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Methodology Concept of Customer Profile Definition

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Abstract

In the twenty-first century, a company has to organize around the customer in order to be a successful and viable firm. Customers expect to get what they would like, with a side order of customization. This approach raises several questions that have to be answered, one of which is that despite nowadays customers are knowledgeable in general, they are still far from being experts that can really co-create a product or a service. Therefore, the fundamental challenge is to avoid the abortion of the configuration process by the customer. Based on problem analysis regarding customers' involvement in the configuration process, the main areas of investigation to be considered are the minimization of the complexity experienced by the customers and the reduction of the cognitive overhead, considering not only the extent of choice, but also the lack of understanding about which solution meets their needs and also the uncertainties about the behavior of the supplier and the purchasing process. The paper presents one approach towards defining the appropriate customer profile that enabes the adaptation of the process of co-creation to different customers that suits each individual customer's needs and limitations.

Key words: *Customer Profile Definition, Mass Customization, Adaptive Configuration*

1. INTRODUCTION

In the twenty-first century, a company has to organize around the customer in order to be a successful and viable firm. Today, the marketplace is customer driven. Customers expect to get what they would like, with a side order of customization. This approach raises several questions that have to be answered, one of which is that despite nowadays customers are knowledgeable in general, they are still far from being experts that can really co-create a product or a service [1]. Companies are forced to change their activities from a seller's point of view towards a buyer's point of view, which results in a drastic increase of product variety offered by enterprises. That is one of the main characteristic trends of the modern economic system [2]. To maintain their competitiveness, companies are modularizing their products and introducing platform concepts, and this transfer from no customizable products to modular products that involve individual customer variants is one of the most important industrial strategies nowadays. The recent development of IT technology enables the software based product configuration systems that support the process of customized product development. They compose customer-specific solutions using the modules based on the customer's requirements.

These drastic changes in modern economy introduce mass customization that alters traditional product development and moves towards a two-stage model, the first, the realm of company/designer establishing the solution space and the second, that of the customer as co-designer. This second stage fundamentally changes the role of the customer from the consumer of a product, to a partner in a process of adding value [3].

This alteration of traditional product development through the involvement of the customer into the configuration of the final product faces some obvious problems. The fundamental challenge is to avoid the abortion of the configuration process by the customer. In many cases, the customer aborts the configuration process by himself. Major problem areas include the lack of a customer-desired option value regarding a specific attribute within the system as well as the inability of the customer to create definite preferences between certain option values. As a result, the customer aborts the configuration process and does not come up to the sales phase [4]. Also if customers are overwhelmed by the configuration task, there is a chance that they may abort the configuration process. Customers usually only want the product alternatives that exactly meet their requirements. If too much of a choice is offered, customers can feel frustrated or confused, and therefore incapable of making proper decisions. This overload of information is sometimes called external complexity. This external complexity is caused by the limited information processing capacity of humans, the lack of customer knowledge about the product, and customer ignorance about his or her real individual needs [5]. Based on problem analysis regarding customers' involvement in the configuration process, the main areas of investigation to be considered are the minimization of the complexity experienced by the customers [6], [7] and the reduction of the cognitive overhead, considering not only the extent of choice, but also the lack of understanding about which solution meets their needs and also the uncertainties about the behavior of the supplier and the purchasing process [8].

The paper presents one approach towards defining the appropriate customer profile that enables the adaptation of the process of co-creation to different customers that suit each individual customer's needs and limitations.

2. CUSTOMER PROFILE DEFINITION

Generally, the identification and implementation of customer requirements are significant issues for successful product development [9]. To be able to select or filter objects for an individual, information is needed about the individual [10], [11]. Based on experience, the problem of adapting the process of co-creation to different customers can be solved by identification of different customer profiles that suit each individual customer's needs and limitations.

The area of customer profiles (**Figure 1**) consists of general information about customers, which usually deals with basic and demographic attributes, information about specific product interests, information about general interests, information about relationships to other customers, information about the buying history and usage/interaction behavior and ratings of products, product components and certain attributes [12], specific information about customers, which is derived from input questions [13], [14], [15] and contextual information about customers, such as time of the day, the date, etc. [11], [16].

