Original scientific paper
UDC 663/664:336.1

NUTRITION BUSINESS MODELS OF CONSUMER BEHAVIOUR WHEN PURCHASING SELF-EXPLANATORY FOOD PRODUCTS

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Abstract

Successful operation of large companies is very dependent on having information on consumer's decisions and shopping schemes for best buyers. Various methods are used to predict their behaviour when purchasing food products. These phenomena are complex, but despite their diversity, they have structural and functional characteristics which can efficiently be simulated with modelling, and later on the basis of the generated model, to create powerful and easy to use software. The research subject of this paper is modelling for creating business models of consumer behaviour when purchasing food products, including the nutrition determinant. The aim is to develop a nutrition business model of consumer behaviour in order to obtain information on the extent of the impact of labelling when buying food products and information related to significant new elements of nutritional determinant that should be included in foodstuffs.

This paper showcases a concept of modelling for building a business model of consumer behaviour when purchasing food products. The model is developed by using modern technologies such as GIS and data mining. The modelling is done in several stages in relational entity connection, with a self-explanatory model. In order for there to be a partial implementation of the nutrition behaviour pattern, as part of the research a survey was conducted among students enrolled in the first and second cycle at the Faculty of Technology and Technical sciences in Veles and the analysis included statistical methods One of them is a Statistical model for t-test.

In building the business models of consumer behaviour when purchasing food products, it is necessary to use advanced methods and technology. This will contribute to raising business models to a higher level. Specifically, patterns of consumer nutrition behaviour will enable obtaining information on the impact and role of nutrition determinant on consumer behaviour and the need for improvement and production of healthy food products.

***Key words**: Nutrition Business Model for Consumer Behaviour, Nutrition Modelling, Data Mining, GIS.*

1. Introduction

Economic development and profit have structural and functional characteristics, and one of the main tasks of large companies is to learn the behaviour of consumers. This is a complex task, because there is no ready formula for human behaviour when buying, and oftentimes the consumers themselves do not know what influenced their purchase. Therefore, comprehensive research methods are needed with the main objective to identify all the key determinants affecting the purchase. One of the possibilities in order to obtain a lot of answers for consumer behaviour is creating business models of consumer behaviour.

Human behaviour when buying, although it has many diverse forms, can be presented as a complex system, which consists of structural and functional characteristics that can effectively be stimulated by dynamic modelling and creating a model, and later on the basis of that model, can be used to create a powerful and easy to use software. As a result, the nature of human behaviour when buying can be studied, in all the parts of its complexity and all dynamic behaviours can be analysed in a series of assumptions and conditions.

In the creation of these models we need to include methodologies and concepts by using modern technology such as: Database Management Systems (DBMS), Geographic information system (GIS), which enables creating system models that can describe

the current situation and project the future, advanced analysis of databases by using advanced methods of data mining, that will allow getting good information on consumer behaviour etc. [12, and 14].

Databases on consumers and their consumer behaviour are very important, they are inherently geographical, and may contribute to identify all customers. Also, marketing research (exploratory, descriptive and causal research) is a component in the identification of customers, what they buy, their way of life and their unique buying habits. One of the commonly used marketing methods is descriptive research via a survey, which allows collection of primary data and creating of databases, which can be very useful for the business model of consumer behaviour.

Trends for the prevention of diseases in developed countries are increasingly moving towards the consumption of a healthy diet. A large number of studies show that there more and more consumers of food products are paying much more attention to their diet and increasingly considering nutritional properties of foodstuffs [6, 8, and 10]. This type of information is significant for bigger companies in the food industry, because understanding how consumers view nutritional quality of the food, knowing the various elements that stimulate the purchase, could help expand the profile of the brand, to improve and to develop it. Creation of nutritional business models is significant, because this will determine the degree of impact of the determinant - nutritional properties (vitamins, minerals and other beneficial ingredients to the body) in the purchase of products [13].

Building good nutritional model of consumer behaviour when purchasing food products will enable companies to get answers to questions about their marketing strategy, but also for the need for improvement and production of healthy food products. Also, parallel to this there is significant development in the area of planning in the health sector, nutrition and prevention of diseases by using the so-called PSS (Planning Support System) [2 and 3].

2. Materials and Methods

2.1 Nutritional business model for consumer behaviour

In studies and practice, we meet several types of consumer behaviour models, such as: deterministic or probabilistic, linear ODE model, lumped model or agent model, continuous product range or finite number of brands, continuous valued or discrete valued, continuous time or discrete time, identical consumers or different consumers, and etc. The previously pointed out models are constructed for specific cases, they are analytical and statistical (mathematical and logical models) and use binary comparison and networks [1, 5, 11]. In most there are psychological and sociological (Markov model) determinants included [9], but do not include the determinant - nutritive properties of food products. Regarding the understanding of these models, very little has been done and it has been reduced to a help section. I believe that the level of understanding of business models should be raised to a higher level.

