



CORVINUS UNIVERSITY OF BUDAPEST
LANDSCAPE-ARCHITECTURE AND DECISION SUPPORT SYSTEM
DOCTORAL SCHOOL

THESIS OF PHD DISSERTATION

**Analysis of mineral water consumption patterns
and sensory evaluation of mineral waters**

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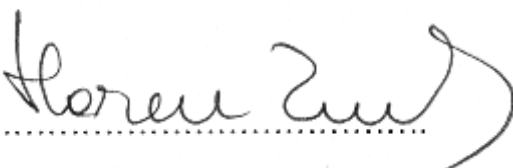
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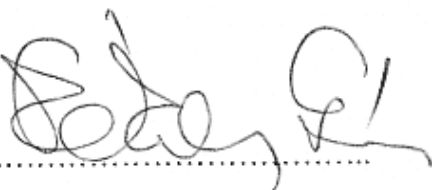
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1. BACKGROUND OF THE STUDY

Carpathian-basin possesses unique mineral water potential. Geothermic energy has a strong impact on the underground water layers, which facilitates the dissolve of minerals and thus the formation of mineral waters. Hungarian mineral waters are especially valuable due to the composition of the dissolved components. Hungarian mineral waters are usually richer in minerals than those of other origin (Borszéli, 1998).

In the last two decades there was a major change in the structure of Hungarian food and beverage market, both on supply, and demand aspects. The soft drink sector became the most dynamically developing sector of the domestic food business. Certain types of new products emerged to meet the new consumer expectations (e.g. mildly carbonated mineral waters, flavoured mineral waters, ice tea based on mineral water). In the consumption of other products there was a strong decrease (soda-water, tap water, spirits, etc).

In Hungary tap water and traditional soda water was usually consumed till the 90s, but now mineral water consumption is more dominant. Among all food and beverage products this category showed the greatest increase in quantity of the sales in the last 20 years. Due to the dynamic increase the consumption per capita value changed as follows: in 1980 it was almost esteemed a luxury item (2,3 litres); in 2002 50 litres and in 2007 over 100 litres. It has not yet been explored, how long and how much the growing trend of mineral water consumption would continue. It is also not known, how much consumers prefer it, and how often it is consumed.

According to a survey on soft drinks and food (performed by AC Nielsen), the strength of mineral water lies in the fact it meets three distinctive and global types of consumer need simultaneously: (1) raw material for new, innovative products; (2) easy to carry; (3) a product of natural origin, clean, free from additives and safe.

2. AIMS OF THE RESEARCH

The major goal of my PhD thesis is to predict and analyze Hungarian mineral water market in the forthcoming years. Another aim is to investigate the most important factors in the consumption patterns and decision procedures among Hungarian university students. I also put a special emphasis on the sensory issues.

Sub-units of my survey:

- To review Hungarian mineral water market; to analyze the principal parameters of mineral water consumption (quantity, preference, frequency); to identify, model and predict market trends.
- To understand the typical opinions, reasoning, attitudes and preferences of the chosen consumer segment. To analyze the relative contribution of several factors to the decision making of this group. To identify and characterize the sub-clusters of these consumers.
- To explore the sensory quality of the major non-carbonated mineral water types (and a tap water sample from Budapest). To identify the sensory vocabulary of mineral water testing.
- To investigate the correlation between blind and branded tasting of the usually consumed mineral water type of the test persons. To measure the impact of the brand on the sensory perception.

Hypotheses of my PhD research:

- H1. Since mineral water consumption grows at a very dynamic rate, the saturation in this trend will take place after 10 years.
- H2. The price of mineral water is the most important factor, which defines the preferences of the chosen consumer segment.
- H3. The university students' product perception is influenced by the brand of mineral water.

3. MATERIALS AND METHODS

In my research I planned to perform a multi-layer, successive and integrated data collection and analysis. First, I applied qualitative methods for a better understanding of the marketing phenomena and of the typical attitudes, motivation factors and decision patterns of the consumers. Later on sensory tests were conducted on the basis of these qualitative methods. I also executed structured quantitative surveys, which can be thus projected to the chosen population. Steps of my research are shown in *Table 1*. The major focus of my study was on the full-time university students for several reasons. Consumers between the age of 18 and 25 years are an important and increasing part of the target group. People with a higher level of education have a stronger influence on their environment. The consumption patterns of the target group is converges to the total active population's attitudes. The customs from the university years might be determinative for the future. This target group was accessible for the primary research methods. And last but not at least the mineral water consumption patterns of the Hungarian full-time university students are not known and explored in details (OM, 2006; Szép, 2006; GFK, 1989-2007).

Table 1. Steps of the research

Secondary research and data analysis	
1.	<i>Secondary analysis performed on primer data (4.1.)</i> Identification and prediction of trends on mineral water consumption, preference and frequency
Primary research, qualitative methods	
2.	<i>Focus group interviews (4.2.)</i> (layered, multi-step random sampling, 2 x 8 groups from Budapest, 2 x 16 groups from other regions of Hungary, 10 persons / group, altogether 48 groups, consisting 480 university students)
3.	<i>Consumer deep interviews (4.3.)</i> (layered, multi-step random sampling, 2 x 8 individuals from Budapest, 2 x 16 individuals from other regions of Hungary, altogether 48 individual interviews with university students) <i>Expert deep interviews (4.3.)</i> (Hungarian Board of Mineral Waters, National Office for Spas, Coca-Cola Hellenic Bottling Company, experts of the mineral waters technical committee from FAO/WHO Codex Alimentarius)
4.	<i>Sensory tests (4.4.)</i> <i>triangle tests (214 panellists)</i> <i>computer supported profile analysis (28 persons)</i> <i>pairwise ranking tests (64 persons)</i> <i>mineral water brand identification blind test (100 persons)</i> (sample: university students of the Horticulture Science, Food Science and Landscape Architecture faculties at Corvinus University of Budapest)
Primary research, quantitative methods	
5.	<i>Conjoint- and cluster analysis (4.5.)</i> <i>branded mineral waters</i> <i>private label mineral waters</i> (layered, multi-step random sampling from 8 universities or faculties in Budapest, and 16 from other regions of Hungary. 60 persons / location, 1440 university students altogether)
6.	<i>Questionnaire (4.6.)</i> (layered, multi-step random sampling from 18 universities or faculties in Budapest, and 22 from other regions of Hungary. 40 questionnaires / location, 1600 university students altogether)

