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# Self-Explanatory Nutrition Business Models of Consumer Behavior

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***ABSTRACT:*** *Research on the degree of influence of nutritional properties (labeling) of foodstuffs on consumer behavior shows an increasing trend, and therefore, the successful operation of large companies may depend on the inclusion of the nutritional status determinant in their food stuffs. Although consumer behavior is complex and different, it has structural and functional characteristics which can efficiently be simulated with modeling, and later on the basis of the generated model, to create software which is powerful and easy to use.*
***The research subject*** *of this paper is the use of modeling for creating business models of consumer behavior when purchasing food products, by including the determinant of nutritional status and involving a self-explanatory component. The* ***first objective*** *is to develop a nutrition business model of consumer behavior in order to obtain information on the extent of the impact of nutritional labeling when buying food products and information related to significant new elements of the nutritional determinant that should be included in foodstuffs. The* ***second objective*** *is to implement in the business model an explanation of that model so that the user could obtain information on the methodologies used, i.e. an explanation of how the output was obtained in correlation with the methodologies and model input.*
***This paper*** *showcases a concept of modeling for building a business model of consumer behavior. The model is developed by using modern technologies such as Geographic information system (GIS) and data mining. The modeling is done in several stages in an entity-relationship diagram,* ***by including a so called self-explanatory component in the model.*** *A partial implementation of the nutrition behavior pattern was done with data obtained from the survey conducted among students enrolled in the first and second cycle at the Faculty of Technology and Technical Sciences in Veles, R.Macedonia and the analysis included statistical methods and data mining.*
***Keywords:*** *Data Mining, GIS, Nutrition Business Model , Modeling, Self-explanatory*

## I. INTRODUCTION

Some of the main tasks of big companies are their technical-technological development and making profits, but apart from these, their marketing strategies and implementation are as significant. The best business concept or an idea can fail if they haven't appropriately been presented to the consumers. Determining consumer behavior is a complex task because there isn't a readymade formula for consumer behavior when shopping, and often even the consumers themselves don't know what instigates them to make a certain purchase. Therefore, comprehensive research methods are needed with the main objective to identify all the key determinants affecting consumer behavior. Human behavior when purchasing products, apart form its diversity, can be presented as a complex system, which consists of structural and functional characteristics that can effectively be stimulated by dynamic modeling and creating a model. As a result, the nature of human behavior when purchasing can be studied, in all the parts of its complexity and all dynamic behaviors can be analyzed in a series of assumptions and conditions.

It is necessary to include scientific methodologies and concepts the creation of business models. Also it is good to use modern technology where necessary, such as: Database Management Systems (DBMS), where the consumer databases and their purchasing behavior are very important and where they can contribute for the identification of such data; Geographic information system (GIS), which enables creating system models that can describe the current situation and project the future via spatial models; as well as advanced analysis of databases by using advanced methods of data mining, that will allow getting schemes of consumer behavior [1] [2].

One component in the identification of consumers is marketing research (exploratory, descriptive and causal research design) which encompasses several studies: what consumers purchase, what is their way of life and what are their shopping habits [3]. One of the frequently used marketing methods is conducting a survey, which enables collection of primary data and creation of databases, which are very useful for the consumer behavior business model. Many studies show that the number of consumers of food stuffs that watch their diet has increased and that they consider nutritive characteristics of food stuffs [4] [5] [6]. This information is of importance to the big companies from the food sector, because knowing which different nutritive elements

(vitamins, minerals and other ingredients useful for the organism) stimulate a purchase, can help in the expansion of the brand profile, its improvement and development.
Design of a good nutritional model of consumer behavior and simultaneous development in the area of planning in the health sector, nutrition and prevention of diseases by using the so-called PSS (Planning Support System), [7] [8], will enable companies to get answers to questions about their marketing strategy.

