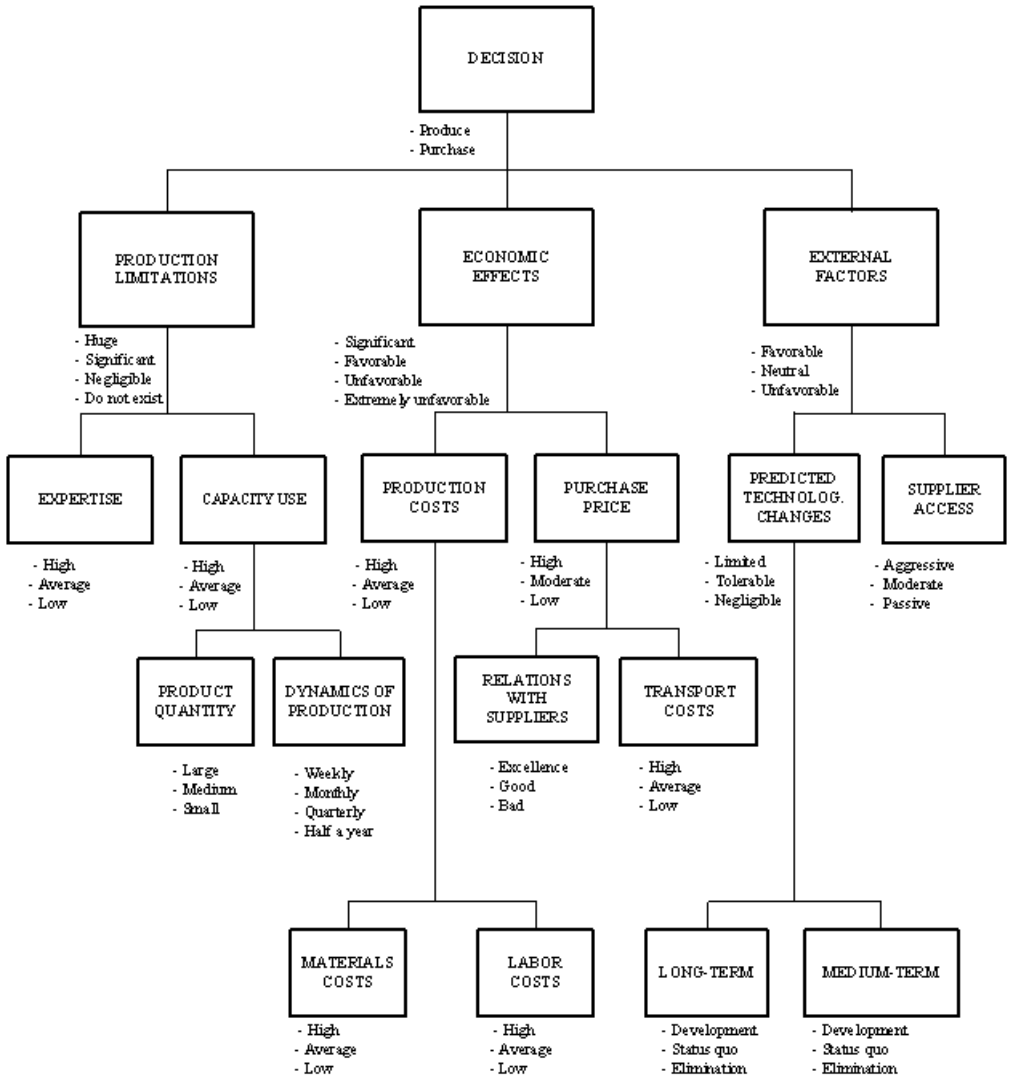

Figure 1. Economic model of the expert system

Such a complete review and analysis of the problem, it would be impossible to implement without the fuzzy logic of relying only on the knowledge, experience and intuition of experts.In the following review given fuzzy variable to the domain of possible values [2]:

- Decision: produce, purchase
- Production limitations: huge, significant, negligible, do not exist,
- Economic effects: significant, favorable, unfavorable, extremely unfavorable,
- External factors: favorable, neutral, unfavorable,
- Expertise: high, average, low,
- Capacity use: high, average, low,
- Production costs: high, average, low,
- Purchase price: high, moderate, low,

- Technological changes: limiting, tolerable, negligible,
- Supplier access: aggressive, moderate, passive,
- Product quantity: high, medium, small,
- Production dynamics: weekly, monthly, quarterly, semi-annual,
- Material costs: high, average, low,
- Labor costs: large, average, low,
- Relations with suppliers: excellent, good, bad,
- Transportation costs: high, average, low,
- Longterm changes: development, without changes, elimination,
- Mediumterm changes: development, status quo, elimination.