4. RESULTS

4.1. Secondary research, results of secondary data analysis

In Hungary soft drink consumption has been increased continuously in the last 15 years. This trend is similar to the ones of other developed West-European countries. In the analysed period (1994-2007) consumption has been almost doubled (90,9 l/capita/year in 1994, 211,0 l/capita/year in 2007). The trends of the consumed quantity clearly show the permanent change in the structure of soft drink consumption. Though consumption of carbonated soft drinks and fruit juices has also increased in a linear trend, mineral water (which increased more dynamically) took the first place among the soft drinks in 2005 (70 litres/capita/year). Hungarian soft drink sector has reached a long expected goal in 2007, when it reached the consumption level of Austria (95-100 litres/capita/year).

My results proved that Bass model, which describes the diffusion of enduring products well, is also suitable for the description and prediction of Hungarian mineral water consumption. If we compare the fitted data of Bass model and the measured data, the two trends are matching each other (**Figure 1.**).

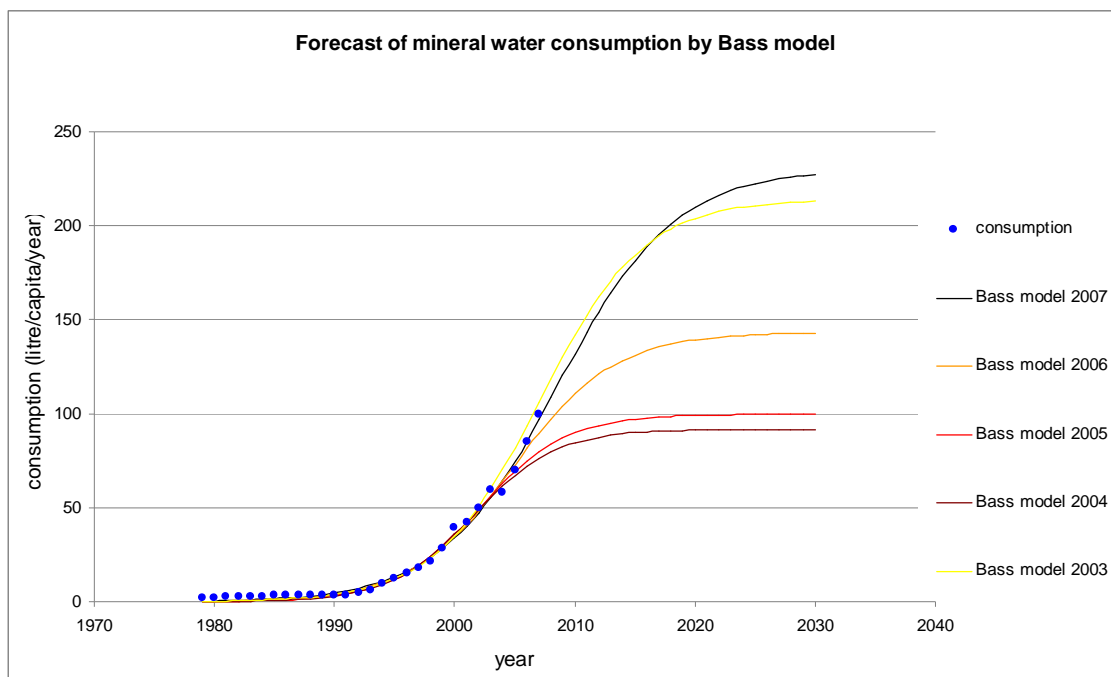


Figure 1. Forecast of mineral water consumption by Bass model. The optimal parameters of Bass model were calculated for the time intervals with their common beginning year 1979 and different ending points 2003-2007.

The inflexion point of Bass model is in year 2009. On the basis of the model consumption will be 108 litres/capita/year in 2008, 120 litres/capita/year in 2009 and 131 litres/capita/year in 2010. Saturation will take place in 2033 with approximately 230 litres/capita/year value. When I estimated the saturation value, I performed the calculation with stepwise method (always adding one more year to the basis data of the modelling). I observed that after 2004 the saturation value sets back, and exceeds the estimated value of the previous years (1999-2003). During my research I've found, that from the millennium the fitting of Bass model is better with every additional year's data.

The frequency of mineral water consumption has been continuously increasing in the last 18 years. While in 1989 the average frequency was three times in every fortnight, in 2003 it was three times a week and in 2007 it is more than four times a week. According to the logistic model ($R^2=0,99$; $F=99,6937$; $t_{p1}=9,914$; $t_{p2}=4,156$; $t_{p3}=3,948$; $t_{p4}=10,311$) the frequency of mineral water consumption has reached its inflexion point (3 times / week). On the basis of the model the frequency of consumption will be 4,7 times / week in 2009, 5 times a week in 2011 and 5,1 times / week in 2013. The trend saturates around 2023 with 5,3 times / week.

The preference of mineral water consumption has also increased during the last 18 years, in accordance with the frequency of consumption. According to the logistic model ($R^2=0,99$; $F=1526,362$; $t_{p1}=8,2430$; $t_{p2}=6,4296$; $t_{p3}=4,2537$; $t_{p4}=14,842$) the preference of mineral water consumption reached its inflexion point in 2001 (with 61%). On the basis of the model preference is expected to be 84,5% in 2009, 86,7% in 2011, 88,7% in 2015 and this parameter saturates with 89,7% in 2023.

4.2. Primary research, results of the focus group interviews

I've proven that the choice of mineral water brand contributes to the prestige in typical community situations among full-time university students. I applied the focus group method. In these situations the choice of brand has a rather enhanced prestige value. My results also pointed to the fact, that in community situations the social embedment of mineral water purchase / consumption is specially emphasized. The other outcome of the focus group interviews were the list of those seven important attributes, which strongly define the choice of the interviewed persons. These are the followings: taste, price, brand, carbonation, certificate or award, prize winning and packaging. These focus group interviews facilitated to define further questions during my research.

