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Doctoral School of Management and Business Administration

ECONOMIC EVALUATION OF THE PRODUCTION AND UTILIZATION OF BIOFUELS IN HUNGARY

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1. INTRODUCTION

The increasing use of energy, world hunger and population is unsolved problems in several decades which are aggravated by climate change and extreme weather conditions and the economic crisis would complicate their solutions.
The use of bioethanol and biodiesel as renewable energy source cannot be considered completely new. The diesel engine was originally designed to use vegetable oils and ethanol was blended with gasoline in significant amount between the two World Wars. Despite that technological potential, the scientific focus of the renewable energy sources has been biased by the cheap fossil energy sources.
Ethanol can be produced by starchy crops (wheat, maize, potato, sugar beet, sugar cane and cassava) and the oil plants (rapeseed, sunflower, soybean and jatropha) can be used directly as vegetable oil or as biodiesel which can be prepared through the process of esterification and using methanol. The second-generation biofuels can be obtained after the cellulose breakdown or gasification[1] of starchy plants. [HANCSÓK, 2004]

The amount of biofuel use is affected[2] by the by the targets of European Union as the most important legal force in sectorial politics. The common plans determine that the proportion of renewable energy sources must achieve the 20% in the total energy use to 2020. According these large scale targets, half of that 20% will be achieved by biofuel use. The solution of following problems has been expected through the application of EU's biofuel policy:

- to reduce the dependence on fossil fuels (to improve the security of energy supply)
- to reduce the greenhouse gases (hereafter: GHG) from transport (to slow down the climate change)
- to generate demand for agricultural surplus (indirect income support for farmers)

Despite the expected benefits – on the basis of the results of 2010 – it has been certainly shown that some countries will not be able to achieve not only the 20% (e.g.: Czech Republic, Cyprus, Poland, Hungary) but also the 10% biofuels target because of the characteristics of vehicles. Of course there are also countries that are successful/will be able to achieve both of the 10% and 20% and these countries (as Sweden, Lithuania, Slovenia, Romania) can overfulfill the cumulated targets of renewable energy sources. These large-scale plans provide the (export) demand of bioethanol and (in smaller amount of) biodiesel for today's main agricultural producers. [FAO, 2008]

The base of my PhD dissertation was the next train of thoughts:

Consumers change their consumption habits because of the increase of fuel prices. This reaction is temporary – according to my hypotheses – consumers will return to their previous habits. It needs long time (10-15 years) and change of consumers approach to change significantly the habit. If this assumption can be accepted:

- *the investment appraisal calculations of biofuel plants are also made for 10-12 year long period,*
- *that is why it is recommended to take into consideration the attitude of consumers as risk factor in investment appraisal methods.*

[1] Fischer-Tropsch process uses indirect liquefaction to produce liquid hydrocarbons; Biomass to Liquid - BtL
[2] Calculations of international organizations (IEA, OECD, FAO) can be considered more recommendations or guidelines than obligation. As one of the not obligatory programs, the Renewable Portfolio Standard (44 countries have joined by 2007; typically not EU members) has declared the achievement of 5-20% proportion of renewable energy by 2010 or 2012. The definition of exact proportion of biofuels within the renewable energy sources is national authority.

The importance of logical framework above is extraordinary when the obligatory amount – to achieve of national blend rate – of biofuels is covert by national level of production. In this case the production of a new biofuel plant would be marketed as high biocomponent content fuel and the consumer can make a real decision about the purchase of (bio)fuel blends.

The most commonly used methodology classifying the consumer attitudes is the factor analysis. Finally, there are needs to find an indicator in the factor analysis which can represents the characteristics of (qualitative) attitudes in (quantitative) investment appraisal calculations.

The abovementioned thoughts are far beyond a dissertation topic in both time and scope however I have kept in mind while I defined objectives and hypotheses.

Highlighting my goals from the idea above, I wanted:

G_1: to define that/those element(s) and process(es) of the macro environment which can determine the success of the use of biofuels

G_2: to explore the Hungarian citizens' attitude towards biofuels

G_3: to explore the key factors of the biofuel production and the impact of their changes on the characteristics of the investment return.

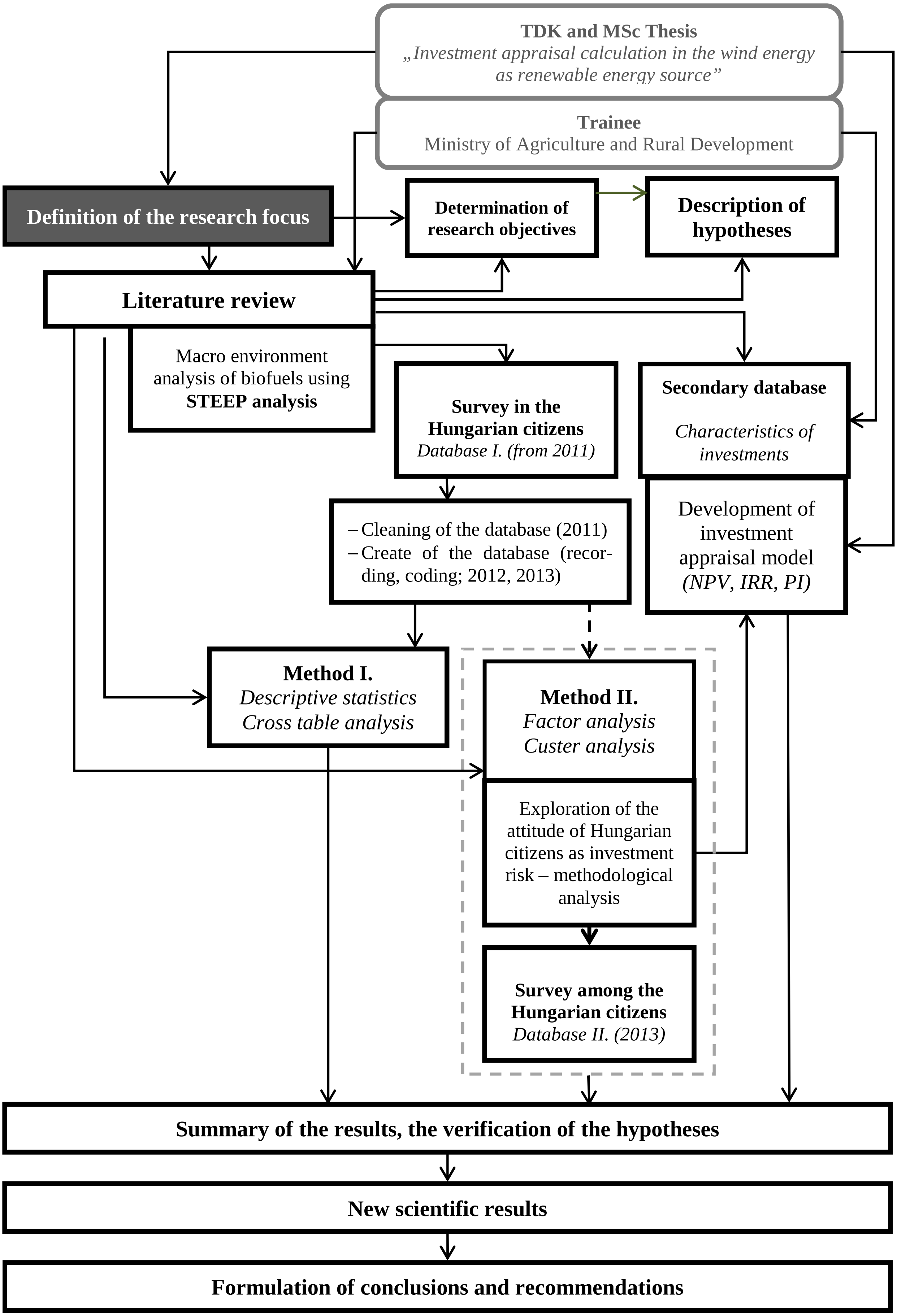
Following my goals, the main hypotheses are:

H_1: The macro environmental conditions for biofuel production (and for the successful accomplishment of national targets) are available in Hungary.

