

Web-Based Decision Support System for the Quantitative Analysis of the Customers' Behavior

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Abstract

In this paper a web-based decision support system for the quantitative analysis of the customers' behavior is presented. The system exploits the benefits of the web that offers a transparent, immediate and easy access to applications running on a remote server. The proposed system was implemented using a variety of established web technologies and consists of two autonomous subsystems.

Keywords: Decision Support Systems, Customers' Behavior Analysis, Multicriteria Decision Making, Market Research

1. Introduction

The aim of the analysis of the customers' behavior is to investigate the way a customer reacts during the purchase of a product. We try to identify the motivations that forces him/her to choose one product from a set of available products and the criteria that utilizes in order to proceed to the specific selection. In this way we can study customer groups with the same behavior. Using the analysis of the customers' characteristics we move to the segmentation of the market according to common characteristics and practices.

In the current work we present an implemented web based decision support system that incorporates the topics discussed earlier. The specific system utilizes the benefits of the web and encapsulates multicriteria methodologies. Furthermore, it consists of two autonomous subsystems that share a common database. In particular, the first subsystem can be used for the creation and the completion of the questionnaires, while the second subsystem performs the analysis and the simulation of the customers' behavior.

We shall proceed to the presentation by utilizing a questionnaire, obtained from a survey of six French oil products (Siskos Y. et al. 2001). Specifically, 204 customers

answered 71 statistical questions, concerning age, sex etc, and 6 multicriteria. The alternatives were the Carapelli, the Lerida, the Kolymvari, the Heriard, the Jarre d'Or and the Puget. The incorporated criteria were the influence, the color, the flavor, the taste, the package and the price. Finally, each customer provided a ranking for the six products.

2. The Questionnaires Subsystem

2.1 Overview

The first subsystem provides a set of tools that can be used for creating the questionnaires engaged during the analysis by the decision maker. Authorized users can insert one by one; all the questions included in a questionnaire and provide the set of their possible answers. The specific questions can be either statistical or multicriteria, and for the latter the corresponding alternatives (i.e. products) and criteria are defined. The customers are called to participate to a survey through the offered web interface, which presents the available questions. All questionnaires and the answers obtained by the customers are stored into a database. Additionally, a file with statistics for each questionnaire can be exported and used for further analysis.

2.2 Questionnaires Console Management

The specific component can be accessed only from authorized users and includes, as we can observe in Figure 2-1, the following features:

1. Tools for the creation and the management of questionnaires.
2. Insertion of the questions that will constitute a questionnaire.
3. Management and modification of the data of a questionnaire.
4. Insertion of the alternatives (products) of the questionnaire.
5. Addition/Deletion of customers to/from a questionnaire.

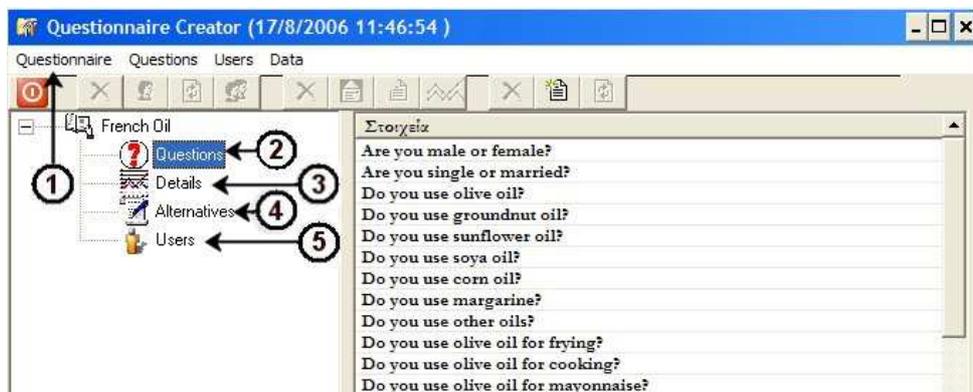


Figure 2-1: Questionnaires console management

The supported question types are either open-ended (the possible answers are not available) or closed-ended (the possible answers are predefined). The second group supports a number of types, which include: binary response questions, multiple choice questions, five-point Likert scale questions, important difference questions, importance scale questions, ranking questions and purchase intention scale questions (www.utexas.edu/academic/diia/assessment/iar/how_to/methods/survey_tables.pdf).