4.3. Primary research, results of the deep interviews with individual consumers and experts

The deep interviews with individual consumers confirmed the situation dependent nature and social embedment of mineral water choice and consumption among university students. I have found no significant differences between the consumption patterns of first year and advanced year students. Among the motivational factors to choose mineral water instead of other soft drinks, the participants mentioned most frequently the healthy lifestyle, the supposed poorer quality of tap water and their demand to provide a sufficient intake of minerals. The word association technique was able to reflect the latent motivations and target value. Most of the interviewed persons were not properly informed about the physiological effects of mineral waters. The time and place of consumption is usually not defined and limited – since the product is easy to carry and can be reclosed. The outcomes of the deep interviews supported the importance of the taste. Majority of the interviewed persons – both in Budapest and in other regions of Hungary – has stated that they are satisfied with their mineral water brand, or they rotate their 2-3 most preferred brands. Those consumers, who have a better financial condition, are suspicious about the private label products. They better trust in the quality and safety of the branded products, and they state that the choice of brand is a way of self-expressing. Similarly to the focus group results, I've proven that the choice of mineral water brand contributes to the prestige in typical community situations among full-time university students. I also integrated expert deep interviews in my research for a better understanding of mineral water market and legislation to improve the final version of the questionnaire and to provide a complex approach of the whole issue.

4.4. Primary research, sensory test results

Water samples were evaluated in three blocks with the application of computerized sensory analysis (with the software ProfiSens). In *the first block of still waters* (Szentkirályi, NaturAqua, Nestlé Aquarel, Theodora Kékkúti, Evian and a tap water sample) Theodora Kékkúti was significantly different from all the other samples in carbonation, salty taste, metallic taste and aftertaste. This was confirmed by the panellists' comments: “acidic”, “highest carbonation”, “the only sample with a (slight) carbonation”, “contains bubbles; definite taste”, etc. The sensory profile of Theodora Kékkúti is rather different from the other waters' profiles, which mostly overlap each other – difference can be found only in 1-2 attributes (**Figure 2.**).

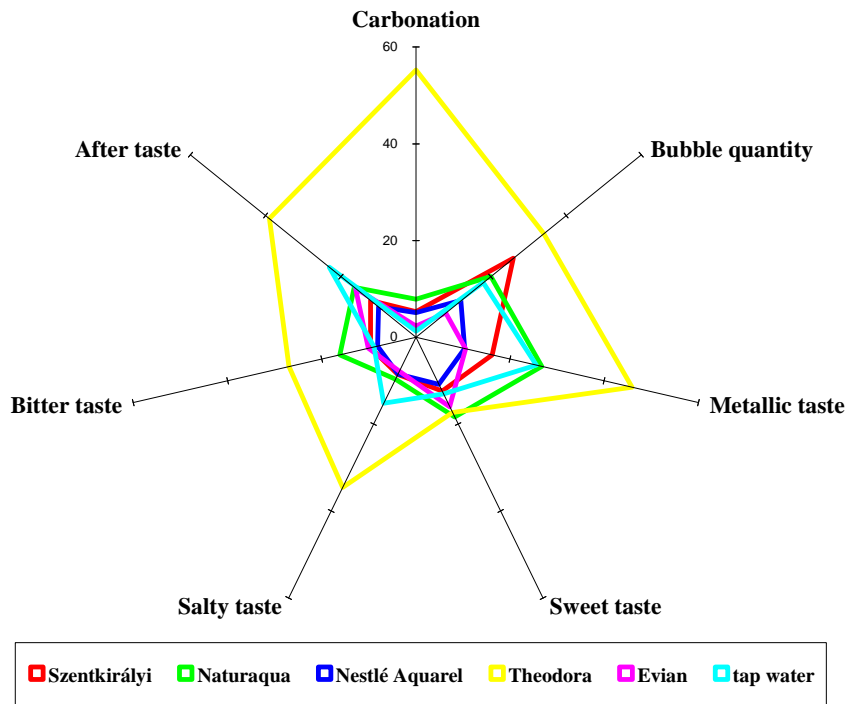


Figure 2. Comparative sensory profiles of the first set of water samples

My studies have confirmed that panellists with an average sensitivity were not able to differentiate between Nestlé Aquarel, Evian and Szentkirályi bottled waters. This is supported by the fact, that the sensory profiles and the comments of the panel were very similar. The tap water sample was described as: heavy; strong chlorine aftertaste; just tolerable; water with a low hedonic value; neutral and metallic.

In the second set of still water samples (Mohai, Veritas, Óbudai Gyémánt, Balfi, Fonyódi and tap water) tap water is clearly distinguished from Mohai, Veritas, Óbudai Gyémánt, Balfi and Fonyódi bottled waters, because of its ‘swimming pool’ scent and chlorine taste. It is important to note that tap water quality may vary greatly even in different districts of Budapest, or regions of Hungary. In acidic taste Mohai and Balfi received higher intensity values, due to their high hydrogen-carbonate content. Among the low mineral content waters there was no sensory difference. Panellists evaluated Fonyódi, as the most natural in its taste character. In mouth feel and in metallic taste there was no significant difference between the analyzed products.

The *water samples of the third group* (Evian, Szentkirályi, NaturAqua, Theodora Kékkúti, Tesco (Aquarius), Spar (Balfi)) were performed twice with the same panel. During the first session products were blind coded (as in all of the other sensory tests); while in the second session brand names were displayed. The most important outcome of this survey is that

sensory perception of mineral waters was not influenced by brand cognition (among the participants). As a summary of these results we can state that computer supported profile analysis (ProfiSens) can efficiently be applied to the evaluation of bottled waters. This method provides a comprehensive sensory description of the analyzed samples. Through the profiling of the samples I assembled a sensory vocabulary for the description of bottled waters.