H_2: There is a correlation between the environmental conscious attitude and the behaviour towards biofuels in Hungary.

H_3: The investment of a biofuel plant can be recoverable, but it is associated with high risk.

The process of the preparation of my PhD dissertation can be seen in Figure 1.



Source: OWN CONSTRUCTION, 2014

Figure 1: The flow chart of the PhD research

2. MATERIAL AND METHOD

I analysed two primary databases from survey to achieve the stated objectives and to verify or refuse my hypotheses in relation with the consumers' attitude. I also created a secondary database according to literature sources and the information which come from my professional work on the field of biofuels.

2.1. Primary database of the analysis of Hungarian citizens

Database I.

I created the first database of public attitudes towards biofuels in 2011 and I used Computer Assisted Telephone Interview (CATI). I used the represented international and national scientific results creating my own questionnaire. The place of research was the office of NOESIS Innovation Inc. from March to May of 2011 where I could use the whole IT infrastructure as research support. According to the phone number database which is made by the Inc., I finished the survey using internet-based telephone service.

The obtained database is representative by age and gender with the next limitation: the population was the Hungarian citizens over 18 years who have landline phone.

One of my objectives was the examination of the effect of fuel price change on consumers' attitude towards biofuels that is why I repeated the survey in 2012 and 2013. In those years, I had no opportunity to make representative databases that is why my family and my friends helped me in the query. It was important that only those citizens filled out my questionnaire about vehicle use and biofuels who have own car which is financed by own salary (i.e. it is not company car).

Database II.

I analysed another database. It was the result of a research which was led by Prof. József Lehota and it is queried in the frame of the Omnibus program (organized by Cognative Market Research Ltd.) in 2013. The sample was representative and its size was 1038. The population was the Hungarian citizens over 15 years old and the method was stratified sampling which based on counties and settlements. I used the Statistical Package for Social Sciences (hereinafter: SPSS 21.0) analysing both of the databases.

2.2. Database of investment appraisal calculations

My secondary – microeconomic – database comes from the sources which is analysed in the literature review and in other hand, comes from my work for the Ministry of Agriculture and Rural Development. I made a model in Microsoft Office's Excel to realize investment appraisal calculations. The simple form of the table is already used in my MSc thesis and I developed it in my PhD dissertation.

I also used statistical databases of different national and international organizations (as KSH, Eurostat, FAPRI, USDA) analysing the trends of the price of the raw materials and selling prices.

2.3. Method of the factor analysis

The factor analysis was used as a mathematical method in relation of psychology which is so called psychometrics. [RÓZSA et al., 2003] It is applied in economics as a multivariate statistical methodology only from 1960 but nowadays it can be found numerous example in any discipline which has to analyse variables on complex way and there is need to reduce their number without information loss [SZAKÁLY – SZIGETI, 2012; LEHOTA et al., 2014].

The factor analysis is used in the marketing and sociological researches for five purposes [SCIPIONE, 1994; p. 220]:

1. *„To disclose or to detect the dimensions or structures between variables.*
2. *As data reduction method.*
3. *To separate market segments or to classify consumers according to habits, needs, preferences and/or to describe their demographic characteristics.*
4. *To develop objective and quantitative weighting of attitudes, needs, etc.*
5. *To compare hypothetical trends or to compare the result of analysis which are made in different time."*

It can be mentioned other numerous benefits of factor analysis [WÁGNER, 2003; p. 350.]:

- *„there is no need to rank the relevant data before the analysis,*
  the factor analysis can handle on the complexity of different kinds of data (quantitative and quantifiable qualitative data),
- *there is no need to differentiate dependent and independent variables*
- *the result of factor analysis can be used for regression and cluster analysis."*

The factor analysis can simplify the structure of variables according to their correlations and it facilitates the decisions towards new structure of variables that is why the number of final factors have to be less than the number of original variables.

2.4. Method of the investment appraisal analysis

The basic method of the main microeconomic calculations is the Net Present Value (hereinafter NPV) which contains the time factor through the discount rate that is why it is also called "dynamic" method. Its modified indicators (as PP – payback period, IRR – internal rate of return, DRR – dynamic turnover ratio) can provide more information about economic(al) characteristics of an investment in other points of view and can support the decisions.
There can be distinguished two concepts of NPV: the first one is financial oriented and it is most suitable for the evaluation of financial market transactions. Its main feature is: there are no expected operational costs after a one time capital investment and the benefit is regular income or a single profit (or loss) at the end of the economic period. In face of the "financial oriented approach", the other one is called "project view approach" which summarizes the revenues and cost of each periods and it discounts the cash flows of periods. According to these possibilities, it can be differentiated many ways of NPV method depending on which approach or variable is focused.
I am going to apply the formula of ILLÉS (2000) in my future investment appraisal calculations (Table 1.)

The NPV can be evaluated by the following characteristics [MONGEAU, 2012]:

- the standard deviation of the net present value [it is applied also by: BÉLYÁCZ, 2009]
- the skewness which means the measure of the asymmetry of the probability,
- he effect of used factors in the investment appraisal calculation on the result of NPV which means the identification of the key factors of NPV's sensitivity.

Table 1: Possible ways of the Net Present Value (NPV)

Method of the NPV	Speciality of the method	Source
$NPV = C_0 + \frac{C_1}{1+r} + \frac{C_2}{1+r^2} + ... + \frac{C_n}{1+r^n}$ *C_0= cash flow of the zero period (costs in relation to the investment in negative sign)* *r = alternative (opportunity) cost of capital (expected yield)* *n = the duration of the cash flows (years)* *C_n= income in the n^{th} period*	Only the explanation includes the use of "negative sign" of C_0. They are followed by financial approach and they are typically used in money market transactions.	SUDGEN – WILLIAMS, 1978
$NPV = PV - C_0 = \sum_{t=1}^{n} \frac{C_t}{(1+r)^t} - C_0$ *C_0 = cash flow of the zero period (costs in relation to the investment in negative sign)* *C_t = income t^{th} period (with positive sign)* *n = the duration of the cash flows (years)* *r = alternative (opportunity) cost of capital (expected yield)*	This formula also contains a negative sign for C_0.	BREALEY – MYERS, 2005
$C_0 = R_0 - I_0 * q^0 + ... + (R_t - I_t) * q^{-t} + L_t * q^{-t}$ *C_0 = net present value, q = calculative interest rate* *R_t = return per period* *I_t = capital expenditure in each period* *L_t = liquidation value at the end of the return period*	Investment expenses are not taken into account as summary of a period. It is assumed constant costs.	ULBERT, 1992
$NPV = -I + \{N * [s - l + m]\} * PVIFA_k^n$ *I = initial capital expenditure* *N = annual sales volume* *s = revenue of production* *l = wage costs of production* *m = costs of raw materials; k = cost of capital* *n = period of calculation; PVIFA = present value interest factor of annuity*	The economic characteristics of the production activity are in the focus of the method. (sales, labour costs, material costs) This method accumulates the annual discounted cash flows and it is reduces with the investment costs.	BÉLYÁCZ, 2009
$NPV = -B_0 + \sum_{i=0}^{n} (k_i - b_i) * q^{-i}$ *B_0 = Cash flow of the zero period (expenditure in relation to the investment with negative sign)* *b_i = revenues of the i^{th} period, k_i = expenditures of the i^{th} period* *q = technical number, where 1+p, p = calculative interest rate*	The categories of revenue and expenditure are aggregated in the defined periods.	HUETING, 1990 ILLÉS, 2000
$NPV = \sum_{i=1}^{i=n} CF_i (1+d)^{-i}$ *CF = discounted cash flow (profit and amortization in the i^{th} period)* *d = discount rate, i = number of periods* *n = investment/project (years)* ***C = invested capital (this component is listed by the authors but the equation does not contain it)***	The formula does not contain the invested amount of capital. This is an error or it can be a part of the cash flow. This formula is a transitional way between the project and the financial approach.	LAKNER et al., 2010

