Identification of the Patterns Behavior Consumptions by Using Chosen Tools of Data Mining - Association Rules

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Abstract

The research and development in sustainable environment, that is a subject of research goal of many various countries and food producers, now, it has a long tradition. The research aim of this paper allows for an identification of the patterns behaviour consumptions by using of association rules, because of knowledge´s importance of segmentation differences between consumers and their opinions on current sustainable tendencies.

The research area of sustainability will be in Slovakia still discussed, primarily because of impacts and consumer´s influencing to product´s buying, that are safety to environment and to nature.

We emphasize an importance of sustainability in consumer behaviour and we detailed focused on segmentation differences between respondents. We addressed a sample made by 318 respondents. The article aims identifying sustainable consumer behaviour by using chosen data mining tool - association rules.

The area of knowledge-based systems is widely overlaps with the techniques in data mining. Mining in the data is in fact devoted to the process of acquiring knowledge from large amounts of data. Its techniques and approaches are useful only when more focused external systems as well as more general systems to work with knowledge. One of the challenges of knowledge-based systems is to derive new knowledge on the basis of known facts and knowledge. This function in a sense meets methods using association rules. Association rules as a technique in data mining is useful in various applications such as analysis of the shopping cart, discovering hidden dependencies entries or recommendation. After an introduction and explanation of the principle of sustainability in consumption, association rules, follows description of the algorithm for obtaining rules from transaction data. Then will present the practical application of the data obtained by questionnaire survey. Calculations are performed in the free data mining software Tanagra.

Key words

Responsible consumption, apriori, association rules, consumer, sustainability.

Introduction

The responsibility for sustainable development therefore has been spread over the different levels in the society, including the broad mass of consumers (Lušňáková - Kleinová, 2012). The importance of sustainable consumption has been more and more rising over the last decades - in international environmental politics as well as for the consumer. In modern and particular Western societies, the consumers are increasingly discovering their potential in participating policies and influencing economic activity through lots of diverse channels, among them the channel of consumption behaviour. When consuming, the consumer now has attributed at least co-responsibility towards sustainability (Loo et.al., 2014). Consumptions nowadays not only restricted to meet the private needs, but goes beyond as it also regards social justice and the environmental aspects. In business and in consumer behaviour, sustainability is defined as building long-term consequences into processes by managing a business in such a way that processes or the overall state of organizational-dependent resources can be maintained over an indefinite time horizons (Jacobsen, 2011).

Due to the development of database technology and systems in recent years, the importance of the data mining has been increased rapidly of or business domains like marketing, financing and telecommunication. Association rule mining is a data mining technique that finds frequent patterns or associations in large data sets (Chen et.al., 2014) was first introduced (Agrawal –Imielinski - Swami, 1993) in order to mine association rules on large transactional databases. (Agrawal - Srikant, 2006) have developed the most popular association rule mining algorithm called Apriori. This algorithm is easy to implement but slow due to the lots of passes over the data set.

Apriori algorithm is a popular and a classical algorithm in data mining. The main idea of the approach is to find a useful pattern in various sets of data. The algorithm suffers from many drawbacks, concluded Yadav et al. (2013).

Mining association rules in large database is one of data mining and knowledge discovery research issue, although many algorithms have been designed to efficiently discover the frequent pattern and association rules, Apriori and its variations are still suffer the problem of iterative strategy to discover association rules, that's required large process. In Apriori and Apriori-like principle it's known that the algorithms cannot perform efficiently due to high and repeatedly database passes (Fageeri et al. 2014).

Mining frequent item sets is a major key process in data mining research. Apriori and many improved algorithms are lowly efficient because they need scan database many times and storage transaction ID in memory, so time and space overhead is very high. Especially, they are lower efficient when they process large scale database. The main task of the improved algorithm is to reduce time and space overhead for mining frequent item sets. Because, it scans database only once to generate binary item set array, it adopts binary instead of transaction ID when it storages transaction flag, it adopts logic AND operation to judge whether an item set is frequent item set. Moreover, the improved algorithm is more suitable for large scale database, concluded Liu et al. (2013).