## II. NUTRITIONAL BUSINESS MODEL OF CONSUMER BEHAVIOR

In the development of consumer behavior models, we come across several types of models: agent-based and lumped-system modeling, continuous product range or finite number of brands models, deterministic or probabilistic, linear ODE models, continuous valued or discrete valued, continuous time or discrete time, models with identical consumers or different consumers and etc. The main feature of these models is the inclusion of analytic, statistic and logical models, by use of binary comparisons, and they are customized to certain cases [9] [10] [11]. They include psychological, sociological (Markov model) and cultural [12] determinants, but none of these include the nutritional properties determinant of food stuffs. **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 is not sufficient and there could be difficulties in its use.
The nutritional business model of consumer behavior I propose is not a classic mathematical or statistical model. It can include mathematics, statistics, as well as other methodologies such as economic and geographic. The second important property of this model is to provide an explanation on the used models for each output, the needed input and the data sources. Thus, its applicability and development shall drastically be improved. Further on in this paper we shall show an original concept of modeling that will enable improving the consumer behavior business models.

### 2.1. Nutrition determinant of the business model

My research on nutritional properties, which can have an influence on the decision making when purchasing food stuffs, shows that consumers pay more and more attention to product declarations found on the food products, particularly those with included nutritional properties [13]. Studies on the importance of nutritional properties for consumers have been conducted for the member states of the European Union and the Republic of Macedonia. As a summary of these, apart from the general determinants (cultural, social, personal, psychological), we can define the nutritional determinant with elements of the nutrition properties that are of interest to consumers and which should be included in the food stuffs declaration, and they are the following:

- energy value,
- fats and saturated fats,
- amount of sugars and proteins,
- carbohydrates, vitamins,
- minerals,
- fibers,
- nutrition and health claims,
- sensory attributes (color, aroma, taste),
- product safety and
- Certification (for example, organic, quality, etc.)

### 2.2. Geographic information system in business models

Where can we include the Geographic information system (GIS) in the nutrition business models? GIS is as an advanced information technology that 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 [14]**;** for urban and transport planning**;** for creation of health regions; for marketing needs by building marketing thematic maps [15]; general use of the GIS in the economy sector [16]; 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 better convey the real world into digital form through relations and discrete objects, and then analyze it spatially in a certain reference system (with geospatial data). Other advantages offered by the GIS in the nutritional business models include: using geography that can help in the design of appropriate marketing techniques in spatial segmentation and targeting of customers based on geographic and psychographic characteristics; in identification of specific consumer groups categorized by common characteristics, for example consumers from urban environments that pay attention to the nutritional properties; in defining profitable geographical areas, geographic identifying and targeting of best customers; etc.

**2.3. Data bases and data mining in business models**

Databases are needed in any business, and any business model. Data mining is a process for data research conducted by using efficient algorithms for tracking frequent item sets in large databases, including the A-Priori algorithm and its expansions. One of the most important goals of sales managers is to obtain quality information. This information is obtained from association rules, meaning that if consumers buy a certain item set, they shall probably be liable to purchase other related items. Also, data mining uses very efficient algorithms to track the frequent item sets. Apart from the A-Priori algorithm, other types of algorithms are used, such as basic concepts of data mining of frequent forms, association and correlation; classification; decision trees; Bayes method of classification; models of evaluation and selection; methods of cluster analysis and evaluation of clustering [17]. Because one of the aims of nutrition business models of consumer behavior is obtaining of quality information on consumer behavior, it is necessary to include data mining.

**2.4. Modeling concept for designing a nutrition business model of consumer behavior**

The modeling concept for creating a nutritive business model of consumer behavior, 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 define three main groups of entities related amongst each other (Fig. 1).

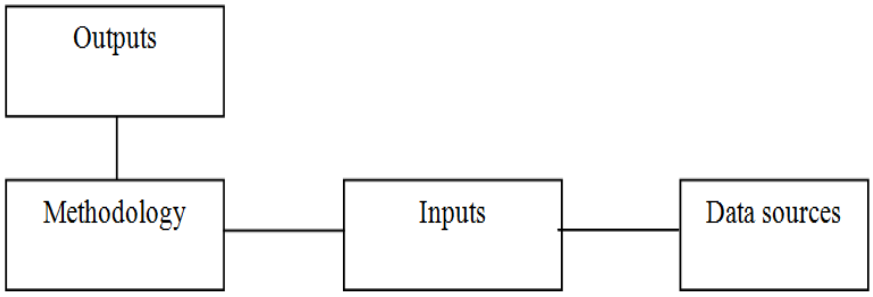


**Figure 1** main entity in Stage 1

First in the entity Output, all of the model outputs are defined, and certainly a group of the outputs is used for obtaining the degree of impact of nutrition properties on consumer behavior, individually or in a pattern of several nutritional properties that were previously listed in the nutritional determinant. The output can be in the form of analytical data (mathematical, statistical) or graphic display in the form of a picture, graph or thematic maps contained in the GIS layers.