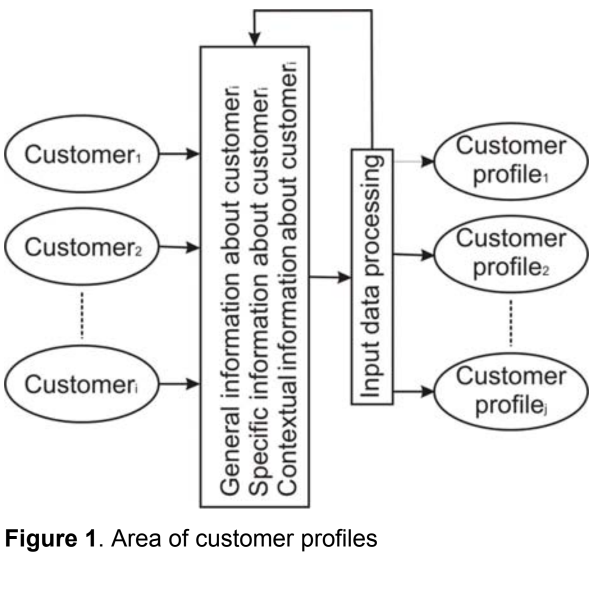

Figure 1. Area of customer profiles

Voices of customers should not only be elicited at the front-end of the process, but rather frequently at various junctures along the process [17]. Besides, not all the requirements can be known at the outset of the task [18]. It is therefore necessary to collect customer opinions consistently.

The rest of the paper deals with collecting and using specific information about customers, while general and contextual information about customers are not discussed here.

To configure the appropriate customer profile, specific information about customers is needed. Therefore a set of initial questions is asked at the beginning of the co-creation process.

There is a need to analyze the answers generated by each customer and to use them to form a customer profile. A number of approaches from the field of data analysis may be used, nevertheless the nature of the questions and the answers refer to the use of a non-crisp logic; therefore fuzzy logic is used to determine the appropriate customer profile [19], [20], [21].

The initial development of the theory of fuzzy sets was motivated by the perception that traditional techniques of systems analysis are not effective in dealing with problems in which the dependencies between variables are too complex or too ill-defined to admit of characterization by differential or difference equations. Such problems are the norm in biology, economics, psychology, linguistics, and many other fields. A common thread that runs through problems of this type is the unsharpness of class boundaries and the concomitant imprecision, uncertainty and partiality of truth. The concept of a fuzzy set is a reflection of this reality [21].

Generally, a fuzzy number A (Figure 2) is defined on the universe R as a convex and normalized fuzzy set, by a membership function $\mu_A(x)$ [20], [21].

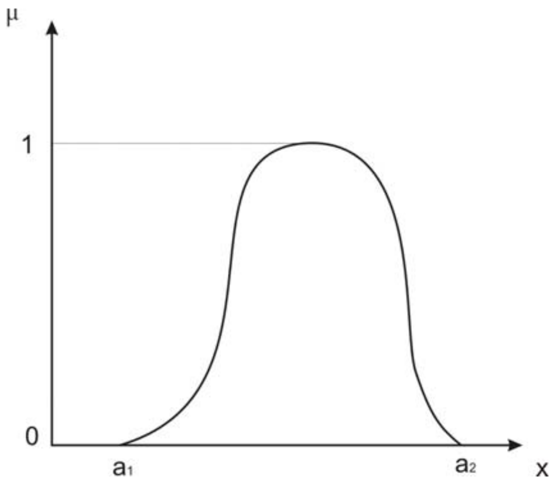

Figure 2. Fuzzy number A

The adaptive customer profile configurator is discussed by using trapezoidal (triangular) fuzzy numbers (Figure 3). A trapezoidal fuzzy number A is defined on R by membership function (1).

Each question from the set of initial questions can have answers that can range from 0 to 1. 0 usually means that the answer is negative, 1 means that the answer is positive. The presented approach takes into consideration not only the answers to questions, but also the order of answering to questions. Also, during and after the process of co-creation, the customer's feedback considering his satisfaction with a configured profile is analyzed and the future profile is adapted according to the feedback.

$$\mu_A(x) = \begin{cases} 0, x < a_1 \\ \dfrac{x-a_1}{a_2-a_1}, a_1 \le x \le a_2 \\ 1, a_2 \le x \le a_3 \\ \dfrac{x-a_4}{a_3-a_4}, a_3 \le x \le a_4 \\ 0, x > a_4 \end{cases} \quad (1)$$

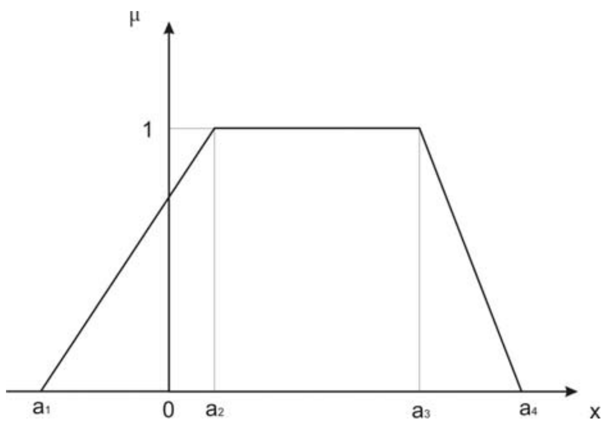

Figure 3. Trapezoidal fuzzy number

Based on asked questions and answers, several linguistic variables are defined, that can have different values. Next example shows a linguistic variable a that has three values (high, average and low) with the appropriate membership functions $\mu(x)$ for the variable (**Figure 4**).