The nutritional business model of consumer behaviour I propose is not a classic mathematical model. It can include mathematics, statistics, and other methodologies such as economic and geographic. The second important characteristic is for this model to be self-explanatory, which means that for every output there shall be an explanation, i.e. an explanation of the relations from the input parameters and used methods. Thus, its applicability and development shall drastically be improved. In the further text we shall show an original concept of modelling that will enable improving the consumer behaviour business models.

2.2 Nutrition determinant of the business model

Our research shows that the consumers of food products are more and more sensitive to the product declarations found on the food products, particularly to nutritional properties. The nutritional properties elements that can be found as part of the declaration of the foodstuffs and are of interest to the consumers, include: energy value, fats and saturated fats, amount of sugars and proteins, carbohydrates, vitamins, minerals, fibres, nutrition and health claims, sensory attributes (colour, aroma, taste), product safety and certification (for example, organic, quality, etc.)

In the nutritive business model, apart from the other general determinants (cultural, social, personal, psychological) a new determinant has been included, called nutrition, which contains elements that are of interest to the consumers, and which were previously stated.

2.3 Geographic information system

The Geographic information system (GIS) as an advanced information technology contains a great range of tools, including tools for: economic and demographic analysis; spatial analysis, for example for analysis and creation of regions for organic farming [17]; for urban and transport planning; for creation of health regions; for marketing needs by building marketing thematic maps [7]; general use of the GIS in the economy sector [18]; etc.

Using the GIS as an advanced technology in the nutritive business models is one of the advantages in relation to other types of models, because it provides an opportunity to impressively convey the real world into digital form through relations and discrete objects,

and then analyse it spatially in a certain reference system (geospatial data). Other advantages offered by the GIS can be used in the nutritional business models, and these include: using geography can help in the design of appropriate marketing techniques; in spatial and non-spatial segmentation and targeting of customers based on geographic and psychographic characteristics; in identification of specific consumer groups categorized by common characteristics; in defining profitable geographical areas, identifying and targeting of best customers; etc.

3. Results and Discussion

3.1 Modelling for creation of the nutritive business model of consumer behavior

The modelling for creating a nutritive business model of consumer behaviour, which I propose, consists of several stages, where entities are defined in a relational model (E-R model).

In Stage 1, called "Output - Methodology - Input", we set an entity relational connection (Figure 1). First in the entity Output, all of the model outputs are defined, and the shopper responses or shopper behaviour are characteristic for the nutritive business model of consumer behaviour. The Output can be in the form of analytic data or a graphic display (thematic maps) contained in the GIS layers.

On the basis of the outputs, the entity Methodology is defined, i.e. the necessary methodology is defined that is needed to obtain them. In using advanced methodology and technology, methods of GIS and data mining are important [16] and they include: basic concepts of mining of frequent forms, association and correlation; classification; decision trees; Bayes classification method; models of evaluation and selection; methods of cluster analysis and evaluation of Clustering [4].

GIS functions that can be applied as methods are: Binary models - for spatial query, Logical models - spatial collection, Index models - spatial ranking, Regression models - prediction and assessment, Process Models - defining the processes in the real world represented in a set of relations and equations ([7, and 19]).

On the basis of the methodology the entity Inputs and the entity Data sources are defined. In order to get all the previously defined outputs, it is necessary to define all the necessary inputs. General inputs can be of two types: spatial and non-spatial (attribute). Data sources of inputs can be different, but for a nutritional business models it is important to use databases on consumer behaviour derived from marketing research (surveys, consumer databases) and so on.

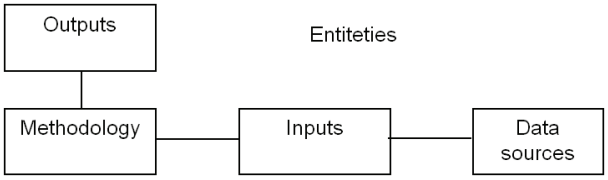

Figure 1. Relational connection of the entities from stage 1

Stage 2 - Conceptual model, consists of defining all the relations between the entities from the first stage and all of the strategies needed for building the business model. Here all the entity relations among outputs are defined, as well as the used methodology and inputs. An important aspect is the defining of the structure of the entities and the manner of constructing the self-explanatory component of the model. One way to create the self-explanatory component of the model is for the structure of the entities from stage 1 to be a systemic relational structure, which will be self-explanatory, i.e. will explain each individual output (figure 2).