Mining generalized association rules between items in the presence of taxonomies has been recognized as an important model in data mining. The classic Apriori itemset generation works in the presence of taxonomy but fails in the case of nonuniform minimum supports. Wang et al. (2011) extended the scope of mining generalized association rules in the presence of taxonomies to allow any form of user-specified multiple minimum supports. This method considers taxonomy of itemset, and can discover some deviations or exceptions that are more interesting but much less supported than general trends. Finally, the algorithms is validated by the example of transaction database. The result indicates this algorithm is successful in discovering consumer's purchasing behavior by user specifing different minimum support for different items.

Association rule mining, generally, is understood as positive association rule mining. Positive association rule is stated as "if A occurs in a transaction, then B will likely also occur in the same transaction" (Wu et.al, 2004). However, with the increasing usage of data mining technology, researchers have recently focused on finding alternative patterns like negative associations (Antonie - Zaiane, 2004; Wu et al., 2004). The following example given (Wu et al., 2004) illustrates negative association rules: "birds can fly is a well-known fact, but penguins cannot fly although they are birds". Negative association rules provide valuable information to data owners, but there are few algorithms that are proposed in the literature for negative rule mining.

Main objective of this paper is to identify patterns of behaviour which we are gained by using interview. Based on association rules, we attempted to create a consumer models. This important information's we will analyse by using quantitative research methods, concretely data mining techniques - association rules (Mura et al., 2012). This approach provide its user with possibility of looking into past (quantity and type of sold products), identifying a current state (profitable customers, risk customers) and what is most important nowadays – opportunity to forecast the future. From the methodological aspect paper is focused on applying chosen data mining tool – association rules in the consumer behaviour. That technique is practically demonstrated information about customers and their purchasing behaviour from the different aspects.

Materials and methods

As a method of research, we chose questionnaire. The survey was conducted online via Google Documents or through social networks and email but also at universities in printed version from February to May 2013. Overall, we received 318 completed questionnaires. Representativeness

of the sample by sex, residence, age, social status, education and income group was verified using the Chi-Square Goodness of Fit Test. The test results confirmed the representativeness of the sample in terms of gender and residence, which is a prerequisite for the realization of further analyses.

Behaviour patterns of customers using association rules and statistical methods. Association analysis is the process of discovering association rules, relationships and dependencies between attributes and their values (Kozelová et.al, 2012). The analysis is performed on the incidence of these attributes and their values in the transactions. In the area of knowledge-based systems can be a recommendation using association rules and considered one of the possible methods of acquiring knowledge from a variety of data, or already known knowledge. (Horská - Berčík, 2014). To generate recommendations for the user may be using one of the at least three strategies. These vary in shape transactions, which are used for mining association rules, respectively, using different metrics in the final stages recommendations. To obtain rules from transaction data can be used Apriori algorithm.

Association rules: The concept of association rules was introduced by scientist Agrawal (Miština, 2007). From there the following definition where, $L = I_1, I_2, I_m$ is a set of binary attributes called items. Than T is a database transaction. Each transaction is represented as a binary vector, where $t[k] = 1$ if t buys item I_k and $t[k] = 0$ other. May X is a set of specific items L. We call it, a transaction t corresponds X if it is for all items I_k v X, [k] = 1. Under Association rules are represented in the form of implication $X => I_j$, where X is set of certain items in L and Ij is one item from L, which isn´t real in X. The rule is satisfactory in the set of transactions T with factor of trust $0 \le c \le 1$ if minimum c % from transactions in T, that are significant to X and Ij too. Trust is usually referred to as c.

Given the set of transactions T, we are interested in generating all rules that satisfy certain additional constraints of two different forms: Given the set of transactions T, we are interested in generating all rules that satisfy certain additional constraints of two different forms:

1.Syntactic Constraints: These constraints involve restrictions on items that can appear in a rule. For example, we may be interested only in rules that

have a specific item Ix appearing in the consequent, or rules that have a specific item I_y appearing in the antecedent. Combinations of the above constraints are also possible - we may request all rules that have items from some predefined itemset X appearing in the consequent, and items from some other itemset Y appearing in the antecedent.

2. Support Constraints: These constraints concern the number of transactions in T that support a rule. The support for a rule is defined to be the fraction of transactions in T that satisfy the union of items in the consequent and antecedent of the rule.

