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REAL TIME ANALYSIS OF SOFTWARE ASSESSMENT OF RECYCLING PRODUCTS

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Abstract: The market validation of any recycling equipment presents the last phase of developing process of a new product. The considered problem is defined into ISO 9000:2008.The developed software can be realized into seven steps and it is based on the proposed mathematical model. A new model for market validation of device for recycling is proposed which includes both quantitative and qualitative factors. The uncertainties into the relative importance and values of factors are described by pre-defined linguistic expressions. These linguistic variables are modelled by triangular fuzzy numbers.Factor weights is given by fuzzy AHP. The obtained results represent an input for future research which should include a good benchmark base for tested different devices which use in reverse logistic chains and their continuous improvement.

Key Words: software/market validation/uncertainties/ fuzzy AHP

1. INTRODUCTION

Increasing global competition forces companies to increase the profit constantly and to improve competitive positioning. Manufacturing enterprises are expanding simulation models to obtain both quality of products, and to enable the validation of the products. The validation is vital to reduce process faults and to facilitate efficient and effective engineering changes [1]. On the other hand, the validation of new physical products is of primary importance for customer perception. In the literature, there are many definitions of the validation term. According to [2] and [3] validation is method that is used for confirming that a product meets its respective specifications and fulfils its intended purpose. The definition given by ISO 9000 validation is focused on fulfilling an intended use or application. There are many methods used for the market validation of products projects which can be based on the market analyses, benchmarking tool, mathematical statistics, etc. In this paper, author's attention is focused on the recycling equipment. The uncertainties in: (1) the relative importance of factors (2) the some sub-factor values and (3) the customer satisfaction levels are

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described by management team. They use linguistic expressions is close to the human way of thinking. Modeling of linguistic terms is based on the fuzzy sets theory [4]. Fuzzy set theory resembles human reasoning in its use of approximate information and uncertainty to generate decisions. In this paper, all uncertainties are modeled by triangular fuzzy sets. The relative importance of each pair of factors is stated as fuzzy group decision making problem [5]. By using fuzzy agreeing method, the consensus of decision maker's opinions can be achieved. Handling of FAHP is performed by an approach which is introduced by [1]). This approach does not involve cumbersome mathematical operation, and it has the ability to capture the vagueness of human thinking style. In the literature, this approach is most widely used [6,7]. The software is based on the proposed a new fuzzy model. The paper is organized in the following way. The section 2 describes the evaluation framework. A new software for determining the market validation of recycling equipment is proposed in Section 3. Conclusions are presented in Section 4.

2. EVALUATION FRAMEWORK

3. Results of good practice show that market validation of every piece of recycling equipment should be performed and have the strong influence on the economies of countries and environmental protection. Assessment of market validation for every piece of recycling equipment has to be observed as a separate and unique problem.

Step 1. In this step, management which leads to increasing costs, decreasing product quality team which assesses market validation of considered equipment is established. Generally, management team can be presented by index set E={1...e...E}, where e is the index for decision maker while E is the total number of decision makers of management team.

Step 2. The software is defined into seven steps: (1) defining the business the strategy, competencies, business model and product concept, (2) defining of product context to entry the market, (3) identification of the leader in the area and positioning with respect to him, (4) defining key values for buyers, (5) testing of key values for buyer with respect to the competition, (6) defining the market strategy, (7) marketing strategy correction for product positioning.

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Step 3. In this paper, the factors which influence to market validation of device for recycling oils are identified by management team. The identified factors are based on considered device performances. Each factor should be decomposed into many subfactors. Formally, factors and their sub-factors are presented by set indices I={1...i...I}, and, Ji = 1, … , j. , , , Ji , respectively. The index for identified factor and their sub-factor are denoted as i and j, respectively. The total number of identified factors and their sub-factors are presented by I and Ji , i = 1, … , I, respectively.

Step 4. All the identified factors which can lead to reduction of safety of equipment are usually not of the same relative importance. The assessment of the relative importance of identified factors is stated as fuzzy group decision making problem. The fuzzy pair-wise comparison matrix of the relative importance of factors is constructed. It is assumed that decision makers of management team have equal importance, so that the values of the elements of this matrix are obtained by fuzzy averaging method. By using the extent analysis method in [1], the weights vector of each identified factors is given. The relative importance of sub-factors under each identified factor are equal.

Step 5. All sub-factors are both quantitative and qualitative. The values of quantitative factors are measurable and presents by crisp numbers. The crisp values are given by measurement and using evidence data. The qualitative factor values are assessment by management team. It is assumed that management team makes decision by consensus in assessment values of device for recycling oils problem.

4. STEPS OF DEVELOPED SOFTWARE

In this Section, steps of the developed software are presented. The all steps are presented by GUI Screens (in further text only screens). Step 1. Defining the business strategy, competences, business model and product concept. The information of this steps are: size of enterprise, annual profit, the share in total income from the new product income, number of employees on new product implementation, product's life cycle and investments in new product. The pieces of information of the second

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screen are: production capacity of full product, outsourcing potentials, development quality and product quality. The third screen contains the following pieces of information: knowledge and skills of product development employees, knowledge and skills of ICT sector, knowledge and skills in marketing, team work knowledge and skills, production knowledge and skills Step 2. Cover the defining of the product context form market entry. The first screen of this step shows next pieces of information: product's name, price, capacity, reliability, competitiveness and selling rate. The second screen contains questions: Who, Why and Where buys. Step 3. Cover the identification of leader in this area and making the position with respect to him. Step 4. Cover the recognition of key values for a buyer. Key values for buyers are shown in Table 1. Step

Cover the testing the key values with respect to competition from buyer's view. The Algorithm of proposed fuzzy model is presented in the following.