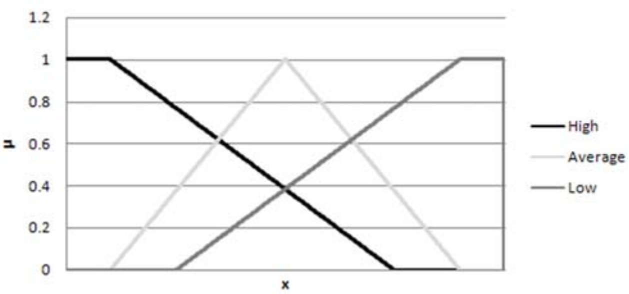

Figure 4. Linguistic variable a

Beside the values of the input variables, during the process of customer profile definition, the order of answering the questions is also taken into consideration. The reason for doing so is that customers usually, based on their belief, sooner answer questions that are of higher importance to them than questions that are not. There is also a possibility that customers do not answer unimportant questions at all; then the value of the answer is 0.5 [22].

For the same answer values (customer input), the membership functions change, based on the answering order. For the same variable, if the answer to the question is the first one, the membership functions taper, i.e. the equations are changed in the following manner (2), where $y_i \ge 1$.

$$\mu_a^{1st}(x) = [\mu_a(x)]^{y_i} \quad (2)$$

Figure 5 shows the previously disscussed variable a, if the answer to the question is the first one for the following membership functions $\mu(x)$ (3). It results in a more unique response (Chosen values for y_i are used just as an example).

$$\begin{aligned} \mu_{a=high}^{1st}(x) &= [\mu_{a=high}(x)]^2 \\ \mu_{a=average}^{1st}(x) &= [\mu_{a=average}(x)]^2 \\ \mu_{a=poor}^{1st}(x) &= [\mu_{a=poor}(x)]^2 \end{aligned} \quad (3)$$

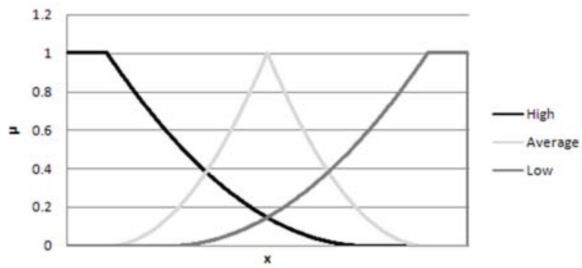

Figure 5. Linguistic variable a

If the answer to the question is the last one, the membership functions expand, i.e. the equations are changed in the following manner (2), where $y_i \le 1$. **Figure 6** shows the previously discussed variable a, if the answer to the question is the last one for the following membership functions $\mu(x)$ (4). It results in a more vague response (Chosen values for y_i are used just as an example).

$$\begin{aligned} \mu_{a=high}^{last}(x) &= [\mu_{a=high}(x)]^{0.25} \\ \mu_{a=average}^{last}(x) &= [\mu_{a=average}(x)]^{0.75} \\ \mu_{a=poor}^{last}(x) &= [\mu_{a=poor}(x)]^{0.25} \end{aligned} \quad (4)$$

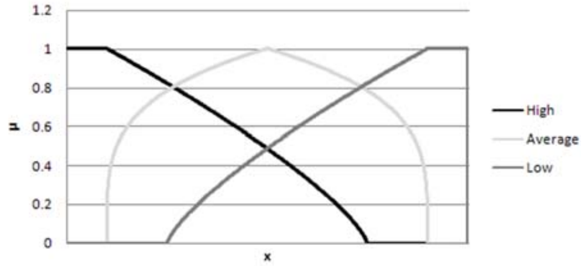

Figure 6. Linguistic variable a

The fuzzy output from the system, i.e. the decision is made in a manner that for i initial questions, each of which can have y_i values, $y_1 * y_2 * ... * y_i$ if-then rules can be defined. The rules are designed to produce j different outputs o with defined membership functions [22], [24].