Source: OWN CONSTRUCTION, 2014 by the indicated sources

I summarized my objectives, hypotheses and the relations between used databases and the applied methods in Table 2.

Table 2: The context of the objectives, the hypotheses, the databases and the methods of the dissertation

My goals were during the thesis:	Hypotheses		Material	Method
C_1 to define that/those element(s) and process(es) of the macro environment which can determine the success of the use of biofuels	**H_1** The macro environmental conditions for biofuel production (and for the successful accomplishment of national targets) are available in Hungary.	**$H_{1.1}$**: In the European Union (including Hungary), the production and use of biofuels is controlled by a top-down legal framework but the whole economic process goes beyond the borders of the European Union. The realization of the positive effects of the use of biofuels – which is expected by the Member States – is doubtful because of the result of the interactions.	Synthesis of literature	STEEP-analysis
		$H_{1.2}$: The legislation on the actors in the supply chain of biofuels does not support the goals of biofuels in Hungary.		
C_2 to explore the Hungarian citizens' attitude towards biofuels and to apply this characteristics of attitude in the investment appraisal calculations	**H_2** There is a correlation between the environmental conscious attitude and the behaviour towards biofuels in Hungary.	**$H_{2.1}$**: The vehicle owners knows (has information about) biofuels.	Own data collection (survey)	descriptive statistics, cross table analysis
		$H_{2.2}$: The responses of car owners in relation of biofuels are influenced by demographic characteristics.		
		$H_{2.3.}$: Some variables of the statement list are related regardless of the factor extraction or the nature of the data. (These constant factors can be applied in the investment appraisal calculations.)	OMNIBUSZ research (2013)	factor analysis
		$H_{2.4}$: As the result of relation of environmental conscious behaviour and vehicle use patterns, three consumer groups can be defined.		factor and cluster analysis
C_3 to explore the key factors of the biofuel production and the impact of their changes on the characteristics of the investment return.	**H_3** The investment of a biofuel plant can be recoverable, but it is associated with high risk.	**$H_{3.1}$**: The raw material cost of biofuel production is not influenced economic factor but an optimum point can be calculated.	Statistical databases (USDA, KSH etc.)	statistical deviation
		$H_{3.2}$: The investment return characteristics of bioethanol and biodiesel are different and the primary reason of that can be due to the technological differences.	Database of biofuel plants	investment appraisal analysis
		$H_{3.3}$: The regions of Hungary can be differentiated in the relation of installation of first-generation technology biofuel plant.	Statistical databases and regional results of H2.1 and H2.2 hypotheses	weighted score method of plant allocation

Forrás: OWN CONSTRUCTION, 2014

3. RESULTS

3.1. Analysis of willingness to pay and willingness to use of biofuels of Hungarian citizens'

According to the answers of the question, which was asked about the biofuel content of the generally used fuels, only 131 vehicle owners have been able to say exactly the right proportion of bio component content. Nearly 10% higher the proportion of those responders who believe that the general fuels does not contain biofuels in the sample of 2011. The results of 2012 and 2013 years were very similar in view of proportions. In relation of my "willingness to use" question, nearly the same number of respondents (respectively: 24,4%, 23,3%, 22,3%) did not choose the high bio component content fuels because they do not know that their vehicles are suitable for use them. This is true every three years of the survey. Couple higher rates was represented but the similarities of percent remained when the answer was "yes, but only if it reduces the cost of fuelling".

The literature review represented numerous possible advances from the use of biofuels but the most of the respondents expect the environment protection (respectively: 40,6%, 29,0%, 30,1%). I could explore some fault of my questionnaire and the first modification was the enlargement the answers with: „no, because I know that my car does not suitable to use high bio component content fuels". This version of responses was chosen by the 13.8% (2012) and 16.5% (2013) of responders, therefore the awareness of the respondents appears to improve. Only the 14-22% of vehicle owners who knew the correct rate of biofuel's content would pay more for the high bio component content fuels and it means that the willingness to pay is not affected by the knowledge.

Based on the given answers on consumer willingness to use – no matter what year is taken into account – it can be concluded that who are more willing to pay for high bio component content fuels do it primarily because of the expected positive environmental impact. The cost reduction is expected from the higher the blending rate by those who refuse the price premium. I created three hypothetical group of car owners accepting the idea of EK (2005) that the energy conscious behaviour can be deduced from the environmental conscious behaviour. These hypothetical groups are also qualitative risk for a biofuel plant when the car owner has to decide about the high bio component content fuel (over the national blending rate).

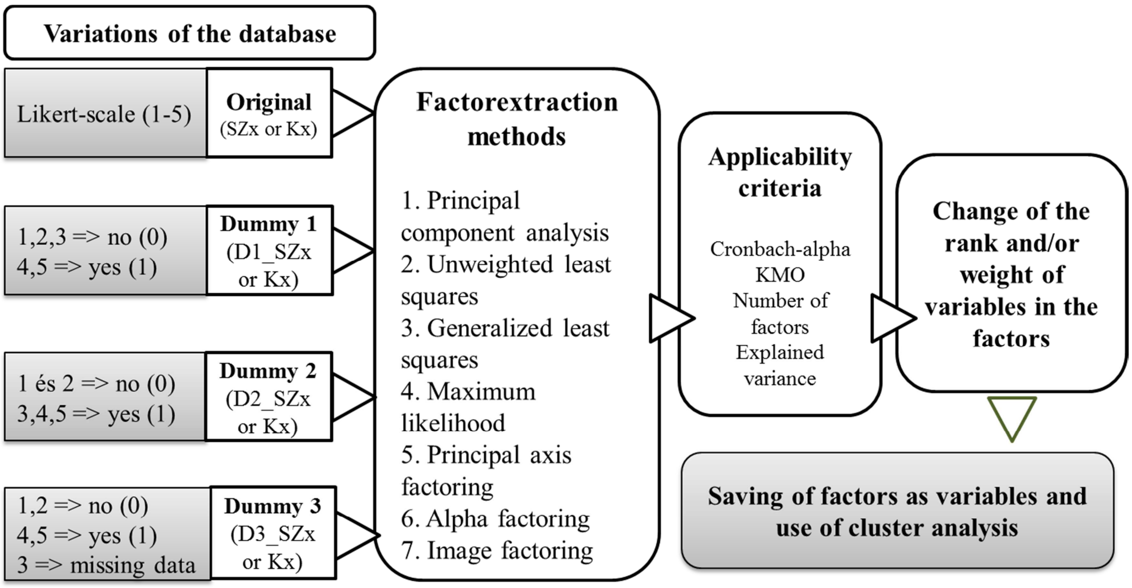
The most commonly used methodology is factor analysis making the definition of consumer attitudes but its important weakness is the subjectivity of appellation of factors. That is why it is reasonable to name the factors and to characterize by those variables, which would be in the same factor if the factor extraction method was changed or the data were available as dummy variables (not Likert scale). My approach is not the same nor the logic of Cronbach's alpha nor the Kaiser-Mayer-Oklin index (hereinafter referred to as KMO) which examine the applicability of factor analysis.