Through the *triangle tests* of bottled waters I've confirmed that naïve assessors were not able to make differences between still mineral waters of low mineral content of similar magnitude. The results of these tests showed no significant difference between the following waters: Evian – Szentkirályi, Evian – Nestlé Aquarel, Szentkirályi – Nestlé Aquarel, Szentkirályi – NaturAqua, Nestlé Aquarel– NaturAqua. Triangle test data were evaluated with sequential-analysis, **Figure 3.** shows the graph of Evian and Szentkirályi. The magenta line shows the total number of correct answers during the test. Since it crosses the line of acceptance (green line), we can accept H_0 on 95% significance level, and state, that there is no sensory difference between Evian and Szentkirályi (in case of still waters, with naïve assessors).

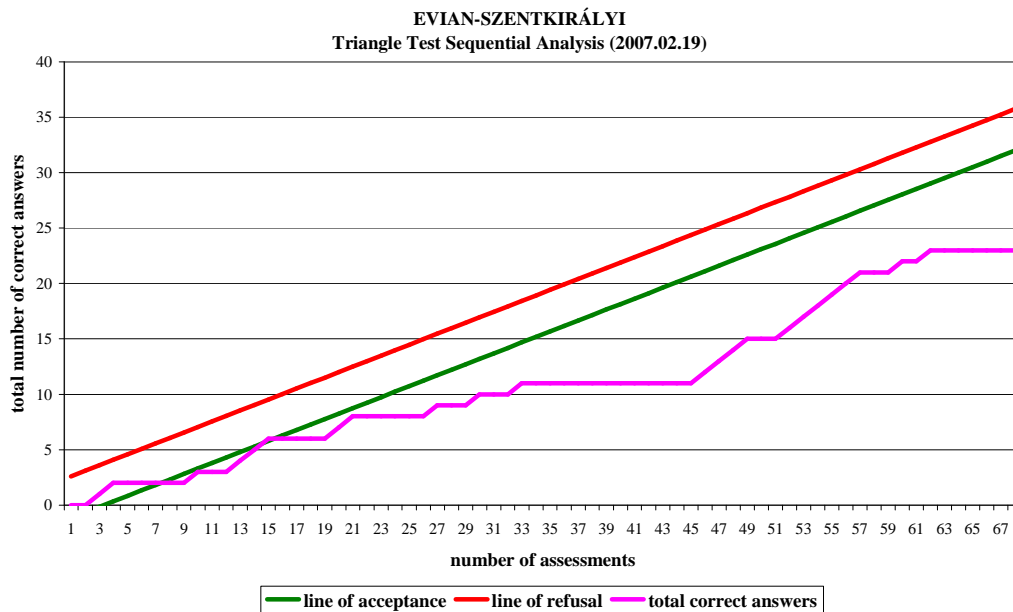


Figure 3. Sequential analysis of the triangle test comparing Evian and Szentkirályi still waters

Among Margitszigeti – Szentkirályi, Balfi – NaturAqua and Theodora Kékkúti – Balfi waters the sensory difference was significant. These differences were supported by the additional comments of the panellists.

Pairwise ranking tests were performed in two test sessions. Panellists were asked to mark the samples with the higher mineral content.

In *the first block* I analyzed waters mostly with a lower amount of dissolved minerals, such as: NaturAqua (627,0 mg/l), Fonyódi (761,0 mg/l), Margitszigeti mineral water (1024,0 mg/l), Mohai (1880,0 mg/l). Results showed, that panellists were not able to differentiate between NaturAqua (627,0 mg/l) and Fonyódi (761,0 mg/l) in mineralization. In any other comparisons, the samples were different on 99% significance level. Pairwise significant differences are shown in *Table 2*. (The lower part of the matrix contains the differences between the rank sums of the samples. In the upper part these differences are compared with the least significant difference values). On the basis of the test results the samples of Margitszigeti mineral water (1024,0 mg/l) and Mohai (1880,0 mg/l) were put in a wrong order. *Table 3*. shows the expected rank order of the samples (on the basis of the measured values) and the panellists' rank order.

Table 2. Pairwise significant difference matrix

	NaturAqua	Fonyódi	Margitszigeti	Mohai
NaturAqua	–	no	99%	99%
Fonyódi	11	–	99%	99%
Margitszigeti	72	61	–	99%
Mohai	43	32	29	–

Table 3. Expected rank order vs. panellists' rank order of the water samples

Dissolved minerals	expected order	panelists' order
NaturAqua= 627,0 mg/l	4	4
Fonyódi= 761,0 mg/l	3	3
Margitszigeti=1024,0 mg/l	2	1
Mohai= 1880,0 mg/l	1	2

The trends of rank sum values are shown on **Figure 4**. The trend of panellists does not totally correspond with the expected one, but Page test confirmed the similarity between them.