After the evaluation of if-then rules, an aggregated output is generated. Changes in input membership functions influence the customer profile definition. For the same answers, but for a different answering order, the configured customer profile can be different (**Figure 7**).

After the configuration task is finished, a feedback is generated. The customer is asked to answer a new set of questions. Each question from the set can have answers that can range from -0.5 to 0.5. -0.5 usually means that the answer is negative, 0.5 means that the answer is positive. The answers to the questions are the feedback about how well the configurator adapted to customer's needs and limitations. Initially, all the answers are set to the value of 0, which means that the customer is satisfied with the configuration process.

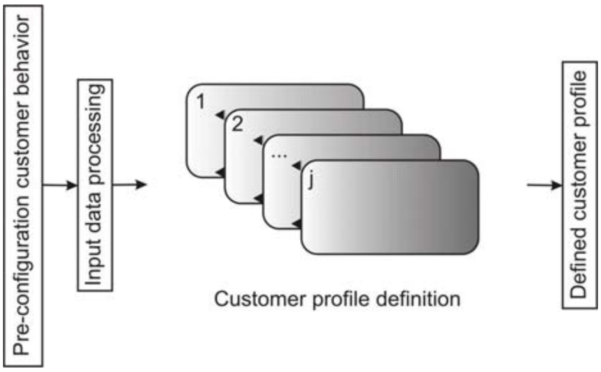

Figure 7. Customer profile definition

Based on the answers to questions, the values for input linguistic variables (for example for linguistic variable a) are modified to new values (for example to linguistic variable a_{new}) in the following manner (5).

$$a_{new} = a + \frac{feedback}{2}, \quad 0 \leq a_{new} \leq 1 \tag{5}$$

This is the input for a new fuzzy output from the system, i.e. a new decision. This new output (o_{new}) takes into consideration whether a customer is satisfied with a configured customer profile. Based on the difference between an original and a new output, the membership functions for o_{i+1}, where o_{i+1} is the output in the future, are shifted left or right to better articulate the future customers' preferences (**Figure 8**).

The amount of shifting (sa) is calculated in the following manner (6).

$$sa = \frac{o - o_{new}}{10} \tag{6}$$

The division by 10 is used to assure that the shift is not too big. The resulted customer profile generation algorithm is shown in **Figure 9**.

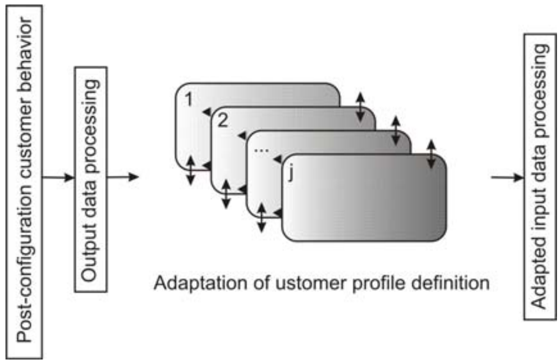

Figure 8. Adapted customer profile definition

3. EXAMPLE*

Next example shows a case where three different customer profiles can be defined:

- Beginner customer;
- Intermediate customer;
- Professional customer.

To define the appropriate customer profile, three initial questions are asked before the start of the configuration process:

- What is your estimate about your knowledge?
- What are your needs considering the accuracy of the configuration results?
- How much time do you have for completing the configuration process?

The answers can range from "I have no knowledge at all" (Where the value of the answer is 0) to "I am a professional" (Where the value of the answer is 1) for the first question; from "I need as accurate result as possible" (Where the value of the answer is 0) to "I just want a rough estimate" (Where the value of the answer is 1) for the second question; and from "I have enough time for completing the configuration process" (Where the value of the answer is 0) to "I have limited time for completing the configuration process" (Where the value of the answer is 1) for the third question. Initially, all the answers are set to the value of 0.5. The answers are used as input data for customer profile definition.

Based on asked questions and answers, three linguistic variables are defined:

- Knowledge k, whose values are: very poor, poor, average, good and very good;
- Accuracy a, whose values are: high, average, low;
- Time t, whose values are: enough, average, not enough.

* *All values used in the example are used just for explanatory purposes.*

The membership functions for the variables are triangular or trapezoidal, where the variables are described on the operating domain of $x=[0,1]$ (7), (8) and (9).