When the administrator decides to create a questionnaire, the form depicted in Figure 2-2 is presented. After the successful creation of a questionnaire, the names of the offered alternatives must be defined (Figure 2-3).

Figure 2-2: Create questionnaire

Figure 2-3: Define alternatives

The console can be used in order to add either statistical or multicriteria questions. In Figure 2-4 we can observe an example of inserting a statistical question of Likert scale type, while in Figure 2-5 we can see the insertion of a multicriteria question.

Answers	Values
I definitely disagree	1
I disagree	2
Neither disagree, nor agree	3
I agree	4
I absolutely agree	5

Figure 2-4: Insert a statistical question (Likert scale type)

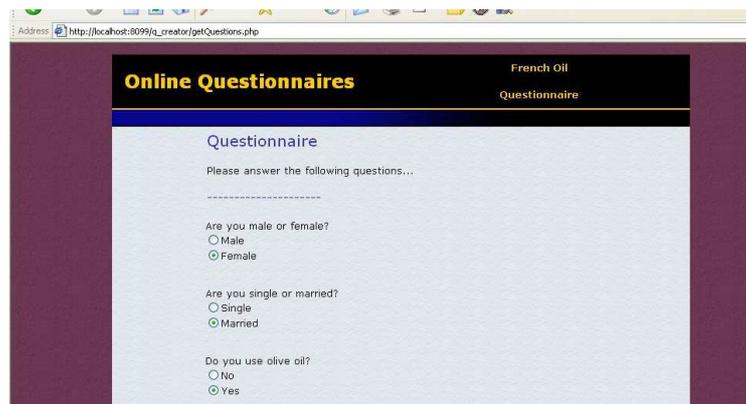
Answers	Values
Poor	1
Medium	2
Good	3

Figure 2-5: Insert a multicriteria question (Multiple choice type)

The specific subsystem can be used in order to export statistics for each questionnaire, which can be sent by e-mail to the administrator. Finally, one can export a questionnaire into a HTML form in order to present it in a web browser.

2.3 Questionnaires Web Interface

Using one of the available web browsers, the customer can access a questionnaire and participate to a market survey. Each customer is granted an access to one or more questionnaires. After performing his/her selection, the corresponding questions are presented (Figure 2-6). The customer can answer one by one the specific questions (initially the statistical and later the multicriteria) and submit the results, which are stored into a database. These answers are later utilized by the second subsystem, which performs the analysis and the simulation of the customers' behavior.



The screenshot shows a web browser window with the address bar displaying 'http://localhost:8099/ta_creator/getQuestions.php'. The page has a dark purple header with the text 'Online Questionnaires' in yellow and 'French Oil Questionnaire' in white. Below the header, the main content area is white and contains the following text: 'Questionnaire', 'Please answer the following questions...', a dashed line, 'Are you male or female?' with radio buttons for 'Male' and 'Female' (where 'Female' is selected), 'Are you single or married?' with radio buttons for 'Single' and 'Married' (where 'Married' is selected), and 'Do you use olive oil?' with radio buttons for 'No' and 'Yes' (where 'Yes' is selected).

Figure 2-6: Answer the French oil questionnaire

3. The Analysis & Simulation Subsystem

3.1 Overview

The decision maker uses the second subsystem in order to perform the analysis and the simulation of the customers' behavior by utilizing their answers. A number of functionalities are supported by the system, which includes the analysis of the criteria, the presentation of market shares, the creation of simple and complex scenarios, the simulation through strategies, and the addition of new alternatives and new criteria. It also utilizes the UTASTAR (Siskos, Yannacopoulos, 1985) multicriteria methodology and different brand choice models. The processes of analysis and simulation can be applied to specific customers' groups by exploiting the statistical questions, which may include information about the age, sex, nationality etc. of the customers. The system offers the ability to the decision makers to narrow their work on a specific group. The results are presented with different types of graphs and tables.

3.2 The methodology

The processing of the customers' answers can be split into two different phases, namely the "Customers' Behavior Analysis" and the "Market Simulation" (Siskos and Matsatsinis, 1993) (Matsatsinis and Siskos 1999).