Second of all, 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 [18] and they include: basic concepts of mining of frequent forms, association and correlation; classification and others that were listed before. The 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, [19].

Third, from the previously defined methodologies, we determine the necessary inputs and data sources. That is how we define the entity Inputs and the entity Data sources. Generally speaking, inputs can be of two types: spatial and non spatial (attribute). Data sources of inputs can be of various kinds, but for a nutritional business models it is important to use databases on consumer behavior derived from marketing research (surveys, consumer databases and so on).

**Stage 2** – **A conceptual model** consists of defining all the entities, and relations between the entities, 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 to be a systemic relational structure, which will be self-explanatory, i.e. will explain each individual output (Fig. 2). The main groups from stage one are divided into entities part of a relational model. This concept of several entities divided into groups is excellent because these models include several different technologies that have many different methodologies. For example, the GIS methods are different from the data mining methods and other mathematic-statistical methods.

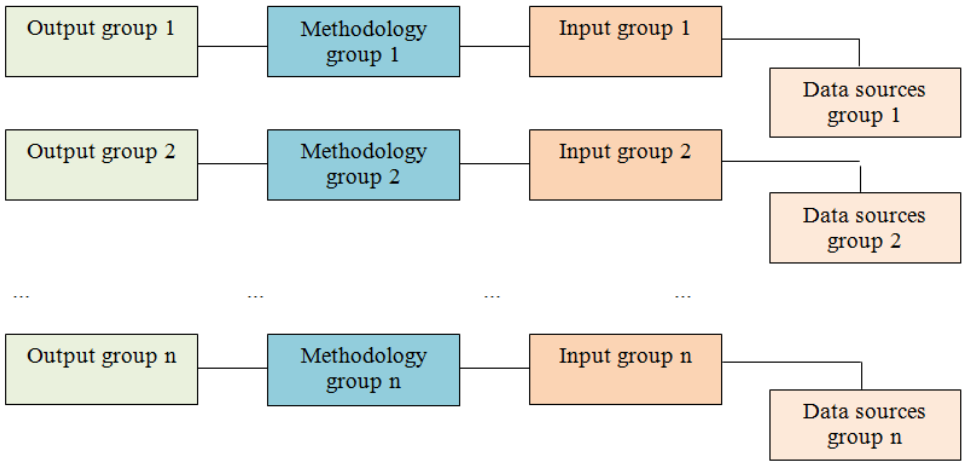


**Figure 2** Structure of entities from stage 2

**Stage 3**: Logical model - all relations between entities in the E-R model are set, so obtaining the self-explanatory component of the process is provided. That means that for each output there shall be a specific explanation as to how to obtain it and which models, inputs and data sources have been used (Fig. 3). This concept enables further development of the model in an easy and simple manner.

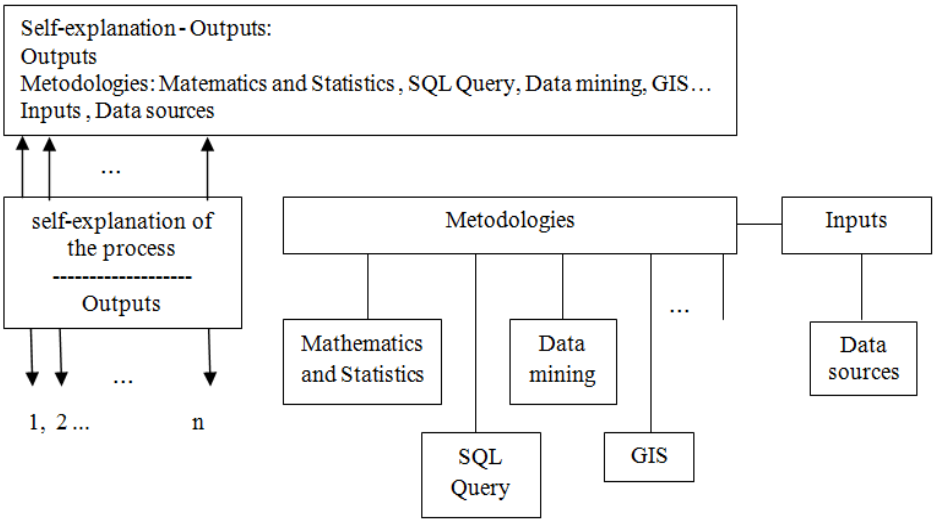


**Figure 3** Self-explanatory feature of the process.

**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 (for example, ESRI software), with integration of DBMS (SQL) and data mining software (specifically, I used the WEKA software [20]).