3.2. A possible way to define the attitude as qualitative risk using the results of factor analysis

The examination of my H2.3 hypothesis about analysis methodology can be seen on the Figure 2. The responses are measured by five itemed Likert scale in the original database (ER) and I generated other three (D1, D2 and D3) database from the first one (ER) depending on the meaning of the middle (3) item. The most important objection in face of transformation from Likert scale (as numeric or quasi-numeric variable) to dummy or dichotomous variables is the information lost. However, it is justified because:

- The respondents can define difficult (and honest) the real difference between Likert items in relation of environment and energy conscious habits and evaluate their own behaviour. Finally, the real activity of respondents could be overvalued.

– The middle (3) item raises a further question: the given habit depending on the decision situation, certain (perhaps demographic) conditions (but these conditions are not exactly known) or the respondent chose the middle item instead "I do not know/No response" option.
– The filling of "yes-no" type questions is fast and simple that is why it can improve the response rates as well.



Source: OWN CONSTRUCTION, 2013

Figure 2: The logical framework of the analysis of II. Database

For accomplishing the objectives of the analysis, I conducted all the four databases by the seven possible factor extraction methods, and I examined the changes of the applicability criteria. I structured the results and I analysed the content of the different factors, the relations between the different variables, and finally I tried to find the reasons of the changes in the content of the different factors. I performed the compliance factors of the factor analysis, weighed by representativeness criteria (which resulted the versions of ER_s, D1_s, D2_s, D3_s). According to the KMO index, all the four versions could be conducted, and the variance remained between 53-63% during the factor analysis. Because of the weighting process, the values of both the KMO and the variance have decreased, while the value of Cronbach-alfa has increased in case of ER, D1 and D2 and has decreased in case of D3. The number of factors was 7 according to ER and D1 data, which increased to 10 after the weighting process, while the 11 factors of D2 and D3 has decreased to 10 after weighting.
The factors resulted by the factor analysis process contained such factors, which remained together[3] regardless the chosen factor extraction method or restructuring of the database were denominated as “Permanent factors”. The “Conditional factors” were those factors, which were moved into other factors in the course of factor extraction and/or the restructuring of the database.

As a next step, I tried to explain the reasons of the different behaviour of the different variables.
The examined features (mean, deviation, communality etc.) could not give definite answer for the behaviour of the permanent and conditional variables of the analysed factors. In case of the other key variables (Table 6.) the change of the factor weights did not show any regularity, therefore they are not suitable for expressing the risk.
Only the strength of the correlation could be used for expressing the factor formulating ability of the variables from the features given by the literature sources. During my analysis, the solutions were not resulted by the strength of the correlation coefficients. I observed that the highest values of the

[3] They were added to one factor at least 5 times from the 7 analyses.

correlation coefficients of the different variables have the most determinant effect during the formulation of the factors, and the strength of the correlation has not have determinant role.
Although I could not reach the original goal of the examination, I defined the reliability of the variables and the factor, as well as the factor formulating ability of the variables.

The reliability of the variables was determined according to the following features:

- the deviation of the factor weight of the variables is low,
- the correlation between the variables of the factor is constant within the factor, and this correlation is independent from the changes of the database and it will not change due to any factor extraction.,
- their rank is constant within the factor, that means it is independent from any factor extraction. This feature was defined as the stability of the variable.

After completing the methodological approach, and after the repeated factor analysis[4], the next step was formulating factor groups and denominating of the factors. Therefore, I have chosen those variables (according to Cronbach-alfa, Communality, and their former place) which should be excluded from the examination. As in all cases the factor analysis was based on the results of KMO and Cronbach-alfa, I accepted the results of that analysis, which resulted the highest variance (i.e. with the less information loss), where I excluded four variables from the process. The factor weights and the names of the factors are given in Table 3, where the four excluded variables are also given. The grey background shows those variables, which were grouped into one factor group after the first factor analysis process, the factors showed in bold letters are those, which were permanent and/or conditional variables of the given factor.

Table 3: The variables and the name of the final factors

Factors and their variables		Name of the factors
H 16, 13, 15, 14, 12 6		Patterns of vehicle use
H 18, 22, **17,** 20, 25, **21**		Refuse collection patterns of waste collection
R 2, 1, 4, 3		Risk assessment and risk perception
H 2, 1, **8, 9**		Energy conscious habits
H 7, 10, 11		Energy consciousness and openness towards renewable energy sources
H **19**, **4**, **5**		Habits for the (energy) savings
Excluded variables	*H3*	*I am building a semi or fully passive house or I am rebuild/modify my present house.*
	H23	*I select and compose the organic waste (from kitchen and garden) by myself or in government form.*
	H24	*I had disabled household appliances repaired or I repair them.*
	H26	*I aspire of socially responsible investments.*

H=Habit, R=Risk

Source: OWN CALCULATION, 2014

Only one element of the first factor – names as “Patterns of vehicle use” has been changed. Comparing with the first analysis, by excluding SZ26, the SZ6 variable were added to that elements which were determined as stable in the course of the methodological analysis. Another significant change is that the windows (SZ1) and the insulation of the house (SZ2) were grouped into one factor with buying energy saving household devices (SZ8) and buying durable goods (SZ9). These habits are not just for decreasing the energy needs, as the last “Habits for the (energy) saving”. The abovementioned four habits refer to the information level, the willingness to pay[5] and long-term perspectives of the individuals, therefore I called this factor “Energy conscious habits”. The name of the last factor (SZ19, 4, 5) is “Habits for the (energy) saving” where emphasize is given on the

[4] Factor extraction: Pricipal Component Analysis, Rotation: Varimax
[5]The insulation of the house and replacing the windows requires significant own financial sources, as the energy-saving and durable goods and products are typically at the higher price range.

cost savings caused by the reduction of the goods consumed and it is not based on the energy and environmental consciousness of the individuals.

The two statements related the renewable energy sources (SZ10 and 11) were grouped into one factor group with statement SZ7 for consciousness of energy use (*"I measure the consumption of devices with high energy use with a different measuring instrument"*). This factor implies that the openness for new technology and devices are closely connected to the attitudes for using renewable energy sources, which is based on the consciousness and the knowledge about the actual energy consumption. The content of this factor complies with the research results of WILHITE and LING (1995).

The results of the factor analysis summarized by Table 3, I used for further analysis, for which I have chosen K-mean cluster analysis. Its results and the demographical characteristics of the clusters are shown in Table 4.