Support should not be confused with confidence. While confidence is a measure of the rule's strength, support corresponds to statistical signicance. Besides statistical significance, another motivation for support constraints comes from the fact that we are usually interested only in rules with support above some minimum threshold for business reasons. If the support is not large enough, it means that the rule is not worth consideration or that it is simply less preferred (may be considered later).

In this formulation, the problem of rule mining can be decomposed into two subproblems:

1. Generate all combinations of items that have fractional transaction support above a certain threshold, called minsupport. Call those combinations large itemsets, and all other combinations that do not meet the threshold small itemsets. Syntactic constraints further constrain the admissible combinations.For example, if only rules involving an item Ix in the antecedent are of interest, then it is suficient to generate only those combinations that contain Ix.

2. For a given large itemset $Y = I_1, I_2...I_k$, $k > 2$, generate all rules (at the most k rules) that use items from the set $I_1, I_2...I_k$. The antecedent of each of these rules will be a subset X of Y such that X has k -1 items, and the consequent will be the item Y - X. To generate a rule $X \rightarrow Ij \mid c$, where $X = I_1, I_2...I_j+1,.I_j-1....I_k$ take the support of Y and divide it by the support of X. If the ratio is greater than c then the rule is satised with the confidence factor c; otherwise it is not. Note that if the itemset Y is large, then every subset of Y will also be large, and we must have available their support counts as the result of the solution of the first subproblem. Also, all rules derived from Y must satisfy the support constraint because Y satisfies

he support constraint and Y is the union of items in the consequent and antecedent of every such rule. Having determined the large itemsets,the solution to the second subproblem is rather straightforward. In the next section, we focus on the first subproblem. We develop analgorithm that generates all subsets of a given set of items that satisfy transactional support requirement.To do this task eficiently, we use some estimation tools and some pruning techniques.

Promotion rule is defined as the percentage of transactions in L, which contents XI$_j$. It denotes as s. Support essentially represents the frequency of occurrence of a given set of items in the database. *Support and confidence are measures (metrics) for association rules.*

Trust (confidence) is the probability of the right hand side rule condition occurrence left side. It is therefore the percentage of rules whose left side is X and Y right of all whose left side is X.

Lift (interest): This rate determines how many times more often X and Y occur together than would be if they were statistically independent. In contrast to expectations is dependent on rules of thumb. The formula for calculating metrics lift:

$$\text{lift} (X \rightarrow Y) = \text{lift} (Y \rightarrow X) = \frac{p\,(x \text{ and } Y)}{p\,(X)\,p\,(Y)}$$

$$= \frac{\text{trust} (X \rightarrow Y)}{\text{support} (Y)} = \frac{\text{trust} (Y \rightarrow X)}{\text{support} (X)} \quad ()$$

Apriori: To find frequently occurring sets of items can be used Apriori algorithm, which is stated in the paper Agrawal. Apriori sequentially generates sets of frequent items, the proceeds from the smallest (with the fewest elements) to largest. As far as possible, from the frequent sets with n elements generating sets with n+1 element. Set of frequent sets having n elements is called Ln. The procedures recommendation using association rules from the said general scheme differs in that instead of Neighbourhood Formation is the algorithm used data mining association rules. Its outputs are the rules containing some items on the left and right sides. In the third phase is recommended for all items that are listed in the consequences (on the right) obtained rules. Therefore it is possible to take a limited number of items (N best), or any that meet certain criteria, such as where a degree exceeds a defined threshold.

Respondent´s characteristics of the questionnaire survey

In our survey has a majority of the female part of the population 68.55 %. Interviewed men were 31.45 %. In terms of verification of the representativeness of the sample we found that Chi-Square Goodness of Fit Test based on the value Pr > = 0.05 ChiSq assumption about the representativeness of the sample.

For better classification concept of domicile, we decided to only two variables: the city and the countryside. Structuring into smaller units, optionally define a dwelling by population in many cases distorted because respondents often do not know the basic demographic statistics. We can see that in our research is distributed evenly city (57.10 %) and the rural (42.9 %). In terms of verification of the representativeness of the sample we found that chi-square test goodness of fit based on the value Pr > ChiSq = 0.099 confirmed presumption of representativeness of the sample.