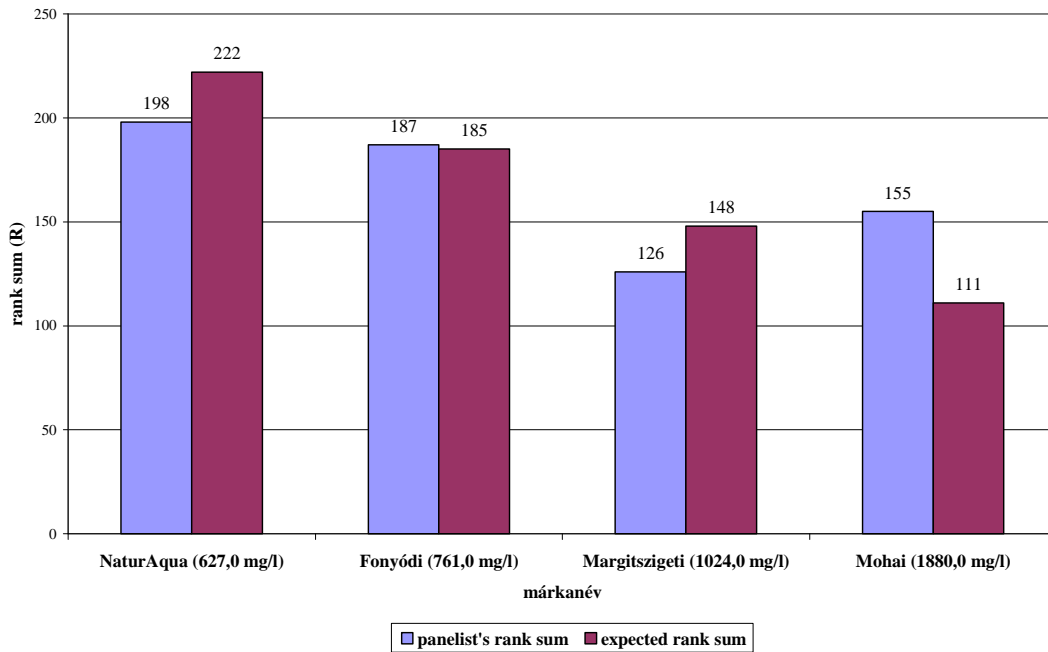


Figure 4. Expected rank order and panellists' rank order of the first set of samples on the basis of the dissolved mineral content

In the second set of samples mineral waters with higher dissolved mineral content such as Visegrádi (1297,0 mg/l), Theodora Kékkúti (1600,0 mg/l), Balfi (1803,0 mg/l) and Mohai (1880,0 mg/l) were analyzed. On the basis of the test results Visegrádi water (1297,0 mg/l) differs significantly from all the other ones on 99% significance level. There was no statistically proved difference between Theodora (1600,0 mg/l), Balfi (1803,0 mg/l) and Mohai (1880,0 mg/l) in the perceived mineralization. Panellists put the waters with the lowest (Visegrádi (1297,0 mg/l)) and highest (Mohai (1880,0 mg/l)) dissolved mineral content into the right order. Theodora Kékkúti and Balfi were incorrectly positioned according to the rank. The results of Page test show that the total trend of the waters is in accordance with the expectation.

My results have proved that consumers are usually not able to identify their favourite, frequently consumed waters in a blind test. Majority (65%) of the inquired consumers stated, that they will surely identify their favourite bottled water, while 22% answered the opposite way. The remaining 13% answered 'maybe' or 'I don't know'. However, in the blind test only 16% were able to identify their favourite brand correctly. It is an interesting result, that 28% of those consumers, who were not sure if they would be able to identify their favourite product before the test, were able to pass the test successfully. From those persons, who were sure, that they would find their preferred product, 15,4% succeeded, only.

4.5. Primary research, conjoint- and cluster analysis

Results of the branded mineral water analysis show that in the decisions of university students, price is not the sole and utmost parameter though it is of quite a great importance in relation to the other factors. Preferences of Hungarian full-time university students are primarily influenced by the brand and the level of carbonation. As a consequence of this, brand development and brand image can be an important motive to gain young consumers.

Through the cluster analysis of *branded water products* I identified two, well-separated segments. The *first group* can be labelled as “*brand and carbonation conscious*” (832 consumers; 64% of the total data). The most important factors in their decision making are brand (33% relative importance) and carbonation (30% relative importance). When they buy their favourite mineral water brand in the preferred carbonation level, price and prize winning is only relatively important (15%). They are more willing to accept the higher price levels from the modelled three (86 Ft, 99 Ft, 119 Ft). The importance of certification/award is low (6%). The simulated ideal product of this segment is the non-carbonated NaturAqua, with ‘Quality Food of Hungary’ label, with money winning contest on 86 Ft price level.

The *second group* (486 consumers, 36%) can be characterized as “*traditional soda water consumers*”. They esteem carbonation as the most important factor (46%), the utility function of this parameter is outstandingly high (20,047). Brand also shows a relatively high importance (23%), but carbonation is the dominant factor. The importance of other parameters is similar to the previous group: prize winning (10%) and price (13%) are moderately important, while certification/award is negligible (8%). Their traditional behaviour is supported by the fact that they esteem a higher importance to the “Quality Food of Hungary” label than the “Eau’Scar” international award. They are not really willing to accept the higher price levels. The simulated ideal product of this cluster (according to the utility functions) the carbonated Theodora Kereki water, with “Quality Food of Hungary” label, car winning contest on 86 Ft price level.

Table 4. shows the summary of branded mineral waters cluster analysis. Importance values of the total data and the clusters are shown on **Figure 5**.

Table 4. Summary of the branded mineral waters cluster analysis

Product parameter levels	cluster 1 utility functions	cluster 2 utility functions	cluster 1 importance values (%)	cluster 2 importance values (%)
Theodora	-1,751	1,944	very high (32,901)	high (22,515)
Nestlé Aquarel	-0,810	-3,051		
Szentkirályi	-0,901	1,286		
NaturAqua	3,461	-0,180	very high (30,917)	very high (46,321)
carbonated	-6,710	20,047		
still	6,710	-20,047	low (5,786)	alacsony (8,437)
Eau'Scar	-0,277	-1,031		
Quality Food of Hungary	0,277	1,031		
car winning	1,436	1,982	middle (15,406)	middle (10,087)
money winning	1,826	-3,033		
bicycle winning	-3,262	1,052		
86 Ft	-4,032	-5,516	middle (14,990)	middle (12,640)
99 Ft	-8,065	-11,032		
119 Ft	-12,097	-16,548		