As an example we have:

Output (2) = t test - in order to statistically determine the existence of probability of the answers on the degree of influence from questions 4 (Table 1) and 12 (Table 2) [20].

Output (4) = frequency of answers on the degree of influence of question 7 (Table 3) of a conducted survey for determining the influence of nutritive properties on consumer behaviour; and output (5) distribution of patterns [20].

Table 1. Question 4: How much attention do you pay to nutritional properties when purchasing food stuffs? (Single answer)

Choice	Degree				
	A little				A lot
	1	2	3	4	5
Question 4					

Table 2. Question 12: How much do you influence your family and friends, regarding the importance of nutritional properties when buying food products? (Single answer)

Choice	Degree				
	A little				A lot
	1	2	3	4	5
Question 12					

Table3. Question 7: Choose the degree of influence of given nutritive properties when purchasing foodstuffs (multiple answers).

Scale	Degree	Energy Value	Fats	Carbohydrates	Fibres	Recommended daily intake of vitamins/ minerals	Nutrition and health claims
A little	1						
	2						
	3						
	4						
A lot	5						

Table 4. Output (2) - Statistical model for t-test

Parameter	Value	Description
μ =	0	Null hypothesis for assumption
n =	406	Sample size
α =	0,05	Significance level
df = n-1	405	Degrees of freedom
s.e.= STDEV/√n	0.026088	Standard error
ẍ	0.157635	Is the sample mean
t_{abs} = (ẍ - μ)/s.e.	6.042372	Test statistic
$t_{crit=}$ INV (α, df)	1.965839	Critical value of t
Degree -question 4 (1 to 5)		
Degree -question 12 (1 to 5)		
$t_{abs} > t_{crit}$	6.042372 > 1.965839	If $t_{abs} > t_{crit}$ then "the null hypothesis is rejected" or "the null hypothesis is accepted, i.e. the events are accidental"

For output (2) (Table 4) a methodology for determining t-test is used: Methodology (2,2) = Excel data analysis for paired samples. For the inputs, the defined input is Input (1, 2) = attributes: degree-question 4 and degree-question 12, and Input (2, 2) = μ, α (μ - Null hypothesis for assumption, α - Significance level), and the data source is: Data source (1, 2) = Database from survey (survey for determining influence of nutritive properties on consumer behaviour).

For output (4) and output (5) a methodology for determining frequency is used: Methodology (5,4) = Excel frequency method and Methodology (6,5)= Frequent Pattern Mining/The Apriori Algorithm. For the inputs, the defined input is (4,5) = attributes from question 7 for degree of influence of nutritive properties when purchasing foodstuffs, and the data source is: Data source (1,4) = Database from survey (survey for determining influence of nutritive properties on consumer behaviour). In Figure 3, output (4) is shown - a graph of the frequency for answers of question 7, and in figure 4 output (5) is shown - graph on the distribution of patterns for Fats-Fibres-Vitamins/minerals [20].

Stage 3: Logical model all relations between entities in the E-R model are set. This modelling concept will enable self-explanation of the process. That means that for each output there is a specific explanation as to how to obtain it and which models have been used. Thus the model is raised to a higher level of understanding.

For outputs the model can provide a self-explanation:

- **Self-explanation output (2)** = data from the survey for determining the influence of nutritive properties when purchasing were used, a t-test was used (calculates the frequency of values within the range of values) and the output is represented in the form of a Table (Table 4). The relation tabs > tcrit points to the fact that the selection of answer for the degree of questions 4 and 12 are not accidentally statistically and are 95% a logical pair (relation).