The age ranges were generated by age of the population of Slovakia located on the Statistics Office (under the current 2013). The largest age group is 18 - 24 years (63.72 %), followed by the age group 25 - 34 years (21.45 %). At least numerous age groups represent the interval from 55 to 64 years (2.84 %). The resulting age structure is not relevant in terms of representativeness. The result of chi-square test goodness of fit, we rejected the argument on the representativeness of the sample.

The structure of socio-economic status was again transposed by the Statistical Office of the Slovak Republic. We found out that it is unrepresentative sample of the population, as the largest groups again are students (64.98 %). There are relatively large groups like: employed in the private sector (15.14 %) and employed in the public sector (13.88 %). Positive survey is the fact that we have obtained the views of groups: senior (0.95 %), unemployed (2.21 %) and women on maternity leave (2.84 %).

Table 1 is a presentation of the group of respondents in terms of income and status. We can see that the students belong to the largest group of respondents and divided into several income groups: no income to between 300 € and 601 - 1 000 €. Answer "no income" they

Status	none	till 300 €	301-600 €	601-1000 €	1001-1500 €	1501-2000 €	above 2000 €
pensioner			2	1			
maternity leave		7		2			
unemployed		3	3	1			
student	78	103	20	5			
employed in the private sector		1	10	19	9	3	6
employed in the public sector		1	17	21	3	1	

Source: own survey

Table 1: Comparison of respondents´ structure in terms of income and status.

Status	secondary education without graduation	secondary school with graduation	bachelor education	master education	elementary education
pensioner		1		2	
maternity leave		1		8	
unemployed		4		2	
student	1	46	2	13	1
employed in the private sector	2	12		29	
employed in the public sector		3		40	

Source: own survey

Table 2: Comparison of respondents' structure in terms of education and status.

understand respondents´ answers as financial dependency on parents. Given the fact we suppose they themselves do not work, but the study. In the latter case it is possible to have a brigade and is able to earn up to 300 €, optionally understand money income they receive from their parents.

Income structure was formed according to the structure of income populations in the national economy and has again been transposed by the Statistical Office of the Slovak Republic. The largest group consists of respondents who have a net monthly income of up to 300 € (36.16 %). Follows a group of people with no income, we expect students and unemployed (24.84 %). Another group of respondents are earning from 300 to 600 € (16.35 %) and the last major group of the respondents with incomes from 600 to 1000 € (15.72 %). Above the € 1 000 per month, yet there are three groups of cases: 1000 - 1500 € (3.77 %), 1 500 - 2000 € (1.26 %) and above 2 000 € (1.89 %).

Income structure was formed by the structure of the Statistical Office. We note that this is an unrepresentative sample of the population. The largest group consists of respondents with secondary school graduates (60.57 %).

Followed there is a group of people with higher education Grade 2 (30.28 %) and the group of respondents with a university degree 1st grade (7.26 %). Secondary education school had only 1.58 %, and primary education had only one respondent and the share of 0.32 % of the total.

The second table that deals with the structure of is a group of respondents surveyed by education and status. A positive finding is that the survey respondents are employed in government and in the private sector and this target group we want to focus in other analyses.

Results and discussion

Behaviour patterns of the consumption

Economic sustainability is a term that is used to identify and describe ways of using available resources to their maximum potential. The entire goal of these strategies is to use resources, natural or not, responsibly and efficiently to receive continuous benefits throughout the long term (Horská - Yespolov, 2013; Belová et al., 2012). Plenty factors and circumstances may influence the consumer's buying decision to a different degree. Summarized, there are three main potential

groups of determinants. These are the sustainable consumption:

- values, needs, motivations and personal involvement/importance of the product;
- information, knowledge and uncertainty (information access, understanding, trust and credibility);
- behavioural control, availability of the product, and perceived consumer effectiveness.