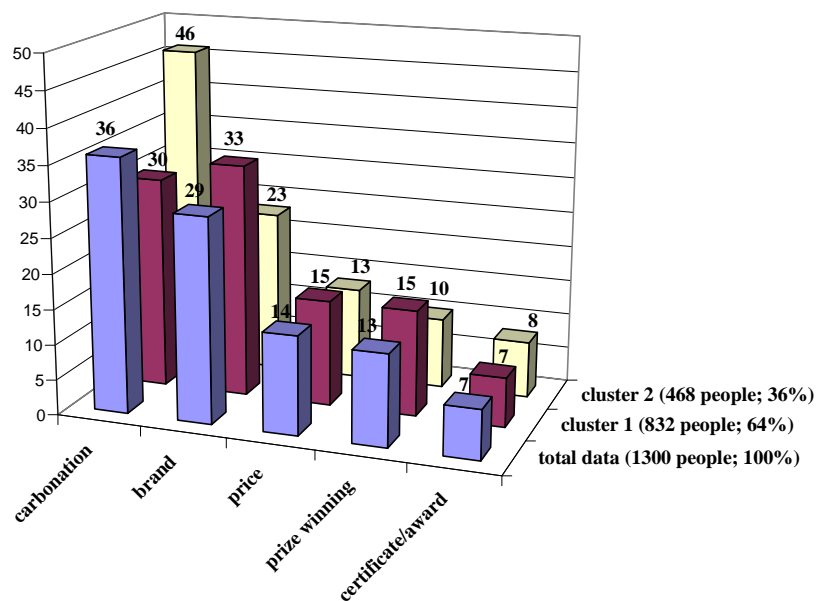


Figure 5. Importance values of the branded mineral waters following cluster analysis

With the cluster analysis of the “*private label products*” data I’ve identified three segments. The *first group* (442 persons, 34%) was called “*brand conscious*”. They make their purchase choice primarily on the basis of the brand (name of the retail company). So the importance of brand is 46%. According to my results the one of carbonation is only half of this (26%). Prize winning (11%) and price (17%) are relatively important factors. The simulated ideal product of this group is non-carbonated Spar water, car winning contest on the 35 Ft price level. Utility function values show that this group avoids the carbonated Tesco Aquarius water. However, they admit their price consciousness, they insist on finding the lowest prices and price levels.

The *second group* was labelled “*carbonation and brand conscious*”. At this segment (546 persons, 42%) the choice of private label water is primarily defined by carbonation (53%), secondly by the “brand” (26%). These are followed by prize winning (11%) and price (10%). The members of this group prefer the carbonated waters definitely, and they are more willing to accept higher price levels, than those of the first group. Their simulated ideal product is Spar natural mineral water with car winning contest.

The *third group* (312 persons, 24%) is the “*brand loyal*” segment. The image of the retail company is the most important in this group, so the “brand” is a cardinal parameter (58% of importance). The importance value of the Spar brand is exceedingly high (19,604) compared to any of the other product parameters. The other three factors (carbonation, prize winning and price) have moderate weight. The members of this group stated that in case of private label products they are willing to pay more for those brands which they esteem better. They accept the higher price level easier from the three options (35 Ft, 45 Ft, 57 Ft). Their simulated ideal product is the non-carbonated Spar natural mineral water with car winning contest.

4.6. Primary research, consumer questionnaire results

95% of the inquired persons consume mineral water. Majority of this population (77%) have been consuming mineral water for 7-10 years. A smaller segment (15%) has a relation to this product since 4-6 years. Only 8% have been using this product for longer time than a decade. Almost half of the university students (47%) drink 1 litre mineral water per day, 26% has an even higher value (1,5 litres/day). Since the preference of the product is high, most of the university students consume mineral water daily or almost daily (53%), and more than one-third (35%) drink it several times a week. Approximately one-third of the interviewed consumers purchase the product on a daily basis (30%), while 25% buy mineral water several

times a week. The other categories of purchasing frequency is rather balanced: once a week (11%), once in a fortnight (9%), less frequently (14%) and never (10%). The most important outcomes from this research concerning the preference, consumption and purchasing of soft drinks are the following:

1. The most preferred soft drinks of the interviewed university students are the non-carbonated fruit juices, mineral water, ice tea and self-made tea.
2. The least preferred products of the target population are the juice concentrates (dilutables) and traditional soda water.
3. When a product has a high level of preference, it does not mean automatically high frequency of consumption and purchase. (Fruit juices and ice tea products have an exceedingly high preference level, while their consumption frequency is lower than we might expect. This might be due to the relatively high price level of these products.)
4. Among breakfast drinks tea has the highest level of preference, though coffee is consumed most frequently. (Although coffee has a lower level of preference, it became an everyday drink in the diet of the majority of university students).
5. The target group consumes the following products daily (or almost daily): coffee, tea, mineral water and milk.
6. The consumer appreciation of mineral water shows an opposite trend with traditional soda water and juice concentrates (in terms of both preference and frequency of consumption and purchasing).
7. Preference, consumption and purchasing frequency of alcoholic drinks (wine, beer and spirits) were typically lower than the ones of soft drinks. (The preference order of alcoholic drinks was: wine, beer and spirits).

There is a detectable change in the frequency of mineral water consumption among the interviewed group of full-time university students – they tend to follow a healthy lifestyle. This is supported by the fact, that 64% of the consumers are conscious about following a healthy diet, and only a low percent of them (15%) are neglecting this factor. The remaining 21% deal with this matter only occasionally.

Tap water has a definitely bad appreciation among mineral water consumers. Every second student (53%) stated that they choose mineral water instead of tap water as frequently as it is possible. The inquired consumers usually rotated 4-5 brands in the last few years. This is also typical for the purchasing patterns of 39% of them. Only one-fourth of the group use more brands, and 20% have only 2 or 3 favourite ones. There is a minority of 16% who insist to

having only one brand. The most preferred bottled waters are: NaturAqua (30%), Nestlé Aquarel (24%) and Szentkirályi (16%). All the other listed brands have lower values than 5%. The size and type of the bottle is often depend on the place of purchase. 1,5 litre bottles are usually bought in large and cheap retail units, while 0,5 litre bottles are preferred in small shops or at the university canteens. In my research I put another question to measure how the consumers would react to a 10-20-30-40% price increment of their favourite brand (*Table 5.*)

Table 5. Effect of price increment on the choice of the favourite brand

	I'd definitely buy	I'm not sure	Maybe	Probably not	Definitely not
10% increment	55%	44%	–	–	–
20% increment	30%	42%	22%	6%	–
30% increment	18%	3%	46%	24%	9%
40% increment	2%	6%	12%	55%	25%

The concerned mineral water consumers prefer the disposable, one-way bottle than the returnable one much more. 80% of them do not take attention to buying a returnable bottle. A smaller group of 16% prefers the returnable bottles and just a “few” consumers (4%) choose only this type of packaging decidedly. Another important result of my survey is that the ratio of female consumers is two times higher than the one of male consumers if we focus on the group with a returnable bottle preference. This might refer to the more environment conscious attitude of women.