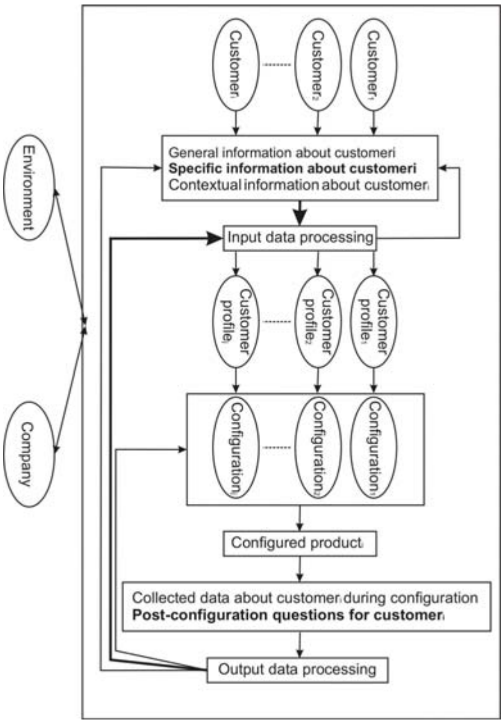

Figure 9. Customer profile definition algorithm

$$\mu_{k=very\_poor}(x)=\begin{cases}1, & 0\le x\le 0.05\\ \dfrac{0.5-x}{0.5-0.05}, & 0.05<x\le 0.5\\ 0, & 0.5<x\le 1\end{cases}$$

$$\mu_{k=poor}(x)=\begin{cases}\dfrac{x}{0.3}, & 0\le x\le 0.3\\ \dfrac{0.6-x}{0.6-0.3}, & 0.3<x\le 0.6\\ 0, & 0.6<x\le 1\end{cases}$$

$$\mu_{k=average}(x)=\begin{cases}0, & 0\le x\le 0.2\\ \dfrac{x-0.2}{0.5-0.2}, & 0.2<x\le 0.5\\ \dfrac{0.8-x}{0.8-0.5}, & 0.5<x\le 0.8\\ 0 & 0.8<x\le 1\end{cases} \qquad (7)$$

$$\mu_{k=good}(x)=\begin{cases}0, & 0\le x\le 0.4\\ \dfrac{x-0.4}{0.7-0.4}, & 0.4<x\le 0.7\\ \dfrac{1-x}{1-0.7}, & 0.7<x\le 1\end{cases}$$

$$\mu_{k=very\_good}(x)=\begin{cases}0, & 0\le x\le 0.5\\ \dfrac{x-0.5}{0.95-0.5}, & 0.5<x\le 0.95\\ 1, & 0.95<x\le 1\end{cases}$$

$$\mu_{a=high}(x)=\begin{cases}1, & 0\le x\le 0.1\\ \dfrac{0.75-x}{0.75-0.1}, & 0.1<x\le 0.75\\ 0, & 0.75<x\le 1\end{cases}$$

$$\mu_{a=average}(x)=\begin{cases}0, & 0\le x\le 0.1\\ \dfrac{x-0.1}{0.5-0.1}, & 0.1<x\le 0.5\\ \dfrac{0.9-x}{0.9-0.5}, & 0.5<x\le 0.9\\ 0 & 0.9<x\le 1\end{cases} \qquad (8)$$

$$\mu_{a=poor}(x)=\begin{cases}0, & 0\le x\le 0.25\\ \dfrac{x-0.25}{0.25-0.9}, & 0.25<x\le 0.9\\ 1, & 0.9<x\le 1\end{cases}$$

$$\mu_{t=enough}(x)=\begin{cases}1, & 0\le x\le 0.1\\ \dfrac{0.75-x}{0.75-0.1}, & 0.1<x\le 0.75\\ 0, & 0.75<x\le 1\end{cases}$$

$$\mu_{t=average}(x)=\begin{cases}\dfrac{x-0.1}{0.5-0.1} & 0\le x\le 0.5\\ \dfrac{0.9-x}{0.9-0.5}, & 0.5<x\le 1\end{cases} \qquad (9)$$

$$\mu_{t=not\_enough}(x)=\begin{cases}0, & 0\le x\le 0.25\\ \dfrac{x-0.25}{0.25-0.9}, & 0.25<x\le 0.9\\ 1, & 0.9<x\le 1\end{cases}$$

For the same answer values (customer input), the membership functions change, based on the answering order. If the answer to the question is the first one, the membership functions taper (10), what results in a more unique response. If the answer to the question is the last one, the membership functions expand, what results in a more vague response (11).