According to the membership functions of fuzzy variables in the observed problem can be distinguished as follows:

1. group (Figure 3): material costs, labor costs, production costs, transport costs, purchase price, product quantity, capacity utilization, external factors.

The value interval (a, b) is determined in each particular case. The observed variable rates are in monetary units, the exception is the capacity utilization, the foreseen technological changes and the external factors that are expressed as a percentage.

2. group: long-term changes, mid-term changes (Figure 4). Measuring unit is the degree of expected change.

3. group: production dynamics (Figure 5). Measuring unit is the time expressed in months.

4. group: relationships with suppliers, supplier access (figure 6). The unit of measurement for the assessment of suppliers,

5. group: expertise (figure 7). The presence of high professional qualifications is expressed in percentages.

6. group: production constraints, economic effects (Figure 8). It is measured by percentage, from the aspect of "producing".

7. group: decision (figure 9). It is expressed centrally, in terms of "produce".

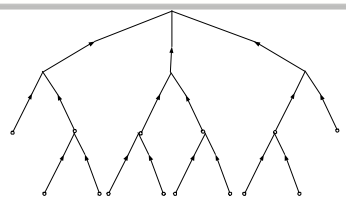

Figure 2 . Oriented graph

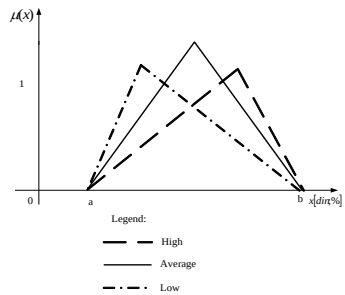

Figure 3. Membership function for production costs; material costs and labor costs