During the first phase we calculate the partial utilities table for each customer using the UTASTAR algorithm. The meta-optimization process follows, which offers us the meta-optimization table for each customer. Each line of the specific $n \times n$ table (where $n = \# \text{criteria}$) contains the final values of the partial utilities from the n^{th} meta-optimized solution. The analysis is continued, using either the mean or the maximum values of each column of the aforementioned table, which are used in order to determine the significance of a criterion. A criterion is considered significant if its mean or maximum utility, mentioned earlier, is above a specific threshold. We can later calculate the percentages of the customers that consider significant some of the available criteria. Additionally, using different combinations of the criteria we can calculate the customers' percentages that attribute significance above the threshold and thus split the market into different groups based on the customers' answers.

The main objective of the simulation phase is to select the model that better approximates the current situation of a specific market segment. Using the partial utilities obtained in the previous phase, we can calculate the total utilities for each alternative and customer. The decision maker has in his/her disposal eight brand choice models namely: the Luce model (Luce 1959; 1977), the Lesourne model, (Lesourne, 1977), the McFadden 1 and 2 model (McFadden, 1974, 1976), the Utility Width 1 and 2 model and the Maximum Utility model (Matsatsinis, Samaras, 2000). Finally, using the values from the total utilities and the available models we can extract the market shares of each alternative.

3.3 The system

In order to prevent unauthorized access, each user (decision maker) must provide his/her personal user name and password. After a successful login, the set of the available questionnaires, associated with the specific user, are presented. The latter can select one of them and the corresponding statistical questions with the respective answers are demonstrated. The user can now focus his/her study on a specific customers group by choosing for example the answers of those customers that are above a specific age and are men.

Application frames. Our application, depicted in Figure 3-1, consists of three autonomous frames.

Specifically:

- A. The upper frame, which contains the application's name, the exit choice and the saving of the processed data.

- B. The control frame, where we can observe all the buttons associated with the process of the customers' answers.
- C. The presentation frame, where the results of the processing are demonstrated.

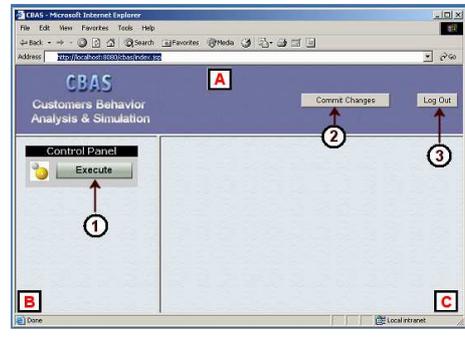


Figure 3-1: Application frames

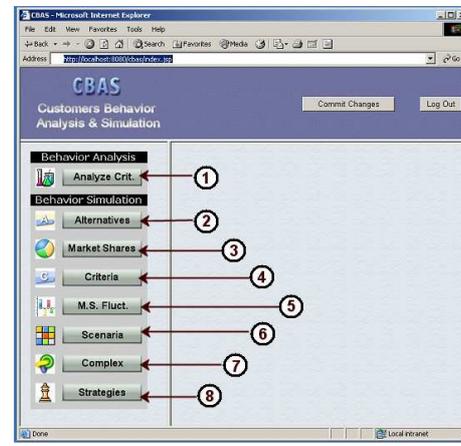


Figure 3-2: Control panel

Control panel. After executing the proposed methodology on the selected questionnaire (Figure 3-1_1), all the available functionalities are presented to the decision maker (Figure 3-2). The specific functionalities concern either the customers' behavior analysis (Figure 3-2_1) or the customers' behavior simulation (Figure 3-2_2-8). In particular the following tasks are available:

1. Analysis of the significance of the criteria. The criteria analysis is the first step in order to specify the threshold that the users associate to each criterion and in order to select the significance that will be used during the simulations.
2. Simulation with the customers' answers and addition of new alternatives.
3. Presentation of the market shares and selection of the brand choice models.
4. Addition of new criteria and re-execution of the UTASTAR algorithm.
5. Presentation of the competitive alternatives (products).
6. Creation of simulation scenarios and presentation of the new market shares.
7. Creation of complex scenarios and presentation of the variation of the market shares.
8. Focus on specific strategies and presentation of the variation of the market shares.

Criteria analysis. The specific analysis is the first step in order to determine the significance threshold that the customers associate to the criteria and subsequently determine the significance that will be used during the simulations.