Table 4: The demographical characteristics of clusters

<table>
<tr><th colspan="2">Variables</th><th>Cluster 1.</th><th>Cluster 2.</th><th rowspan="2">Measure of the association (CramerV)</th><th rowspan="2">Sig. level</th></tr>
<tr><td colspan="2">Related factors</td><td>Selective garbage collection
Energy saving habit (NEGATIVE)</td><td>Energy conscious behaviour and open mind towards renewable energy sources (NEGATIVE)
Energy saving habit
Selective garbage collection (NEGATIVE)</td></tr>
<tr><td rowspan="11">Demographical variables used for defining the clusters</td><td>Gender</td><td>no significant difference</td><td>rather women</td><td rowspan="4">weak</td><td rowspan="3">0,05</td></tr>
<tr><td>Age</td><td>active worker</td><td>retired (or close to retirement)</td></tr>
<tr><td>Marital status</td><td>married/single</td><td>married/widow</td></tr>
<tr><td>Child under 15 year</td><td colspan="2">no</td><td>0,1</td></tr>
<tr><td>Educational attainment</td><td>high-school graduation</td><td>elementary</td><td>0,296</td><td rowspan="6">0,05</td></tr>
<tr><td>Revenue</td><td>over 100.000 HUF</td><td>under 100.000 HUF</td><td rowspan="6">weak</td></tr>
<tr><td rowspan="2">Region</td><td colspan="2">Budapest and Pest County</td></tr>
<tr><td>Northern Transdanubia
Southern Hungary</td><td>Northern Hungary
Eastern Hungary</td></tr>
<tr><td>Exist of car</td><td colspan="2">No car</td></tr>
<tr><td>Cubic capacity</td><td colspan="2">1.000 – 1.500 cm^3</td></tr>
<tr><td>Type of fuel</td><td colspan="2">Gasoline</td><td>0,1</td></tr>
<tr><td colspan="2">Name of cluster</td><td>Environmental but not yet energy conscious</td><td>(Energy) Saver</td><td></td><td></td></tr>
</table>

sig.level = significance level

Source: OWN CALCULATION, 2014

As a result of the factor analysis, the habits of vehicle use were grouped into a different factor; these habits did not show any correlations with other habits or statements of global risks. The results of the cluster analysis are in compliance with these results, namely that there is no significant difference between the clusters of vehicle use and the special features of the vehicles. The only significant and medium strong correlation, which was found among the demographical characters, was the educational level.

In accordance with the results of the former analyses of my research, the factor of vehicle use was not significant in the cluster analysis.

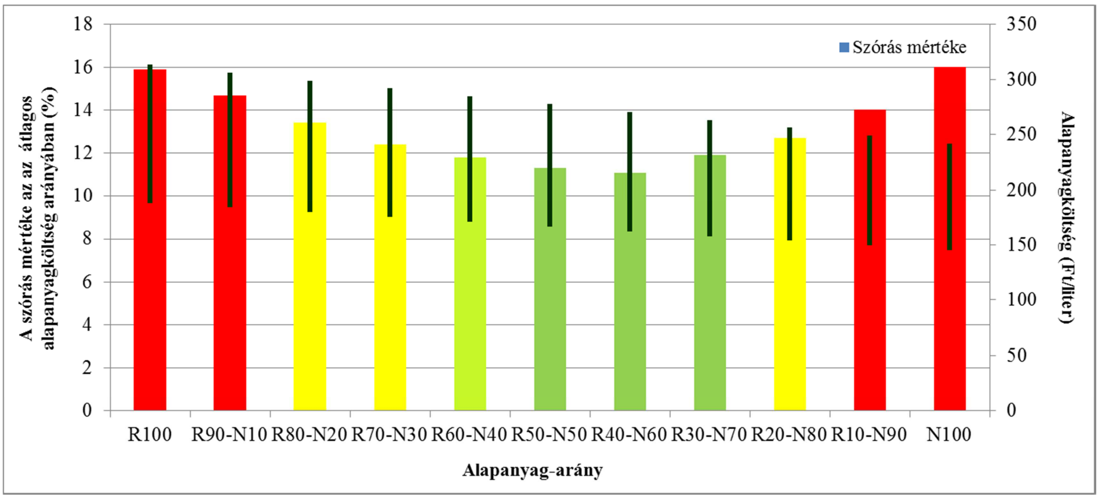
Based on the findings of the analysis of the people's attitudes, it can be stated that the environment conscious attitudes and the vehicle using habits do not show any correlations in the Hungarian population. The reasons of the changes of these habits are induced by the need for cost saving not in environmental protection. Although the respondents could understand the environmental (global and social) risks (risk handling factor), but their own role in this situation is not clear enough, therefore their habits cannot be considered as conscious.

3.3. Results of price analysis

The STEEP analysis, which I prepared in the literature review chapter of my dissertation, has proved that the different quantification of the different direct and indirect impacts, which are related to or generated by biofuels, is very complicated, because of the complexity of correlations between the different economic sectors. As the key element of my dissertation is the examination of investments to biofuel production, and the price of raw materials and biofuels are the critical influencing factors of these investments, I evaluated the role of prices in a separate sub-chapter.

„If the deviation of yields in the past is low, then the deviation of the investments will presumable be also low, with higher deviation of prices will bring higher deviation in the investments. Based on these facts, the risk of the investments may be defined as the deviation of the yields in the past." [FIALA, 1999; p. 73.] Although the definition of FIALA (1999) was primarily concerned to financial transactions, in my opinion it may be used for the analysis of the sales price of the raw materials of biofuel production and the price of biofuels as well.

During the analysis of the prices I could not find such point that might be considered as optimum point at operational level, therefore – based on the abovementioned concept of deviation – I calculated the matrix of the price change of all the raw materials and their deviation, and these results were used as risk factors of biofuel production. I found a minimum point of the deviation results in case of the raw material combinations of biodiesel and bioethanol production; therefore, I concluded that at this point the economic risk of the production plants, which is derived from raw material prices, is minimal.
Figure 3 summarizes the results of the calculations when rapeseed and sunflower were used as raw materials. The columns show the deviation, the colours refer to the risk. The results showed that the lowest economic risk would not represent the lowest raw material cost level.



Rxx-Nxx = Rate of rape (%) – Rate of sunflower (%); red = high risk; yellow = moderate risk; green = low risk

Source: OWN CALCULATION, 2014

Figure 3: The combined effect of the change of the raw material's combination and price on the production cost of biofuels

The combined effects of technological efficiency and the price change

The changes in the quantity of produced biofuels and technological efficiency are important not only because of the quantity of the used raw materials and the related cost reduction. In case of improved technology with reduced raw materials, the resistance of those consumers might also be reduced, whose low willingness to use is related to the food vs. fuel dilemma.

The calculations for the impacts of the changes of technological efficiency were analysed for both bioethanol and biodiesel at 90 (rapeseed or maize as primary raw material)/10 (sunflower or wheat) ratio. According to the accessible database, the price ratio of rapeseed/sunflower prices was 108%, which was not appropriate when compared with statistical data. Therefore, I conducted the analysis again, according to the relevant statistical data. For these calculations I used 95,3% price ratio calculated for the period between 2007-2013.

Every additional percent of rapeseed oil has resulted cost decrease, but the scale of the cost reduction has shown decreasing tendency. The optimum ratio of 40/60 has not been changed until reaching the 40% biodiesel yield; from this point, the costs started to increase. This result means that from this point the risk reduction – determined by the deviation – will bring the increase of cost per unit of the biodiesel production.