Step 1. Calculation of aggregated values of the relative importance factor i, over factor ' i by using the fuzzy averaging method:

$$\tilde{W}_{ii'} = \frac{1}{E} \cdot \tilde{W}_{ii'}^{e}, \; i,i' = 1,..,I; i \neq i';$$

$$e = 1,..,E$$

$$\tilde{W}_{ii'} = \left(x; l_{ii'}^{e}, m_{ii'}^{e}, u_{ii'}^{e}\right), i,i' = 1,...,I; i \neq i';$$

In this paper, the fuzzy rating of each pair of considered factors is described by all decision makers. Their assessment are represented as a TFNs

Table 1. *Factors and their sub-factors*

Marketing factor (i=1)	**Factor of occupational safety and servicing (i=3)**
Lead time to customer (j=1)	Occupational safety level (j=1)
Rating market and production costs (j=2)	Maintainability (j=2)
Market entry velocity (j=3)	The possibility of using for different fluids (j=3)
Customer satisfaction level (j=4)	
Factor of environmental protection (i=2)	
Level of satisfaction of demands of environmental protection (j=1)	
The percent of materials which can be not recycled from recyclable materials (j=2)	
Reusability level of developed device (j=3)	

Step 2. Construct the fuzzy pair-wise comparison matrix of the relative importance of the factors

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$$\tilde{WF} = \left[\tilde{W}_{ii'} \right]_{kI}, i,i' = 1,..,I; i \neq i' \quad (2)$$

Step 3. Weights vector of the considered factors is calculated by applying the concept of extent analysis

which is developed in [1]:

$$W = (w_1,..,w_i,...,w_I) \quad (3)$$

Step 4. Calculate the normalized crisp sub-factor values by applying the simple normalization

procedure:

(a) for a benefit type sub-factors

$$r_{ij} = \frac{v_{ij}}{t_{ij}^*}, \; j = 1,..,J_i; i = 1,..,I \quad (4)$$

(b) for a cost type sub-factors

$$r_{ij} = 1 - \frac{v_{ij} - v_{ij}^{\min}}{t_{ii}^{\max}}, \; j = 1,..,J_i; i = 1,..,I \quad (5)$$

where

max min , *ij ij t t* is the target and the lowest value of crisp sub-factor j under factor i.

Step 5. Calculate the normalized uncertain subfactor values by applying the modified linear

normalization procedure [8]:

(c) for a benefit type sub-factors

$$\tilde{r}_{ij} = \left(\frac{L_{ij}}{U^*}, \frac{M_{ij}}{U^*}, \frac{U_{ij}}{U^*} \right), \; j = 1,..,J_i; i = 1,..,I \quad (6)$$

(b) for a cost type sub-factors:

$$\tilde{r}_{ij} = \left(\frac{L^-}{U_{ij}}, \frac{L^-}{M_{ij}}, \frac{L^-}{L_{ij}} \right), \; j = 1,..,J_i; i = 1,..,I \quad (7)$$

Where:

$U^* = U_{ij}^{\max}, \; j = 1,..,J_i; \; i = 1,..,I$

$L^- = L_{ii}^{\min}, \; j = 1,..,J_i; \; i = 1,..,I$

and L is the total number of linguistic expression which are defined for describing uncertain sub-factor

values.

Step 6. Calculate the weighted normalized values of identified factors, *Ci*

$$\tilde{C}_i = w_i \cdot \frac{1}{J_i} \cdot \sum_{j=1}^{J_i} \left(r_{ij} + \tilde{r}_{ij} \right) = (z; Li, M_i, U_i \quad (8)$$

Step 7. Defining the market strategy

The first screen requires next information: buyer's profile, market trends and design. The second screen

contains information about macro trends, the third about industrial trends and the fourth screen contains

information about potentials about product placement.

Step 8. Strategy of marketing correction and product placement. This step is based on the results

from the previous step.

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5. CONCLUSION

In this paper, the software for market evaluation problem of equipment is treated. The proposed
market validation factors are presented as well as constraints and the steps for assessment. The
assessment uncertainties in the relative importance factors and values some their sub-factors is based on fuzzy sets theory. The fuzzy approach is easy to understand and flexible as well as tolerant to imprecise data. In the literature, there are almost no papers in which assessment market validation is performed in exact way. It can be said that the main contribution of this paper is the development of a mathematical model and software for evaluation recycling equipment with respect to market. Finally, marketing strategy lead to learn and improve of identified factors. The proposed model clearly identifies the weakest identified factors which should be the input for creating an enhanced business strategy in reverse logistic chain. The general limitations of the model are the need for well structured factors.

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