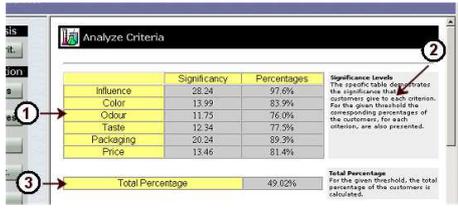


Figure 3-3: Customers' percentages

In Figure 3-3_1, the mean utility value for each criterion is presented followed by the percentage of the customers that attribute significance above a specific threshold (initially with a value equal to 20). The specific mean utility value is obtained from the meta-optimization table. Using the selected threshold and considering the provided significance of each criterion we obtain the percentage of the customers that offer answers that conform to the specific limitations (Figure 3-3_3). The decision maker can specify whether a criterion is significant, not significant or neutral (Figure 3-4_4) and change the value of the aforementioned threshold (Figure 3-4_5). Finally the new customers' percentages can be re-calculated (Figure 3-4_6) and the results are presented in a corresponding graph.

Alternatives. The alternatives are in fact the products that we examine. Using the corresponding button, the decision maker can manage or add new alternatives.



Figure 3-4: Determine significance



Figure 3-5: Alternatives management

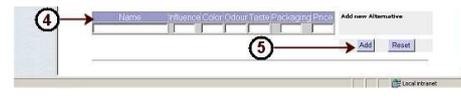


Figure 3-6: Alternatives addition

The table depicted in Figure 3-5_1, contains the mean values of the answers of all customers and for all the alternatives and the criteria. The decision maker can alter one of the specific values or exclude alternatives with no interest. The specific changes will be mirrored to all the customers' answers and the recalculation of the total utilities will be performed. Moreover the decision maker can add new alternatives (Figure 3-6) and re-execute the specific procedure.

Market shares. At any time the corresponding market shares can be presented in a pie graph (Figure 3-9), either using the initial alternatives or the new alternatives. Additionally, the user can choose among the eight brand choice models.

Criteria. Similarly to the alternatives paradigm, the decision maker can manage or add new criteria.

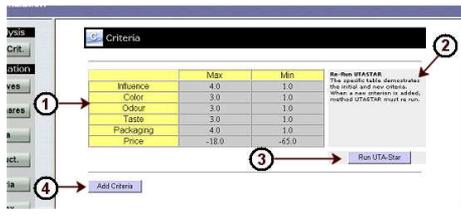


Figure 3-7: Criteria management

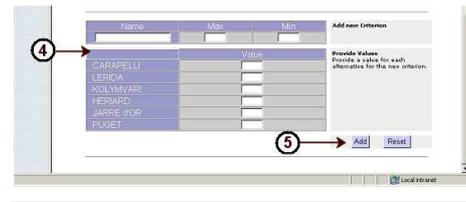


Figure 3-8: Criteria addition

As we can see in Figure 3-7_1 the available criteria with their corresponding minimum and maximum value are presented and the decision maker can add new criteria (Figure 3-8).

We should note that the addition of a criterion requires the re-execution of the UTASTAR algorithm in order to obtain new partial utilities for each customer and subsequently modified total utilities (Figure 3-7_3).

Market shares variation. The addition of new criteria, besides other benefits, helps us to identify competitive products. By comparing the initial market shares with those obtained after the addition of a criterion, we can get the fluctuation of the market shares presented in a bar chart (Figure 3-10). The specific chart presents the products that increase their share (positive value) and the products that encounter a decrease of their share (negative value). We can therefore identify the competitive products and focus our study on them.



Figure 3-9: Market shares

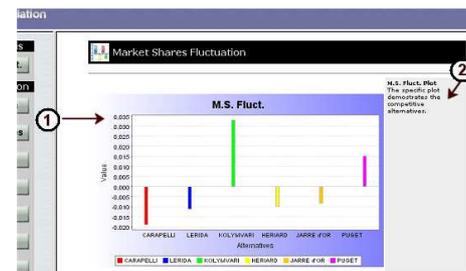


Figure 3-10: Market shares fluctuation graph

Scenarios. The objective of creating scenarios is to perform simulations of the customers' behavior rather easily, by altering the values of the criteria of interest. The decision maker can choose the criteria that will participate in the scenarios and the variation of their values (Figure 3-11_1). In a scenario we focus on one alternative and we compare it with the competitive alternatives (Figure 3-11_3).

The results as shown in Figure 3-12, are the created scenarios, which contain a specific value for each selected criterion, followed by the corresponding value of the market share of each alternative.