The investment support of the adding „sustainable"value to food products should continue in upcoming period 2014-2020. Only the targeted support can be the incentive for enhancing economic viability of enterprises as well as the tool for improving competitiveness of the food industry. This plan corresponds with the vision of forming the European food sector as a world leader being competitive in the long term (Mezera - Špička, 2013). As discussed earlier, marketing has witnessed changes as the sustainability is making its way in marketing practices. There is need to consider

sustainability to develop marketing strategy, which means that the company has to adopt sustainability in strategic marketing practices and marketing mix. But, on the other hand, it is not easy to formulate and implement, because customer is the one according to needs and wants of whom marketing strategy of the company is designed. (Kumar et.al. 2012).

The effort was to see to identify patterns of behaviour which we are gained by using interview. Based on association rules, we attempted to create a consumer models. Due to the nature of the questionnaire where two large and specific groups of respondents, we decided to split a pattern of behaviour into four groups:

- *Consumers - non-students in terms of consumer behaviour when purchasing food (Table 3)*
- *Consumers - students in terms of consumer behaviour when purchasing food (Table 4)*
- *Consumers - non-students in terms of consumption (Table 5)*

N	Antecedent	Consequent	Lift	Support (%)	Confidence (%)
1	"Q5 = till 30 €"	"Q2 = till 1 hour"	1.89565	22.018	80.000
2	"Education = master education - "status = employed in private sector"	"Age = "25 - 34"	1.50345	22.018	80.000
3	"Age = "25 - 34" - "Q2 = till 1 hour"	"Address = city"	1.32997	21.101	79.310
4	"Age = "25 - 34" - "status = employed in private sector"	"Address = city"	1.28564	21.101	76.667
5	"Q2 = 2 - 3 hour" - "status = employed in state sector"	"Education = master education"	1.27388	21.101	95.833
6	"status = employed in state sector"	"Education = master education"	1.20843	36.697	90.909
7	"Sex = man" - "Q6 = I plan buying without list"	"Education = master education"	1.18157	22.018	88.889
8	"Sex = man" - "status = employed in state sector"	"Education = master education "	1.17288	27.523	88.235
9	"Net Income = 301 - 600 €"	"Sex = man"	1.15721	23.853	83.871
10	"Q5 = till 30 €"	"Sex = man"	1.14979	22.936	83.333
11	"Education = master education " „Address = country"	„Sex = man"	1.14322	26.606	82.857
12	„Sex = man" - „Age ="25 -34""	„Education = master education"	1.12988	31.193	85.000
13	"Q1= every second day"	"Sex = man"	1.11053	30.275	80.488
14	"Q5 = till 30 €"	"Education = master education"	1.10772	22.936	83.333
15	"Age = "25 - 34""	"Education = master education"	1.10008	44.037	82.759

Source: own survey

Table 3: Consumers - non-students in terms of consumer behaviour when purchasing food.

- *Consumers - students in terms of consumption (Table 6)*

Association analysis of the output is sorted by the values Lift, therefore, in determining the rate of how many times more often X and Y occur together than would be if they were statistically independent.

The highest rate of reported Interest reply within 30 million or 22.018 % of respondents purchases to 30 € and 80 % of those who spend up to 30 € purchase within hours.

The following is information that 22.018 % of respondents are people working in the private sector and in the public sector and have a college education. 80 % of these people are also aged 25 to 30 years.

22.018 % of men planned to buy, but not to the list, and 88.889 % of them are university graduates.

23.853 % of respondents have income from 301 to 600 € and 83.871 % are men.

Association analysis of the output is sorted by the values Lift, therefore, in determining the rate of how many times more often X and Y occur together than would be if they were statistically independent.

Highest interest rate reported net income of 300 million or 37.864 % of respondents receive grants to 300 € 75.728 % who meet the previous conditions are students - males aged 18 to 24 years of secondary school graduates.

The second part of the questionnaire was given to the issue of sustainable consumption and basic environmental sustainability attributes. We tried to identify certain patterns of behaviour in terms of sustainability.

We can state the following: The highest rate of Interest shows the status-employed in the public sector, so 35.714 % of respondents and 90.09 % of respondents have a college education. For more detailed identification of this group, we arrive at the next information. 36.60 % of respondents said that consumes the goods he buys and 25 - 34 years, subject to the following two information 85.41 % has a garden and higher education and try to separate waste.

Because we analysed specific group not just in terms food consumption, but also environmental behaviour, we continued deeper analysis of the behaviour among students.