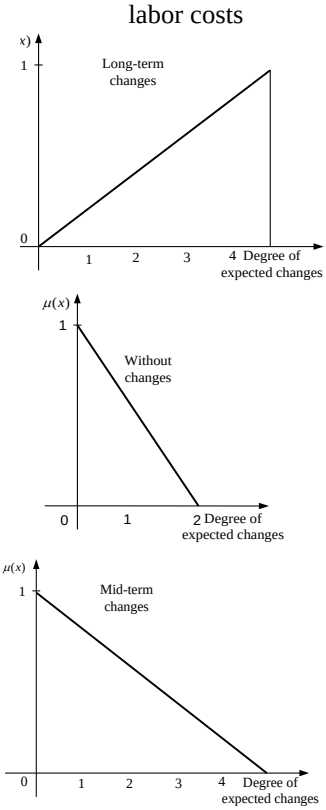

Figure 4. The membership functions for mid-term and long-term changes

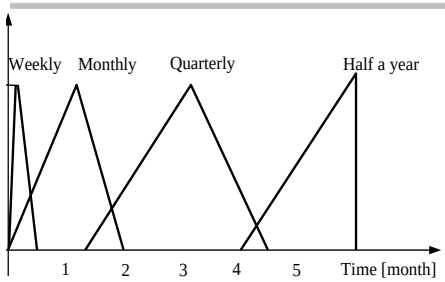

Figure 5. The membership function for dynamics of production

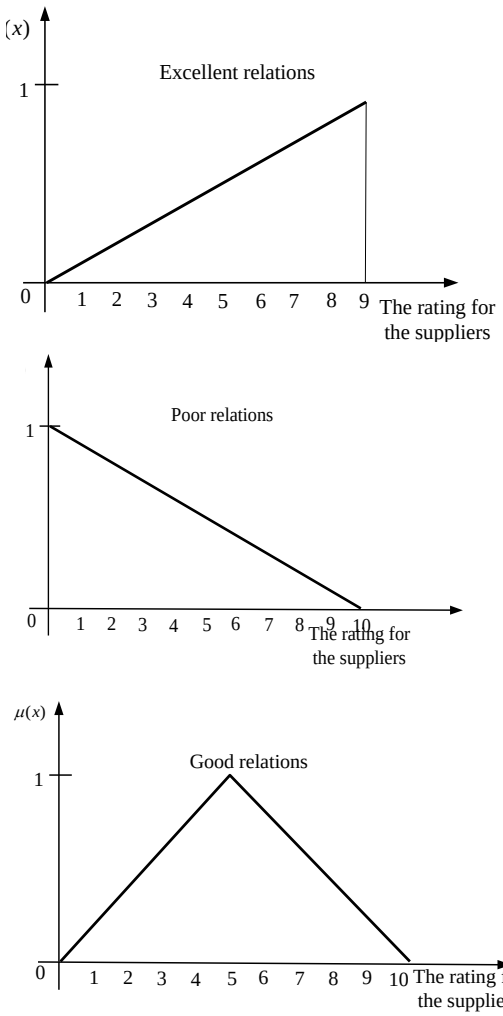

Figure 6. The membership functions for relations with suppliers

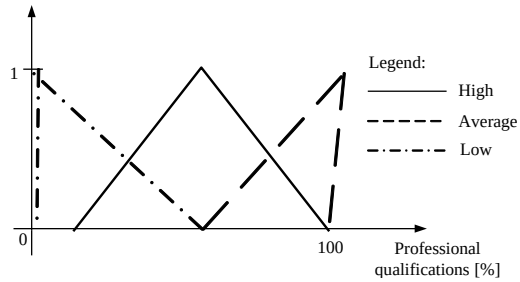

Figure 7. The membership function for expertise

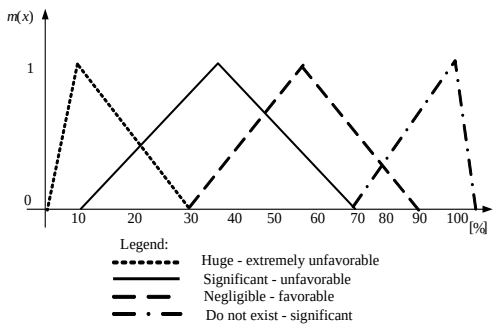

Figure 8. The membership function for the production limitations and economic effects

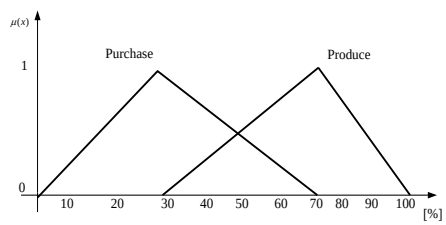

Figure 9. The membership function for the decision making

The algorithm for decision "purchase or produce" (Figure 1) contains three steps that characterize three levels of variables. Each of the steps contains a logical conclusion rule defined by a specialist. An example of a decision is considered only for some fuzzy variables from Figure 1. If Production limits are huge and Economic effects are unfavorable and External factors are unfavorable, then decision is - PURCHASE. If Production limitations do not exist and Economical effects favorable and External factors are neutral then decision is -

PRODUCE, etc. The process is continued on the basis of logical conclusions, in the previous steps of the obtained fuzzy variables: production constraints, economic effects and external factors.

4. Conclusion

The nature of the problems encountered by industrial enterprises has all the characteristics of uncertainty. Therefore, it is very difficult to determine the input parameters and predict possible conditions in which decisions need to be made. Values obtained from the subjective assessment of specialists is more accurate if thez are given as the interval of data values, but not specific, dotted value. Since the fuzzy sets theory offers such a solution, developed the algorithm for making a decision based just on its rules.

Acknowledgment: This paper presents the part of research conducted under the project III 46001: Creating wealth from the wealth of Serbia, funded by Ministry of education, science and technological development of the Republic of Serbia.

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