**Stage 5**: Verification, the last stage of modeling is always necessary and significant and it includes verification of the business model with test data. The output data is analyzed, 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 when an error in the physical model appears, and major changes starting from stage 1, in case one of the outputs can not be obtained, and thus a redefining must be made in stage 1 for the specific outputs.

**2.5. An example of implementation of the nutritional business model of consumer behavior**

To determine the level of the impact of the nutrition determinant on the behavior, we interviewed a special group in a separate group of consumers of food products – students from the Faculty of Technological and Technical Sciences in Veles in all four years of the study program "Nutrition and food technology and biotechnology", as well as students from the second cycle of studies at the study programs: Nutrition and Quality management and food safety, and a total of 460 students were surveyed. The survey consists of 12 questions related to nutritional determinant, namely:

**Table 1.** Question 1: Gender (Single answer)

| **Choice** | male | female |
|---|---|---|
| | 1 | 2 |
| Question 1 | | |

**Table 2.** Question 2: Age (Single answer)

| **Choice** | from 18 to | from 31 to | >45 |
|---|---|---|---|
| | 1 | 2 | 3 |
| Question 2 | | | |

**Table 3.** Question 3: Study year (Single answer)

| **Choice** | *Study year / Master* | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | Master |
| Question 3 | | | | | |

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

| **Choice** | **Degree** | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Question 4 | | | | | |

**Table 5.** Question 5**:** When you buy a product because of its nutritional properties, how much do the following sources of information on these properties affect your decision? (Multiple answers)

| **Choice** | **Degree** | | | | |
|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** |
| Labeling (label) of the product | | | | | |
| Previous knowledge of nutritional | | | | | |
| The history of use of the product | | | | | |
| Promotion (advertising) of the nutritional properties of the product | | | | | |
| Recognition of the brand product | | | | | |

**Table 6.** Question 6**:** How well do you understand (select the degree of how well you understand and interpret the meaning of) the section on the product where the nutrition facts are labeled? (Multiple answers)

| **Choice** | **Degree** | | | | |
|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** |
| Declared Energy Value | | | | | |
| The amount of fats and saturated fats | | | | | |
| The amount of sugars and proteins | | | | | |
| The amount of fibers | | | | | |
| Vitamins /minerals as part of the recommended daily intake | | | | | |
| Nutrition and health claims | | | | | |

**Table 7.** Question 7: Select the degree of influence of given nutritional properties when buying food products (Multiple answers)

| **Choice** | **Degree** | | | | |
|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** |
| Energy value | | | | | |
| Fats | | | | | |
| Carbohydrates | | | | | |
| Fibers | | | | | |
| Vitamins /minerals | | | | | |
| Nutrition and health claims | | | | | |

**Table 8.** Question 8: Choose the importance of the given attributes when buying food products (Multiple answers)

| **Choice** | **Degree** | | | | |
|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** |
| Sensory attributes (color, aroma, taste) | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Price | | | | | |
| Product safety | | | | | |
| Brand | | | | | |
| Certification<br>(for example: organic, quality | | | | | |

**Table 9.** Question 9: Select the level of receiving information about the importance of nutritional properties of food products for the human organism (Multiple answer)

| **Choice** | **Degree** | | | | |
|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** |
| Learning at the University | | | | | |
| Books and scientific publications | | | | | |
| The Internet | | | | | |
| Mass Media | | | | | |
| Experts | | | | | |
| Scientific conferences - seminars | | | | | |

**Table 10.** Question 10: Select the level of influence on your decision to purchase a product regarding the information obtained about the importance of the nutritional properties of food products for the human organism, presented in a given resource (Multiple answers)

| **Choice** | **Degree** | | | | |
|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** |
| Learning at the University | | | | | |
| Books and scientific publications | | | | | |
| Internet | | | | | |
| Mass media | | | | | |
| Experts | | | | | |
| Scientific conferences - seminars | | | | | |