34.951 % of respondents aged 18 to 24 years, bought the food actually consumed and where unused food residues move livestock. Confidence 87.805

N	Antecedent	Consequent	Lift	Support (%)	Confidence (%)
1	"Net income = till 300 €"	"status = student" - "Sex = man"	1.13043	37.864	75.728
2	"status = student" - "Net income = till 300 €"	"Sex = man"	1.13043	37.864	75.728
3	"Net income = till 300 €"	"Sex = man"	1.13043	37.864	75.728

Source: own survey

Table 4: Consumers - students in terms of consumer behaviour when purchasing food.

N	Antecedent	Consequent	Lift	Support (%)	Confidence (%)
1	"status = employed in state sector"	"Education = master education"	1.24169	35.714	90.909
2	"Q10 = yes, I consume" - "Age = "25 - 34""	"Q4 = he/she has a garden"	1.19583	36.607	85.417
3	"Q10 = yes, I consume" - "Age = "25 - 34""	"Education = master education"	1.16667	36.607	85.417
4	"Education = master education" - "Q14 = I try to separate"	"Q10 = yes, I consume"	1.16148	37.500	93.333
5	"Q4 = he/she has a garden" - "Q14 = I try to separate"	"Q10 = yes, I consume"	1.15556	34.821	92.857
6	"Education = master education" - "Q4 = he/she has a garden"	"Q10 = yes, I consume"	1.10394	49.107	88.710

Source: own survey

Table 5: Consumers - non-students in terms of consumption.

N	Antecedent	Consequent	Lift	Support (%)	Confidence (%)
1	"Age = "18 - 24"" - "Q10 = yes, I consume" - "Q13 = I provide to domestic animals"	"Q4 = he/she has a garden"	1.24743	34.951	87.805
2	"Age = "18 - 24"" - "Address = country"	"status = student" - "Q4 = he/she has a garden"	1.24106	36.893	87.356
3	"Age ="18 - 24"" - "Sex = man"	"Education = secondary education with graduation"	1.12815	58.252	90.909
4	"status = student" - "Age = "18 - 24"" - "Sex = man"	"Education = country"	1.12815	58.252	90.909

Source: own survey

Table 6: Consumers - students in terms of consumption.

% indicates that 85.75 % of those respondents who meet the previous conditions have a garden. For more detailed identification of this group, we gain next information. 58.252 % of the respondents are men aged 18 - 24, while 90.90 % have secondary education and come from the countryside.

Conclusion

Famous saying of the French philosopher and lawyer in one person, the founder of modern scientific gastronomy and great gourmand Jean Anthelme 19th century, Brillat - Savarin needs no introduction: "Tell me what you eat and I´ll tell you who you are", will further advancing sustainable food consumption. The association rules seem as an effective data mining rule from the methodological aspect. On the base of the mining results we can say following: Younger people are entering into transactions. They are more confident, have specific ideas about the quality of the product, its image purposefully sought products purchased with knowledge of the matter, but also a new generation of consumers, like the generation of parents still limit their purchases of money. Unlike their parents, however, so does not adhere to the Slovak food since grown to a global brand, notes the changes in consumer behaviour. High environmental awareness but still a low share of purchased environmentally friendly and socially acceptable products. There are some facts of our research in the following of statistical processing:

- more than 78 % of people who have their own garden, or use their balcony for seasonal supply said they harvested with its officially not cover year-round consumption;

- 21 % of respondents said they cover year-round consumption, but they must also have their own cellars where crops can be stored;

- 21.7 % of respondents in the course of the year to buy up the crop, but 78.3 % note that domestic production is sufficient for them all year. It can be said that the state cannot, must resolve consumers themselves, to ensure the self-help;

- we wondered whether respondents actually consume all food purchased, 85.85 % of respondents said that consumes all bought food;

- in the context of sustainable consumption, we investigated, as well as how consumers treat the foods purchased in, and beyond that they consume 45.74 % of respondents said they consumed foods as soon as possible.

- The second almost equally large group 44.48 % of respondents purchased food stocks. Only 9.78 % of respondents prefer fresh food and so soon after buying them and consumed,

- 54.4 % of respondents are aware that eats more food than it actually needs. Nearly 30 % of respondents are trying to eat less.

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