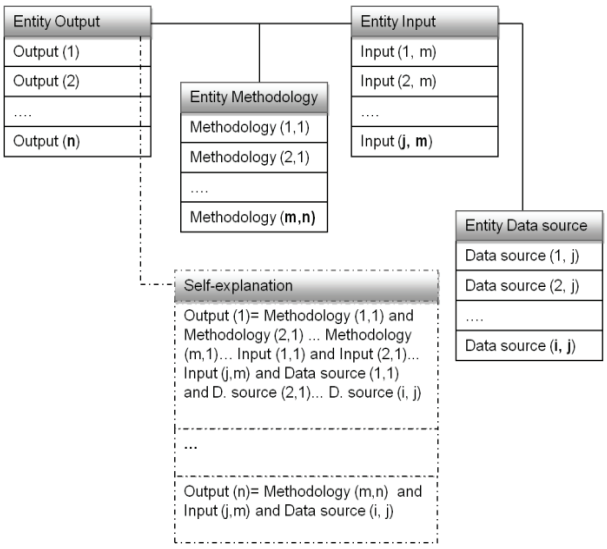

Figure 2. Structure of entities from stage 2

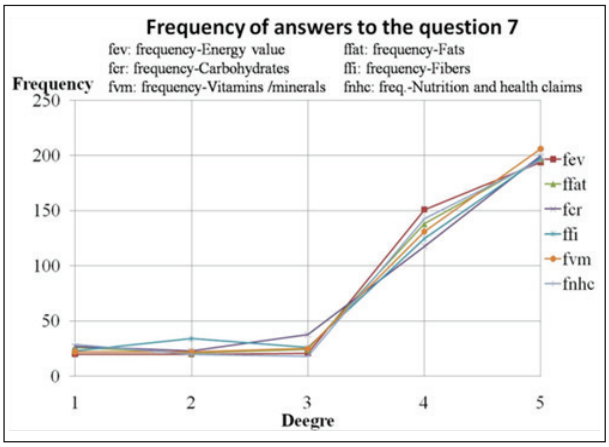

Figure 3. Output (4) - graph of the frequency for answers of question 7

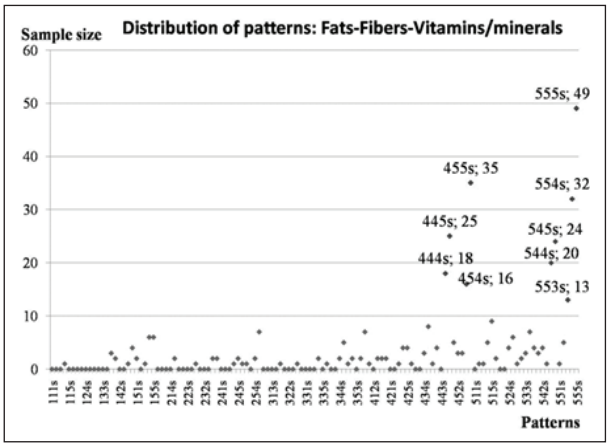

Figure 4. Output (5) - distribution of patterns: Fats-Fibres-Vitamins/minerals

▪ **Self-explanation output (4)** = data from the survey for determining the influence of nutritive properties when purchasing were used, a FREQUENCY METHOD was used (calculates the frequency of values within the range of values) and the output is graphically represented in the form of a graph (Figure 3).

▪ **Self-explanation output (5)** = data from the survey for determining the influence of nutritive properties when purchasing were used, a Frequent Pattern Mining / the Apriori Algorithm was used (Apriori was designed to process databases that contain transactions, and as it is usually the case in data mining, to find subgroups that are common, etc.) *и* and the output is graphically represented in the form of a graph (Figure 4).

This concept further development of the model is in an easy and simple manner.

Stage 4: Physical model is the stage of realizing the logical model into a software solution. The design was done in a software development environment, with integration of existing GIS software (ESRI software), with integration of DBMS (SQL) and data mining software (specifically I used the WEKA software [15]).

Stage 5: Verification. The business model is verified with test data. The output data is analysed, and this can be done easily now because self-understanding, or rather self-explanation is built into the physical model, i.e. every output obtained is explained. Verification of the model can cause general changes: minor changes in the model entities in stage 4 and major changes starting from stage 1.

4. Conclusions

- In a great number of European states, investments are made in educating people and opening study programs at the high education institutions, regarding the significance of a healthy diet and nutritive attributes of foodstuffs. Also, a large number of EU projects feature consumer behaviour when purchasing foodstuffs. Because of this and because of the way modern life is, the trend of the influence of nutritional attributes in the purchase of foodstuffs will be much greater, and the construction and use of nutritional business models of consumer behaviour shall be an important part in the business of companies that manufacture food products.

- For building a good business model, advanced scientific methods and technologies such as: GIS and DBMS, and advanced data analysis with data mining, are used. The modelling concept which is represented in five stages, where all of the important functions are defined as entities in an E-R model, will enable raising the business models on a higher level, will make it possible to better understand the modelling process itself and its better implementation into the system, and this will improve the results, will make it easier to use and easier to develop.

- The benefit of the business models of consumer behaviour when purchasing foodstuffs can be threefold: benefits for the companies through developing new foodstuffs that would satisfy consumers, and thus increase the profit, benefits for the citizens in their consumption of healthy and safe products, and benefits for the country.

- Future steps in modelling and building business models are: the inclusion of expert systems and inclusion of ready-made tools in the software development environment for embedded self-explanation of the process, which will make the entire process easier.

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