$$\mu_{k=very\_poor}{}^{1st}(x)=[\mu_{k=very\_poor}(x)]^2$$
$$\mu_{k=poor}{}^{1st}(x)=[\mu_{k=poor}(x)]^2$$
$$\mu_{k=average}{}^{1st}(x)=[\mu_{k=average}(x)]^2$$
$$\mu_{k=good}{}^{1st}(x)=[\mu_{k=good}(x)]^2$$
$$\mu_{k=very\_good}{}^{1st}(x)=[\mu_{k=very\_good}]^2$$
$$\mu_{a=high}{}^{1st}(x)=[\mu_{a=high}(x)]^2 \qquad (10)$$
$$\mu_{a=average}{}^{1st}(x)=[\mu_{a=average}(x)]^2$$
$$\mu_{a=poor}{}^{1st}(x)=[\mu_{a=poor}(x)]^2$$
$$\mu_{t=enough}{}^{1st}(x)=[\mu_{t=enough}(x)]^2$$
$$\mu_{t=average}{}^{1st}(x)=[\mu_{t=average}(x)]^2$$
$$\mu_{t=not\_enough}{}^{1st}(x)=[\mu_{t=not\_enough}(x)]^2$$

$$\mu_{k=very\_poor}{}^{1st}(x)=[\mu_{k=very\_poor}(x)]^{0.9}$$
$$\mu_{k=poor}{}^{1st}(x)=[\mu_{k=poor}(x)]^{0.75}$$
$$\mu_{k=average}{}^{1st}(x)=[\mu_{k=average}(x)]^{0.25}$$
$$\mu_{k=good}{}^{1st}(x)=[\mu_{k=good}(x)]^{0.75}$$
$$\mu_{k=very\_good}{}^{1st}(x)=[\mu_{k=very\_good}]^{0.9} \qquad (11)$$
$$\mu_{a=high}{}^{last}(x)=[\mu_{a=high}(x)]^{0.25}$$
$$\mu_{a=average}{}^{last}(x)=[\mu_{a=average}(x)]^{0.75}$$
$$\mu_{a=poor}{}^{last}(x)=[\mu_{a=poor}(x)]^{0.25}$$
$$\mu_{t=enough}{}^{last}(x)=[\mu_{t=enough}(x)]^{0.25}$$
$$\mu_{t=average}{}^{last}(x)=[\mu_{t=average}(x)]^{0.75}$$
$$\mu_{t=not\_enough}{}^{last}(x)=[\mu_{t=not\_enough}(x)]^{0.25}$$

As an example, for the same customer input (answer to the first question) of 0.65, but for different answering order, the membership functions are different, i.e. the values of the membership functions are also different, which is shown in Figure 10.

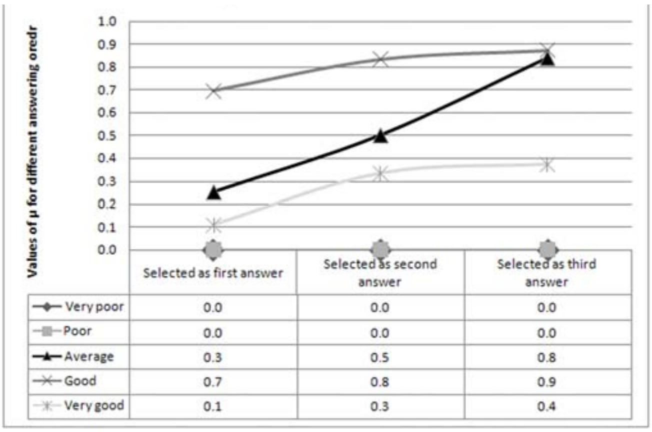

Figure 10. Different values of the membership functions for different answering order

The fuzzy output from the system, i.e. the decision is made in a manner that 45 if-then rules are defined. The rules are designed to produce three different outputs o: beginner, intermediate and professional. The membership functions are triangular or trapezoidal (12).

$$\mu_{o=beginer}(x)=\begin{cases}1, & 0\le x\le \alpha_0\\ \dfrac{\beta_0-x}{\beta_0-\alpha_0}, & \alpha_0<x\le\beta_0\\ 0, & \beta_0<x\le 1\end{cases}$$

$$\alpha_0=0.2$$
$$\beta_0=0.5$$

$$\mu_{o=intermediate}(x)=\begin{cases}0, & 0\le x\le \chi_0\\ \dfrac{x-\chi_0}{\delta_0-\chi_0}, & \chi_0<x\le\delta_0\\ \dfrac{\varepsilon_0-x}{\varepsilon_0-\delta_0}, & \delta_0<x\le\varepsilon_0\\ 0 & \varepsilon_0<x\le 1\end{cases} \qquad (12)$$

$$\chi_0=0.3$$
$$\delta_0=0.5$$
$$\varepsilon_0=0.7$$

$$\mu_{o=professional}(x) = \begin{cases} 0, & 0 \le x \le \phi_0 \\ \dfrac{x-\phi_0}{\phi_0-\varphi_0}, & \phi_0 < x \le \varphi_0 \\ 1, & \varphi_0 < x \le 1 \end{cases}$$
$$\phi_0 = 0.5$$
$$\varphi_0 = 0.8$$

After the evaluation of if-then rules, an aggregated output is generated. Changes in input membership functions influence the customer profile configuration. For the same answers, but for a different answering order, the configured customer profile can be different.