In case of sunflower, every additional 1% increase, which was generated by technology efficiency, has brought increased cost reduction, and the optimum point based on calculating the deviation has changed for R30/N70 ratio. I also wished to explore what changes will occur in the diesel yield of these two raw materials. The optimal ratio (based on the deviation) has not changed, but the cost level has decreased with a lower tendency. At 35/50 diesel yield ratio (2,44) has not reached the results of the sunflower (2,46). In that case, when the starting price ratio remains unchanged, the rate of sunflower should be increased.

When using the statistical data of price ratios the technological efficiency would be improved in case of both the rapeseed and the sunflower, and there is no point from which the costs will start to increase. Using the price ratios based on the statistical data, the raw material combination has been changed towards the R30/N70 ratio (30% rapeseed 70% sunflower), and in case of improving the technology of sunflower, it has been changed towards R20/N80 ratio. The cost of 1 litre of bioethanol production has decreased with an accelerating rate by involving every additional 10% of sunflower.

According to the technology described in the available literature sources, the bioethanol yield was equal with 42% of the raw material in both two plants. Therefore, despite the increase in the technology efficiency, the cost reduction and the optimal raw material ratio based on the deviation has remained unchanged. It means that improving the efficiency – with unchanged price ratio – will influence only the cost level.

In order to measure the impacts of increasing the technology efficiency, I changed the technology efficiency data in accordance with the available literature sources. In case of maize, it changed for 46, while for wheat the 42% remained unchanged. The increase of technological efficiency of maize has resulted the decrease of cost per units. The optimum point (based on deviation) has not been changed, but the cost reduction has shown an accelerated rate as a result of the three examined factors. The results of wheat showed that the cost per unit would just slightly change by the technology improvement; it remains unchanged until 45%. Because of the combined effects of the three factors – i.e. price change, raw material ratio and technological efficiency – the decrease of costs has shown a slowing rate. At 46/50 maize/wheat efficiency rate the lowest risk could be reached between 70K/30B to 30K/70B ratio. In this case, the main problem of the biofuel producer will be minimizing of the transportation distances and the transportation costs. At 51% yield ratio of wheat-based biofuels the optimum point is at 50/50 ram material ratios, and the cost reduction rate has increased. It is important to mention that these calculations have not dealt with the increased cost level of the technological efficiency improvements, which may influence the investment costs per biofuel yield.

3.4. Results of investment appraisal calculation

As several researches were conducted in the field of economic analysis of bioethanol and biodiesel production [BAI, 1998; VARGA, 2007; BABÁK et al., 2007; SOMOGYI, 2012] therefore I tried to find new aspects for analysis using the given methodological approach. In my researches, I focused on the risk-based approach and on the depth of analysis of the different factors. Despite these differences, it was important to compare the results of my researches with the results of selected literature sources. Table 5 summarizes the results of VARGA (2008) and SOMOGYI (2012) at the most important investment appraisal indicators.
The results of VARGA (2008) shows that a product, which has a very unstable market in Hungary has a strong stock value, it is quite well represented by its IRR, which is 55%. These values are misleading, because the author stated that only static investment appraisal methods were used in that research. According to literature sources, the static calculation methods are not appropriate for huge investments, because the long-term risks may not be calculated through discounting calculations therefore the results may be distorted. [see the works of: ULBERT, 1992; ILLÉS, 2000; BÉLYÁCZ, 2009]. The results and the methodology of SOMOGYI (2012) are much closer to the international researches and the used practice.

My results are lower than the high IRR values of VARGA (2008). The payback period according to my calculations is different from the results of SOMOGYI (2012): in case of oil pressing technology the payback period is longer, and in case of estherization technology, it is shorter by one year, using the same discount rate.

Table 5: Summary of the results of investment appraisal calculations (comparing to two indicated literature)

Indicators of Investment Appraisal Calculation	Literature		RESULTS OF OWN CALCULATION, 2014		
	VARGA*, 2008	SOMOGYI, 2012	Bioethanol	Biodiesel	
	biodiesel	bioethanol		Database I.	Database II.
period of calculation (year)	*20*	*22*	*15*		
NPV	+	+	+		
Payback time (year)	3	10	8	13	9
Discount rate (%)	regressive**	6	6		
IRR (%)	55	-	13%	10	15

**= results of Varga (2008) come from static investment appraisal method;*
***1.year: 26%, 2.year: 25%, 3.year: 23,5%, 4.year: 22,5%, from 5.year: 13,5%*
Source: OWN CONSTRUCTION, 2014 by own calculation (2014) and the indicated sources

As it may be seen, the value of NPV is positive in each case, therefore a part of my H_3 hypothesis – namely the investments for biofuel production plant is profitable has been proved. My $H_{3.2}$ hypothesis may also be prove*n, because the differences between technologies caused differences in the results of my investment appraisal calculations.

The results of sensitivity analysis

According to the research results of VARGA (2008), when the price of the biodiesel falls under 0,56€/litre, the value of the NPV will be zero. If the rapeseed price reaches the 250€/tonne price level, it will bring also a zero NPV value. When the price of oil cake is 95€/tonne, it will increase the value of IRR above 200%. In my opinion, these results should be considered as distorted, because they were calculated by using only the static indicators. SOMOGYI (2012) examined the impacts of different taxes (local business taxes and corporate income tax) in the course of the calculations of the sensitivity analysis.

In the following, I will present the results of the sensitivity analysis for the biodiesel production. During the sensitivity analysis, I assumed changing revenue because of the following reasons:

- The costs were changed due to the changes of the raw material prices resulted by the price increase in 2008, and the impacts of the fluctuating yields caused by the unfavourable weather conditions.
- The production of specific (industrial) species is very low in Hungary, mostly those surplus quantity of crops are used for biodiesel production, which were originally produced for human consumption.

The increase of the revenues has generated an increase in the NPV value (although with a decreasing tendency). Until a +5% increase level of the revenues the tendency of BPV increase has decreased by 0,02 percentage rate. I experienced an intermittent growth, which means that the value of NPV was equal between the 12-14th, the 15-18th and the 19-20th growth stages. On the contrary, the decrease of the revenues has resulted more sensitive reactions in the NPV value: until the decrease by -5% in the revenue the NPV value has decreased quickly, and from this point its value turned into negative. In the further analysis of the impacts of the changes in the revenue, the sales prices of the biodiesel and the glycerine could be differentiated. The glycerine represents only 0,28% of the revenue, therefore it will not influence the NPV significantly. According to my calculations, a 1% change in the glycerine production the value of the NPV has changed by 0,006% at the end of the 15th year.

The impact of the changes in the raw material costs on the NPV is similar to the abovementioned impacts on the revenue, but with the opposite sign. At the first 1% decrease of the raw material costs, the value of the NPV increased by 14%, and then the change showed a slowing tendency of change. On the contrary, the increase of the raw material costs showed an increasing tendency until 5% of change. In details, it means that the first 1% of increase generated 19% decrease in the NPV, and the next steps generated 24% and 37% NPV decrease, respectively. At a 6% increase of the raw material prices the NPV turned into negative, and from this point, the NPV value has decreased with a decreasing tendency. When we distinguish the price change of the different raw materials[6], the 8% change of the rapeseed oil and the 18% change of the sunflower oil have generated a negative NPV. The NPV could react less on the changes of additional raw materials: the NPV turned into negative at 26% of change of the additional raw materials' costs. At this cost type – similar to the others – the slope of the function was increasing when being closer to the axis origin. In the course of my calculations, a very important element – which was very difficult to define – was the fluctuation of the HUF/EUR exchange rate. This factor had hidden, but very significant effects on the return results of the investment:

- by a weaker exchange rate, the investment and additional costs will increase, but
- it will increase the sales price of the bioethanol.