**Table 11.** Question 11: Do you think that other consumers of food products receive enough information about the importance of the nutritional properties of food products for the human organism? (Single answer)

| **Choice** | **Degree** | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Question 11 | | | | | |

**Table 12.** 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** | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Question 12 | | | | | |

A database was created from this survey and a great number of analyses were conducted, wherefrom the defined outputs were obtained. Two outputs are given as an example: Output (1) = To determine statistically the probability of the occurrence of the answers to questions 4 and 12 to determine the degree of influence from of nutrition properties on consumer behavior and the degree of influence on other consumers, t-test was used; and Output (2) = To the determine the distribution of answer patterns to questions 4 and 12.

**Output (1):**
**Output** (1) = t test – in order to statistically determine the existence of probability of the answers on the degree of influence from questions 4 and 12.
**Methodology** (1.1) = Excel data analysis for paired samples (t-test), (table 13).
**Input** (1.1) = attributes: degree-question 4 and degree-question 12.
**Input** (2.1) = $\mu$, $\alpha$
$\mu$ - Null hypothesis for assumption = 0
$\alpha$ - Significance level = 0.05
**Data source** (1.1) = Database from survey

**Table 13.** Methodology - Statistical model for t-test

| Parameter | Value | Description |
|---|---|---|
| $\mu$= | 0 | Null hypothesis for assumption |

| | | |
|---|---|---|
| n= | 450 | Sample size |
| α= | 0.05 | Significance level |
| df=n-1 | 449 | Degrees of freedom |
| s.e.=STDEV/√n | | Standard error |
| ẍ | | Is the sample mean |
| $t_{abs}$= (ẍ - μ)/s.e. | | Test statistic |
| $t_{crit}$= INV(α,df) | | Critical value of t |
| Degree -question 4 (1 to 5) | | |
| Degree -question 12 (1 to 5) | | |
| $t_{abs}>t_{crit}$ | | If $t_{abs}>t_{crit}$ then "the null hypothesis is rejected" or "the null hypothesis is accepted, i.e. the events are accidental" |

**Result Output (1):** obtained in Excel (Table 14). 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).

**Table 14.** Result from statistical model for t-test - Excel data analysis for paired samples

| Parameter | Values | |
|---|---|---|
| μ= | 0 | |
| α= | 0,05 | |
| n= | 406 | |
| df= | 405 | |
| stdev= | 0,605254 | |
| ẍ= | 0,32 | |
| s.e.= | 0,027068 | |
| tabs= | 11,82217 | |
| tcrit= | 1,964729 | |
| $t_{abs}>t_{crit}$ | 11,82217> 1,964729 | 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 |

Self-explanatory component of the model for Output (1) is:
- Metodology is:
Methodology (1,1)= Excel data analysis for paired samples (t-test), where:
μ - Null hypothesis for assumption , α - Significance level
n=number of of surveyed, s.e.=STDEV/□ n- Standard error, ẍ - Is the sample mean, tabs=(ẍ - μ)/s.e. - Test statistic, tcrit= INV(α,df), Critical value of t, If tabs>tcrit then "the null hypothesis is rejected" or "the null hypothesis is accepted, i.e. the events are accidental".
- Input is:
Input (1,1) = attributes: degree-question 4 and degree-question 12.
Input (2,1) = μ=0, α=0,05, n=460

**Output (2):**
**Output** (2) = Distribution of patterns is obtained for the answers of the degree in questions 4 and 12
For **Methodology** (2.2), the entity SQL(1) is created and the SQL Query1 is defined in it:

```
SELECT Question4, Question12, count (degree4) AS CountOfdegree4
FROM anketa
GROUP BY survey.degree4,survey.degree12
HAVING (((degree4)=5 Or (degree4)=4) AND ((degree12)=5 Or (degree12)=4));
```

This questionnaire selects answers to questions 4 and 12 with a degree from 4 to 5 paired as a pattern, and their frequency is measured.

For the **Methodology** (3,2), the entity **DataMininig**(1) is created, where the methods of Data mining, Frequent Pattern Mining / The Apriori Algorithm are defined.
Methodology (3,2)= Data mining, Frequent Pattern Mining / The Apriori Algorithm.