Next example shows that for the following input data:

- 1st answer - customer input for knowledge is 0.65;
- 2nd answer - customer input for accuracy of the configuration results is 0.8;
- 3rd answer - customer input for time for the configuration process is 0.5,

after defuzzification by the "Center of gravity method", the crisp output is 0.387 - and is interpreted as an “Intermediate customer” (13).

$$\begin{aligned} \mu_{o=beginer}(x) &= 0.377 \\ \mu_{o=intermediate}(x) &= 0.435 \\ \mu_{o=professional}(x) &= 0 \end{aligned} \qquad (13)$$

For the following input data:

- 1st answer - customer input for accuracy of the configuration results is 0.8;
- 2nd answer - customer input for knowledge is 0.65;
- 3rd answer - customer input for time for the configuration process is 0.5,

after defuzzification by the same method, the crisp output is 0.369 - and is interpreted as a “Beginer customer” (14).

$$\begin{aligned} \mu_{o=beginer}(x) &= 0.437 \\ \mu_{o=intermediate}(x) &= 0.345 \\ \mu_{o=professional}(x) &= 0 \end{aligned} \qquad (14)$$

Based on the previous example, one can conclude that for the same input data, but for a different answering order, different customer profiles can be definded.

After the configuration task is finished, a feedback is generated. The customer is asked to answer a set of three questions:

- Are you satisfied with the complexity of the configurator? c;
- Is the result satisfactory? s;
- Are you satisfied with the time spent for the configuration process? i.

The answers can range from "The configurator is too complex" (where the value of the answer is -0.5) to "The configurator is too easy" (where the value of the answer is 0.5) for the first question; from "The results should be more detailed and precise" (where the value of the answer is -0.5) to "The results are too detailed" (where the value of the answer is 0.5) for the second question; and from "I could have spent more time for the configuration process" (where the value of the answer is -0.5) to "The configuration process was too long " (where the value of the answer is 0.5) for the third question. Initially, all the answers are set to the value of 0, which means that the customer is satisfied with the configuration process.

Next example shows that for the following feedback:

- 1st answer - customer feedback for the complexity is -0.3;
- 2nd answer - customer feedback for the result is 0.1;
- 3rd answer - customer feedbackt for time is 0,

the input values for k,a,t are modified to k_{new},a_{new},t_{new} (15).

$$\begin{aligned} k_{new} &= k + \frac{-0.3}{2} = 0.65 - 1.5 = 0.5 & 0 \le k_{new} \le 1 \\ a_{new} &= a + \frac{s}{2} = 0.8 + 0.5 = 0.85 & 0 \le a_{new} \le 1 \\ t_{new} &= t + \frac{i}{2} 0.5 + 0 = 0.5 & 0 \le t_{new} \le 1 \end{aligned} \qquad (15)$$

This is the input for a new fuzzy output from the system, i.e. a new decision (16).

$$o_{new} = 0.256 \qquad (16)$$

This new output (o_{new}) takes into consideration whether a customer is satisfied with a configured customer profile. Based on the difference between an original and a new output, the membership functions for o_{i+1}, where o_{i+1} is the output in the future, are shifted left or right to better articulate the customers’ preferences in the future. The amount of shifting is calculated in the following manner (17) as it was discussed before.

$$sa = \frac{o - o_{new}}{10} = \frac{0.387 - 0.256}{10} = 0.0131 \qquad (17)$$

The shifted membership functions for o are (18), with the following corrections (19).