If the 240 HUF/EUR exchange rate which was used for the calculations changes to the exchange rate of January of 2009 (290 HUF/EUR) it will bring significant impacts on the payback period, i.e. the return on the investment – when all the other factors remain unchanged – will be reached in the 7th year. When the exchange rate decreases – i.e. the HUF will be stronger – a 30% decrease of the raw material costs may balance the impacts of the fluctuation of the exchange rate.

3.5. Assessment of risks in different Hungarian regions

For evaluating the regions of Hungary, I used the databases of the Hungarian Central Statistical Office. I used the study of NNFCC (2008) as the starting point of my methodological approach, which I transformed according to some principles used in logistics, for location problems. The main factors used for my research are summarized in Table 6.

[6] Combination of raw materials: 64,3% rape oil and 35,7% sunflower oil.

Table 6: Used variables in the analysis of the Hungarian regions

Categories	Statistical indicators of the analysis (http://www.ksh.hu/teruleti)	
Feedstock availability	Corn	Harvested quantities (tons)
	Wheat	
	Rapeseed	
	Sunflower seed	
Production environment	Livestock of cattle, pig and poultry[7] (1.000 pcs	
	Harvested area of Silage, alfalfa and/or other feed plant (ha)	
	Fertilized	area (ha)
	Manured	
	Irrigated	
	Protected area (ha)	
Social environment	GDP (1.000 HUF/person)	
	Population density (person/km^2)	
	Unemployment rate (%)	
	Employed in agriculture (person)	

Source: OWN CONSTRUCTION, 2014 by the indicated source

The number of biodiesel producer plants which is based on just rapeseed, is very low, although a slow increase may be observed in 2012. It is suggested that in certain regions the biofuel production should be based on sunflower seed, because in my calculations, the introduction of the sunflower has increased significantly the number of those production plants, which production capacity exceeds 5000 tonne biofuel/year. The role of sunflower use was determinant in the Northern and Southern Great Plain. The results of my calculations may be defined from another aspect, namely, the quantity of the available raw materials will improve the safety of the raw material supply, so the risk of the investment into bioethanol or biodiesel plants is the lowest in these regions.
According to the results of my calculations, the lowest risk is in the Central Hungarian region, where the decrease of "Social risk" until 2014 is derived from the increase of GDP per capita and the increase of the share of people employed in the agricultural sector. According to these two assumptions, the regions of Northern and Southern Great Plain are the least favourable for biofuel production, which is resulted by the high animal density. The increase of the "Social risk" in these two regions was similar to the other regions.

When analysing the raw material supply, the changes were the lowest Central Hungarian region both in the aspects of time and raw material. When considering the equal role of all the three aspects, the Southern Great Plain and the Southern Transdanubia regions are the most suitable for bioethanol production. Considering the rapeseed production, as the raw material of biodiesel production the Western and Southern Transdanubia regions shows similar results.

Considering the change of the raw material costs, – i.e. the bioethanol production has more economic advantages when it is based on maize production and less risks – the Southern Transdanubia region should be preferred for this type of production, even though the supply of raw materials has decreased between 2006 and 2012. This reduction could be observed in the Northern Great Plain and Southern Great Plain regions as well, but it was more serious (by 40%) in the second region. The Central and Western Transdanubia region have similar features in bioethanol production aspects.
Based on that the weighting of different aspects is not clear enough, the originally used "Balance scenario" was completed by three other calculations[8].

[7] It is necessary to take into account the rules of calculation of livestock unit because of the differences of the animals feed requirements.
[8] The weighting was the following: "Sustainable" (basic calculations: 33,33% for all scenarios; „BaU" (business as usual): 60/20/20%; „Agro-balanced": 20/60/20%; „Employment": 20/20/60%.

The weighting has affected the Eastern Transdaubia region at the less, but in 2012, there were not significant changes even in the Western Transdanubia region. The weighting in the BaU – i.e. the scenario that emphasizes the role of raw material production – showed the most significant decrease in the Central Hungarian region, in case of both biofuel types, while the highest changes were observed in the bioethanol production in the Southern Great Plain and the Northern Great Plain regions. Considering all the scenarios and years, it may be stated that the Northern Great Plain and Southern Great Plain regions are the most suitable for biodiesel production.

Additional aspects for further research of regional evaluation

Based on the literature review, the evaluation of my questionnaire, my work in the Ministry and the professional experiences of the everyday life I defined further research aspects, which, of course, have no scientific base at the present, but which are suggested to explore in the future.

I prepared a selection of those questions from my questionnaire used for the attitude analysis, which refer to the high use or willingness to pay for biofuels, and the results were filtered according to the regions. Based on the questions and the answers that region is the most preferred, where the number of the respondents was the highest. These questions regions were re-analysed in accordance with the logical framework I used for the different regions. Based on my opinion and the results of the statistical analyses the regions should not be introduced as a different, fourth factor into the analysis, but it is worth to include it in the "Social risk" group. Considering the results of the group "Attitude", it has brought a significant improvement in the Central Hungarian region, and a moderate improvement in the Western Transdanubia region. The "Raw material supply" has reached the best results in the Northern Transdanubia and the Southern Great Plain regions, where the social risk has increased which was manifested by the reduction of the result points.

Additional aspects may be to consider the performance of the present biofuel plants, but I excluded this option from my research for the following reasons:

1. Only limited information is available about the raw material supply of the operated biofuel producer plants.
2. According to the literature sources (mainly found in the internet), a huge amount of imported raw material is in use.
3. About the authorization process of investments and the production and capacity level of the plans, I could have found relevant information only through personal visits. Regarding that performing the questionnaire survey and the evaluation of the statistical and company level data would be a time- and resource-intensive task, so I decided that this work would be performed in the framework of a future research work.

The phenomenon of "fuel tourism" has been introduced in the media in connection with the increase of the fuel prices, which, of course, is restricted to the counties at the border of the neighbouring countries. In order to compare the fuel prices of the neighbouring countries with the Hungarian fuel prices, I had to calculate the exchange rate for the given four-week periods. From 2010, the Slovak and the Austrian price of diesel oil were lower, while from 2011, both fuels were lower in Slovenia, than in Hungary. From 2012, apart from a moderate increase of gasoline price in Slovakia, both fuel types were cheaper in all these countries than in Hungary. I made my calculations with the average exchange rate, which should be considered different at the different locations, as many people who work in the neighbouring countries get their salary in euro. The phenomenon of fuel tourism is influenced by the difference of the fuel prices; the higher the difference is, the greater the fuel tourism affected area will be.

4. NEW SCIENTIFIC RESULTS

As a result of my PhD dissertation, I defined the following new scientific results:

1. By using the STEEP analysis, I defined the risk that is generated by the contradiction between the legal and economic factors of the macro-environment. **Although the top-down legal practice of the European Union generates a demand for the biofuels, the raw materials of biofuel production** – either from grains or crude vegetable oil – **and the sales price of biofuels are highly determined by the production of quantity-sensitive third countries**. As economic efficiency is highly influenced by the price of raw materials, therefore this legal practice represents a high risk for the investments on production capacities and the EU objectives **in an indirect way.** Because of the complexity of the economic processes and the interactions between the different sectors, this risk is difficult to convert into quantifiable terms.