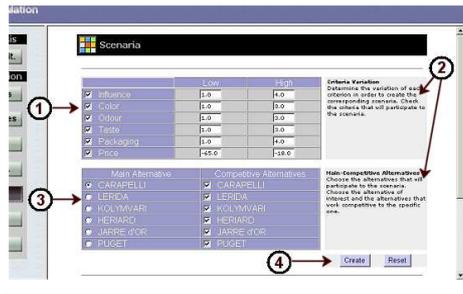


Figure 3-11: Create scenarios

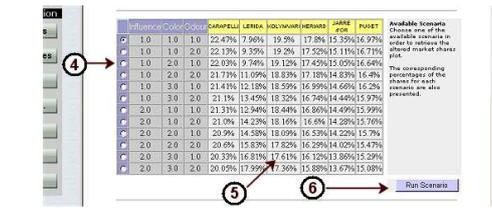


Figure 3-12: Scenarios results

Complex scenarios. The simulation process can be continued with the creation of complex scenarios. Whereas in the simple scenarios we specify the range of the criteria values, in the complex scenarios we choose one criterion as independent and create all the possible scenarios on the values the specific criterion can receive. The rest of the criteria receive a specific value from the user (Figure 3-13). Each scenario is applied on the alternative of interest and the comparison is performed with the competitive alternatives.

The simulation result is a graph, where the x-axis presents the values of the independent criterion and the y-axis demonstrates the market shares. Six plots that correspond to the six alternatives are depicted in Figure 3-14.

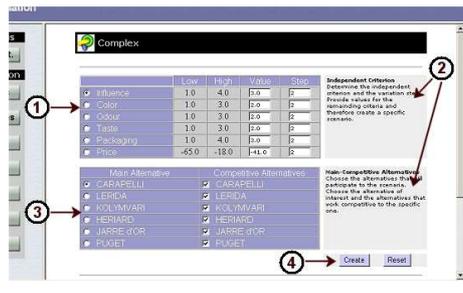


Figure 3-13: Create complex scenarios



Figure 3-14: Complex scenarios results

Strategies. We will conclude the simulation of the customers' behavior with the creation of strategies. These are in fact specific scenarios that we want to examine, utilizing the results obtained from the previous study. Once again we choose a criterion as independent (Figure 3-15_1) and focus on the market shares of the main alternative in respect with the competitive (Figure 3-15_4).

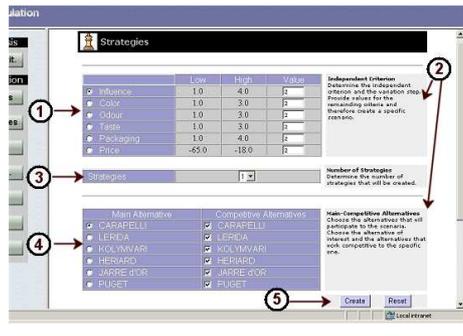


Figure 3-15: Create strategies

After specifying the number of strategies that we want to create (Figure 3-15_3), we can provide specific values for all the criteria, except for the independent (Figure 3-16).

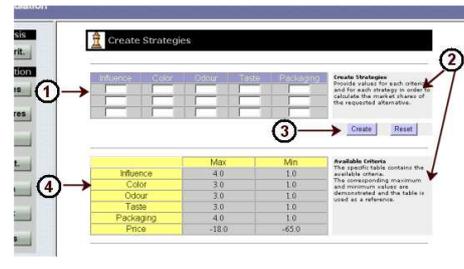


Figure 3-16: Create three strategies



Figure 3-17: Strategies results

Finally, in the resulted graph, the x-axis presents the values of the independent criterion and the y-axis demonstrates the market shares. The three depicted plots correspond to each of the three created strategies.

4. Conclusions

In this work we demonstrated a web based decision support system that can be used in the analysis and the simulation of the customers' behavior. We provided an overview of the functionalities that are offered to the decision maker through a French oil survey. It consists a user-friendly software system, with different representation capabilities (tables, graphs etc), capable of performing different tasks. Furthermore, it can be accessed through the Web and can be easily customized into different languages. Problems due to the lack or the high cost of experts can be solved quite satisfactory with the use of our system.

Our work could be improved with the utilization of brand choice models that incorporate the time parameter in order to observe the evolution of the market shares. The specific models can also incorporate quantitative measurements of the customers' satisfaction. An extension of our system could be the development of an expert system that would direct the sales towards specific markets, using available

distribution channels, taking into account the costs and means of transfer and considering the long-term objectives of the company.

5. References

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