**Input** (3,2) = attributes: degree-question 4 and degree-question 12.

**Data source** (1,2)= Database from survey

**Result Output (2):**

1. With Query 1 the frequency of patterns of the answers is obtained, for the degree in questions 4 and 12. The number of patterns: 55, 44, 45 and 54 is 75% from the total number of all patterns (460).
2. With the method of Data mining e the distribution of patterns is obtained for the answers of the degree in questions 4 and 12 (Fig. 4).

From the obtained results of Output (2) a general conclusion can be adopted:

- a high degree of influence of the nutritional properties when purchasing food stuffs,
- a great influence of the surveyed on their family, friends and other persons, for the significance of nutritional properties.

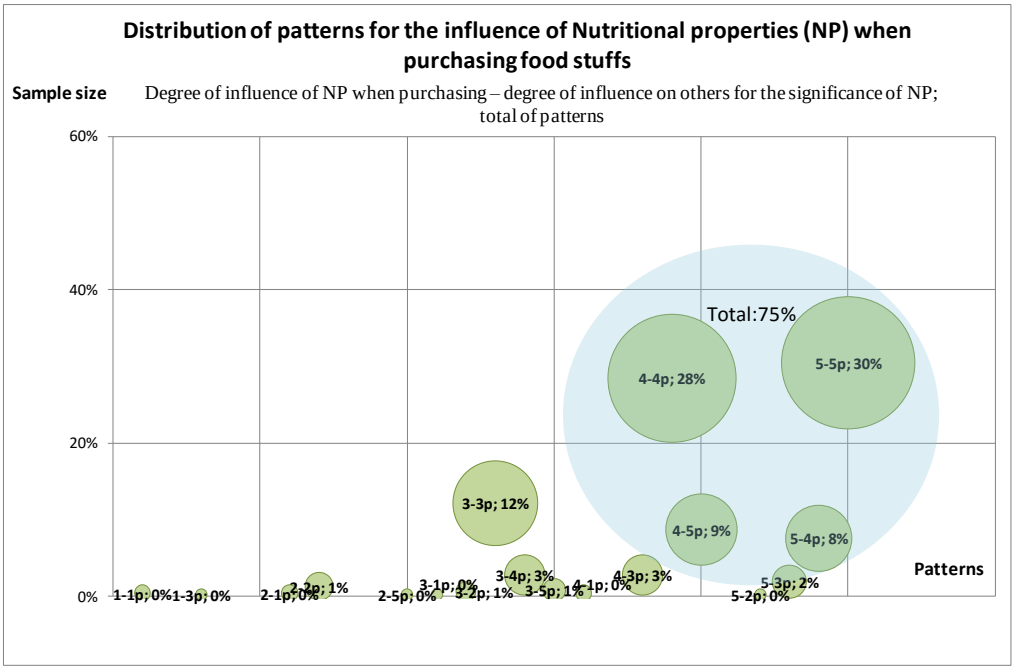


**Figure 4** Distribution of patterns for the degree of influence of answers to questions 4 и 12.

**Self-explanation of output (2):**

1. To determine the percentage of respondents, who answered the questions 4 and 12, as patterns with a degree from 4 to 5, the SQL query for selecting and summarizing was used.
2. To determine the pattern of answer distribution to questions 4 and 5, a data mining method was used, Frequent Pattern Mining / Apriori Algorithm, that provides the distribution of all patterns for the degree of influence of answers so questions 4 и 12.

## III. CONCLUSION

In a great number of European states, investments are made in educating people regarding the significance of a healthy diet and nutritive attributes of foodstuffs. Study programs in Nutrition at the high education institutions in the EU are opened, and in the Republic of Macedonia, study programs in Nutrition have been commenced in the first, second and third cycle of studies at the Faculty of Technological and Technical Sciences in Veles. Also, a large number of EU projects feature consumer behavior when purchasing foodstuffs. Because of this and because of the way modern life functions, nutritional properties in food stuffs shall become even more significant, and an important part in the business of companies that manufacture food products shall be the expansion and strengthening of their brands as important for a healthy diet.

For building a good business model, advanced scientific methods and technologies are important, such as: GIS and DBMS, and advanced data analysis with data mining. The modeling 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, and specifically for the presented nutrition business model of consumer behavior, by implementing the understanding of the modeling process itself, will enable its better use, but also easier development.

The benefit of the business models of consumer behavior 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 modeling 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, and this represents a great challenge for software companies.

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