Participants were also asked to evaluate their decision factors when they purchase mineral water for home use, at a bar or at a restaurant. The most important results are the following: **(Figure 6.):**

1. Taste and carbonation of water is exceedingly important, and it is independent from the purchase situation.
2. Price has a lower importance in a bar, than in a restaurant.
3. The role of brand is especially important in restaurants, and also in case of home use. (From the consumption data it seems that for home use the emphasis is mainly on the private label products.)
4. Prize winning and special offers can be persuasive for waters of home use.
5. Special offers are less important in bars and restaurants than in hypermarkets according to the participants' feedback.

6. The opinion and recommendation of friends are much more important than the of the family members. This is due to the typical behaviour patterns of this age, and also for the longing to be an accepted member among the friends.
7. Returnable bottle and the origin of water are esteemed as the least important parameters. (Results of the deep interviews also show that this target group prefers the clear, transparent bottles, which are free from scrapes – a typical description of the disposable bottle. These consumers do not want returnable bottles, even if they know, that their behaviour is not environment friendly.)

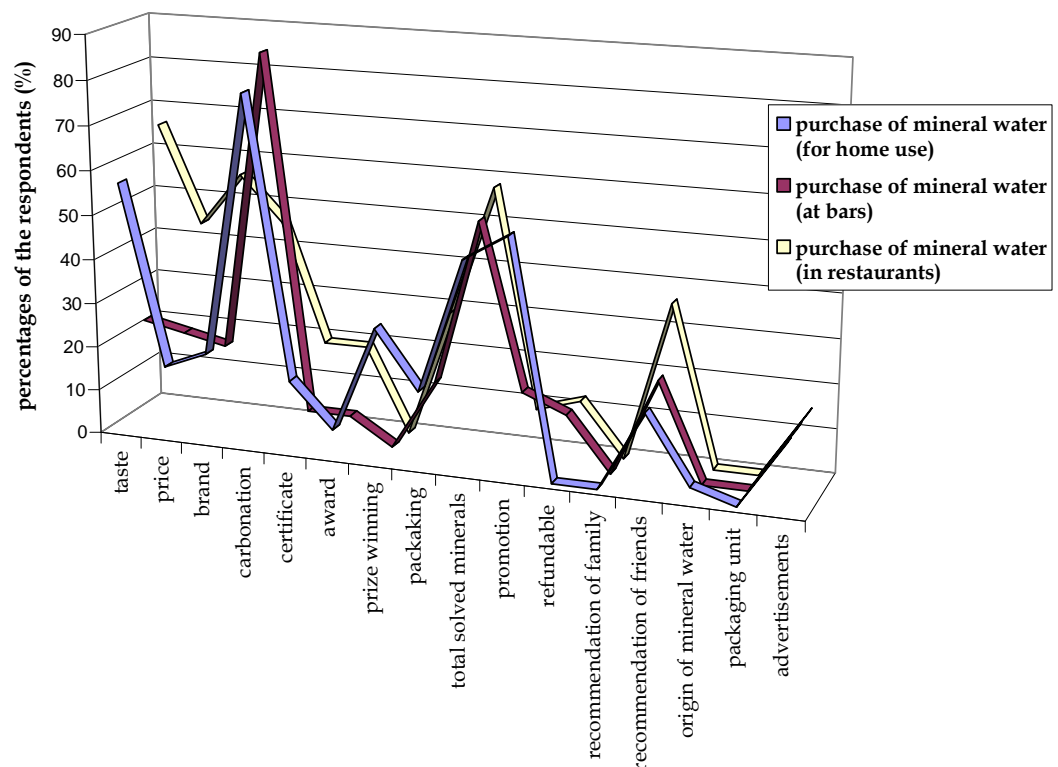


Figure 6. Most important decision factors when purchasing mineral water for home use, in bars and in restaurants (values are the percentages of the total group)

I also examined the reasons of those who do not consume mineral water. At this segment it was proved, that economic difficulties can typically be found in the background of rejection. The socio-demographic indices also supported this phenomenon. Two-third of this group (65%) live in a 5 member household, the net monthly income of the majority (72%) is under 110.000 Ft. The householder has a middle (81%) or lower level (8%) of education. Though the reason of not consuming mineral water is mostly due to the lack of sufficient amount of money, a considerable group of these people are referring to health issues (36%) or the environmental load of the plastic bottles (57%).

5. NEW SCIENTIFIC RESULTS

1. I've proved that Bass model is suitable for the description and prediction of Hungarian mineral water consumption. With my calculation I identified, that Hungarian mineral water consumption shows an exponential trend. The frequency of consumption and its preference follow logistic pattern in the period of 1979-2007. On the basis of the models I made my prediction.
2. I was the first to prove the prestige role of the brand choice in mineral water consumption, which is confirmed by my focus-group and deep interview studies among full-time university students. My results also pointed to the fact, that in community situations the social embedment of mineral water purchase / consumption is specially emphasized.
3. I defined the first time in Hungary the relative importance of the decision factors concerning mineral waters among full-time university students, with the application of conjoint analysis. With the combination of cluster analysis and conjoint analysis I explored and described the typical consumer segments of the branded and private label mineral water products.
4. With the application of triangle tests I was the first to prove that the tested consumers are not able to make a sensory distinction between still waters, which contain a similar magnitude (300-600 mg/l) of dissolved minerals. Results of the pairwise ranking tests showed, that natural carbon-dioxide content may influence the perceived mineralization of the waters.
5. I've proved that the inquired consumers are very rarely able to identify their favourite, regularly consumed mineral water in a blind test. With the application of profile analysis, I was the first to prove, that sensory perception is not influenced by brand cognition in case of the analyzed samples. I also confirmed that the computer supported profile analysis (ProfiSens) can effectively be applied to the sensory evaluation of bottled waters.
6. I was the first to assemble a set of sensory descriptors which are suitable for the analysis of bottled waters.