$$\mu_{o=beginer}^{\,i+1}(x) = \begin{cases} 1, & 0 \le x \le \alpha_{i+1} = (\alpha_i + sa) \\ \dfrac{\beta_{i+1} - x}{\beta_{i+1} - \alpha_{i+1}}, & \alpha_{i+1} = (\alpha_i + sa) < x \le \beta_{i+1} = (\beta_i + sa) \\ 0, & \beta_{i+1} = (\beta_i + sa) < x \le 1 \end{cases}$$

$$\begin{aligned} \alpha_{i+1} &= 0.2 + 0.0131 = 0.2131 \\ \beta_{i+1} &= 0.5 + 0.0131 = 0.5131 \end{aligned} \qquad (18)$$

$$\mu_{o=intermediate}^{\,i+1}(x) = \begin{cases} 0, & 0 \le x \le \chi_{i+1} = (\chi_i + sa) \\ \dfrac{x - \chi_{i+1}}{\delta_{i+1} - \chi_{i+1}}, & \chi_{i+1} = (\chi_i + sa) < x \le \delta_{i+1} = (\delta_i + sa) \\ \dfrac{\varepsilon_{i+1} - x}{\varepsilon_{i+1} - \delta_{i+1}}, & \delta_{i+1} = (\delta_i + sa) < x \le \varepsilon_{i+1} = (\varepsilon_i + sa) \\ 0 & \varepsilon_{i+1} = (\varepsilon_i + sa) < x \le 1 \end{cases}$$

$$\chi_{i+1} = 0.3 + 0.013 = 0.3131$$
$$\delta_{i+1} = 0.5 + 0.013 = 0.5131$$
$$\varepsilon_{i+1} = 0.7 + 0.013 = 0.7131$$

$$\mu_{o=professional}{}^{i+1}(x) = \begin{cases} 0, & 0 \le x \le \phi_{i+1} = (\phi_i + sa) \\ \frac{x - \phi_{i+1}}{\phi_{i+1} - \varphi_{i+1}}, & \phi_{i+1} = (\phi_i + sa) < x \le \varphi_{i+1} = (\varphi_i + sa) \\ 1, & \varphi_{i+1} = (\varphi_i + sa) < x \le 1 \end{cases}$$

$$\phi_{i+1} = 0.5 + 0.013 = 0.5131$$
$$\varphi_{i+1} = 0.8 + 0.013 = 0.8131$$

$$\begin{aligned} &if \alpha_{i+1} < 0.05 then \alpha_{i+1} = 0.05; if \alpha_{i+1} > 0.35 then \alpha_{i+1} = 0.35 \\ &if \beta_{i+1} < 0.35 then \beta_{i+1} = 0.35; if \beta_{i+1} > 0.65 then \beta_{i+1} = 0.65 \\ &if \chi_{i+1} < 0.15 then \chi_{i+1} = 0.15; if \chi_{i+1} > 0.45 then \chi_{i+1} = 0.45 \\ &if \delta_{i+1} < 0.35 then \delta_{i+1} = 0.35; if \delta_{i+1} > 0.65 then \delta_{i+1} = 0.65 \\ &if \varepsilon_{i+1} < 0.55 then \varepsilon_{i+1} = 0.55; if \varepsilon_{i+1} > 0.85 then \varepsilon_{i+1} = 0.85 \\ &if \phi_{i+1} < 0.35 then \phi_{i+1} = 0.35; if \phi_{i+1} > 0.65 then \phi_{i+1} = 0.65 \\ &if \varphi_{i+1} < 0.65 then \varphi_{i+1} = 0.65; if \varphi_{i+1} > 0.95 then \varphi_{i+1} = 0.95 \end{aligned} \quad (19)$$

Based on shifted membership functions for o, for the same input in the future:

- 1st answer - customer input for knowledge about thermal insulation is 0.65;
- 2nd answer - customer input for accuracy of the configuration results is 0.8;
- 3rd answer - customer input for time for the configuration process is 0.5,

after defuzzification by the "Center of gravity method", the crisp output is 0.392 - and is interpreted as an “Beginer customer” (20).

$$\begin{aligned} &\mu_{o=beginer}(x) = 0.404 \\ &\mu_{o=intermediate}(x) = 0.395 \\ &\mu_{o=professional}(x) = 0 \end{aligned} \quad (20)$$

The defined customer profile is changed, because the membership functions for output are shifted to the right.

4. CONCLUSION

The fact that in modern economy traditional product development is changed and moved towards a two-stage model, the first, the realm of company/designer establishing the solution space and the second, that of the customer as co-designer, fundamentally changes the role of the customer from the consumer of a product, to a partner in a process of adding value. This alteration of traditional product development through the involvement of the customer into the configuration of the final product faces some obvious problems. The fundamental challenge is to avoid the abortion of the configuration process by the customer.

The proposed approach for adaptive involvement of customers as co-creators in mass customization of products and services is discussed in the paper. The proposed approach identifies different customer profiles that suit each individual customer’s needs and limitations. The customer profiles are defined based on input questions, and are adapted based on a feedback after the configuration task is finished.

The algorithm has to be tested on real configurators.

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