6. CONCLUSIONS AND RECOMMENDATIONS

I confirmed the permanent structural changes in soft drink consumption with trend analysis. The demand in the beverage sector is increasing especially for mineral waters. On the basis of my calculations Hungarian mineral water consumption increased in an exponential way between 1979 and 2007. I fitted a function on the consumption data, and the analysis showed that the goodness of fitting, the model choice and the parameters are fine. Mineral water consumption data and the estimated values of Bass model show that the trend of observed values corresponds with the predicted values. According to the model the consumption is expected to be 108 litres/capita/year in 2008, 120 litres/capita/year in 2009, while 131 litres/capita/year in 2010.

The inflexion point of Bass model (which was found suitable for describing *mineral water consumption*) is in year 2009, which suggests that the exponential period is probably over, and from that point of time the degree of growing slows down and follows a saturation pattern. Saturation is expected in year 2033 with 230 litres/capita/year value. On the basis of my results (from Bass model) **I reject my H1 hypothesis**, which supposed that mineral water consumption grows at a very dynamic rate, so the saturation in this trend will take place after 10 years.

My research outcomes are in accordance with the opinion of some experts, who say that in the soft drink segment, mineral water will probably show a certain degree of growth in the future. On the basis of the model the near future can be predicted properly, but the far future might be influenced by numerous unexpected factors, so it is recommended to repeat the prediction after every new consumption data.

With my calculations I've proved that the model is sensitive to the early part of the consumption data, where the degree of growth is low. When I fitted Bass model to the years before 1999 (namely 1979-1999), the analysis of the model (R^2 , F and t values) showed weak results. This means that the model cannot be fitted properly to those early years. The consequence is that the saturation value predicted by the model is sensitive to those data which differ strongly from the trend. With my calculations I've confirmed that after the outlier value of year 2004 the trend continues and the predicted saturation value sets back to the previous level and later exceeds it.

The calculated innovation (p) and imitation (q) Bass parameters show that mineral water is a successful product ($q > p$), so more and more new consumers try it. Although, if we compare the calculated innovation and imitation parameters of the given period (1979-2007) with the

ones of literature, the former will be always lower than the latter. It is important to note that in the literature this model was usually applied for long-term consumer goods.

The choice of the logistic model for the description of *mineral water frequency and preference* was proven to be very good. On the basis of the logistic model the frequency of consumption is expected to be 4,7 times a week in 2009, 5 times a week in 2011 and 5,1 times a week in 2013. The trend saturates around 2023 with 5,3 times a week. The frequency of mineral water consumption will not significantly increase afterwards. On the basis of the logistic model preference is expected to be 84,5% in 2009, 86,7% in 2011, 88,7% in 2015 and this parameter saturates with 89,7% in 2023. The preference of this product might increase still 10 more percent according to the model. The inflection points of the analyzed parameters show a *typical time pattern*: in 2001 preference, in 2003 the frequency of consumption and in 2009 the consumed quantity are expected to reach their inflection points. Due to the lack of literature data it cannot be decided whether a similar time pattern might be observed in case of other products. Results of my research prove that with a proper level of computer support conjoint-analysis can be effectively integrated with cluster analysis. With the successive combination of those two methods I was able to define typical consumer segments among full-time university students. Further researches are necessary to examine if the scoring of the product is properly simulating a purchase situation or not. Another problem to investigate is the proper knowledge of the real price levels by the interviewed person. And at last: how the typical decision mechanism is influenced by some product attributes.

In case of the *branded mineral waters* my results have proved that the preferences of Hungarian full-time university students are primarily influenced by the brand and the level of carbonation. As a consequence of this, brand development and brand image can be an important motive to gain young consumers. In case of the separated consumer segments (on the basis of my data) it can be stated that price is not the sole and utmost parameter though it is of great importance in relation to the other factors. **My second hypothesis (H2)** stated that price of mineral water is the most important factor, which defines the preferences of the chosen consumer segment. On the basis of my results **I was not able to confirm** this statement in case of branded water products, since after the segmentation procedure I was not able to find an importance value of price which is higher than 15%.

In case of investigating only the *private label products*, the importance values of the conjoint-analysis do not support this statement in themselves (the importance values of price vary between 10 and 17%). So if the university students are choosing only from private label products, then price is not a factor of primary importance. However if branded products are

compared with private label ones (which is a typical purchase situation), then my previous results of the focus-group and deep interview surveys prove that the major motivation in the choice of private label products is the low price level. So when the two product groups are compared, the **hypothesis H2 is confirmed**.

By the comparison of the *sensory blind test and branded tests* the most important consequence is that there was not a single sensory attribute which showed a significant difference in the perception of the product. Thus it can be stated that **hypothesis H3**, which says that the university students' product perception is influenced by the brand of mineral water, **cannot be confirmed**.

With the *sensory tests* I've proven that university student consumers were not able to make differences between still mineral waters of low mineral content such as: Evian – Szentkirályi, Evian – Nestlé Aquarel, Szentkirályi – Nestlé Aquarel, Szentkirályi – NaturAqua, Nestlé Aquarel– NaturAqua. This was confirmed also by the panellists' comments. Of course, the fact that it is hard to make a sensory difference between them, does not reduce the value of these natural mineral waters.

In my researches I formed the conclusion that profile analysis is a precise and cutting-edge methodology for the sensory description of mineral waters. Thanks to the computer support the necessary time for the procedure has decreased. With the application of the special software panellists and professionals can learn the test results immediately after the session, thus the results can immediately be integrated into the production, research and innovation procedures. Because of the efficiency improvement of the method it can be a daily routine in the industrial quality assurance systems. With the further development of the software our goal is to evaluate the performance of the sensory panel, since the reliability of the sensory tests depends on the precision of the individual panellists. We also plan to build in the preference mapping method to the ProfiSens according to the demands of food sector. A further research subject (closely related to mineral water) can be the synthesis of sensory tests and instrumental analyses. This way we might explore the correlations between those methods and the sensory perception.

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