I examined the environment and energy consciousness of the consumers' attitudes from two different aspects, using two different research databases which content is close to each other.

2. The analysis of the first database could give opportunity for the evaluation of the impacts of the demographic features. Based on my methodological analysis, I stated that despite the former Hungarian and international researches, **none of the used demographic features** (gender, age, salary, location and region) **have significant impacts on the habits of vehicle use and fuel consumption.**

3. In the first database, I focused on the habits of the car owners who use their own vehicles (i.e. they do not have company-owned car). Based on my analysis, **I highlighted that the Hungarian vehicle owners have not relevant knowledge about biofuels, therefore their support is mostly theoretical, and it was not converted into the practice. I also stated that the main motivation of the consumers is cost saving.**

   Based on the results of the factor analysis conducted on the database of the second research, I stated that the **vehicle using habits in Hungary are not derived from the people's environmental conscious attitudes**. The segmentation, which was conducted by the cluster analysis and the demographic features of the clusters, has also proven that the **main motivation of energy conscious habits is generated by cost saving attitude**. I determined six factors and based on these I formed two clusters for the habits of the Hungarian population, which is summarized by Table 7.

Table 7: Factors and clusters resulted by my research work and analysis

Factors	Clusters
1. Patterns of vehicle use 2. Refuse collection patterns of waste collection 3. Risk assessment and risk perception 4. Energy conscious habits 5. Energy consciousness and openness towards renewable energy sources 6. Habits for the (energy) savings	1. Environment conscious, but not yet energy conscious consumers 2. (Energy) Saving consumers

Source: OWN CALCULATION, 2014

Although I had to reject the role of environmental consciousness, according to the findings of the factor analysis, I stated that **the energy consciousness habits are the prerequisites of the openness towards reusable energy sources**.

4. **By using factor analysis, I determined those features of the different variables, which determine the factors that may be or shall be used for the nomination of the different factors. This feature was defined as factor formulating ability.** Analysing the results, this phenomenon may be rooted in the correlations between the different variables.
   I also defined a phenomenon **that the medium or stronger correlation – apart from their transformation from the Likert scale into dummy variables and independently from the factor extraction methods used – will remain in the same factor group. This phenomenon was defined as factor stability. Those variables, which place has been changed through the factor extraction process, I defined as conditional or accompanying variables.**

5. Using investment appraisal methods and indicators, I proved that the production of biofuels may be considered as a successful investment, but it is influenced by many risks derived from the correlations of several risk factors.
   According to literature sources, the raw material price is a determining component of the cost structure of biofuel production. I determined the **optimum of the raw material complex** based on the deviation of the changes of raw material prices, technological efficiency and the ratio of the raw material components. This point will not mean the lowest cost, but it will show the how can be the costs of raw material be minimized based on the joint impacts of the three factors. The **deviation** was used as a **variable that indices the risk derived from the fluctuation of the prices, therefore the minimum deviation of the raw material costs would show the component mixture with the lowest risk**.

   By using investment appraisal methods**, I convinced that using the first generation technologies for biodiesel production the use of rapeseed (as both grain and crude vegetable oil) has an overemphasized role. Based on the cost calculations and the technological efficiency the use of sunflower should be suggested, because of the following reasons**:
   - considering a given technological efficiency, the raw material costs per unit of production was lower in spite of the higher raw material prices,
   - 1% improvement of technological efficiency resulted a higher rate of decrease of the raw material costs per unit of production,
   - the risks derived from domestic prices and the harvested yields are lower than in case of rapeseed.

   I determined the priority of maize for bioethanol production using first generation technology instead of wheat. For this, I used such a calculation method – in accordance with the relevant literature sources – where the technological efficiency of maize was higher. My results were similar to those mentioned above, in case of sunflower:
   - considering a given technological efficiency, the raw material costs per unit of production was lower even when I changed the maize-wheat price ratio,
   - 1% improvement of technological efficiency resulted a higher rate of decrease of the raw material costs per unit of production.

6. **I determined** – by using qualitative and quantified features of the Hungarian regions – that the **risk of establishing** a low output (5000 tonne/year) **bioethanol or biodiesel producing plant** using first generation technology **in which Hungarian region would be the lowest**. In accordance with my results and risk factors:
   - **the most favourable regions for bioethanol production based on maize processing are Southern Transdanubia (and Northern Great Plain), while**
   - **the most favourable regions for biodiesel production based on** rapeseed **and sunflower processing are the Northern Great Plain (and Southern Great Plain).**

5. CONCLUSIONS, RECOMMENDATIONS

Summarizing the literature review and the results of my researches, I would like to present my conclusions and recommendations, and show the possible directions of my future research work. In this chapter, I follow the logical order of my goals and hypotheses.

In the framework of my first goal ($G_{1,}$), based on the information of literature sources and statistical databases, using STEEP analysis and the logical framework of the supply chain of biofuels, I defined those elements and processes of the macro environment which can determine the success of the use of biofuels. According to my first hypothesis (H_1) the macro environmental conditions for biofuel production (and for the successful accomplishment of national targets) are available in Hungary. In my dissertation work, this chapter was that, which was highly influenced by my former works and professional experiences, therefore I wished to confirm my statements and viewpoints by statistical data. The most significant contradiction was found when I examined the biofuel – and particularly biodiesel – production. Despite there are many legal sources refers to the high rate of diesel vehicles and engines and the structure of agricultural production in Europe, I could not find relevant statistical data in this topic. On the contrary, the transformation of the Common Agricultural Policy and the problems of the European agriculture (e.g. overproduction of grains and the withdrawal of intervention system) have regularly raised the questions of biofuel use. Although when I analysed the environmental and energetic regulations (e.g. the decrease of CO emissions), I concluded that renewable energy sources and particularly biofuels represent only an insignificant element.

The legal background of the European Union claims for the support from the member states to the common objectives. However, the economic processes related to biofuels are far beyond the EU borders. There are several countries outside the EU, which is represented in this sector as either raw material producer or biofuel producer, and which countries are able to perform lower price level than the member states. Therefore, the market establishing intention of the EU for the utilization of the agricultural surpluses, the compliance to the common objectives and their realization has established a very complex and contradictory macro-environment, which sometimes may be the barrier of the proposed goals.

In Hungary, the legal rules are mostly connected to the regulations for the biofuel mixing activities, however, the bio components may origin from countries outside Hungary. After summarizing the legal rules and literature sources, I have not find any references for the compulsory domestic utilization of the domestic raw material products. From this process, I concluded that even though the macro-environmental features of Hungary are appropriate for the successful production and utilization of biofuels produced by first generation technology, but for the realization of the additional positive effects (i.e. environmental, job creating etc. impacts) the economic processes should be adjusted. Therefore, the $\mathbf{H_{1.1}}$ and $\mathbf{H_{1.2}}$ hypotheses are accepted and considered as verified.

The next step of my research work was to explore the Hungarian citizens' attitude towards biofuels (G_2). Although that many researches, which I summarized in the literature review, showed that the Hungarian population have a basic knowledge about bioethanol and biodiesel, According to the findings of my questionnaire survey, I have found different results, so I shall reject my $\mathbf{H_{2.1}}$ hypothesis. There was significant difference between the former surveys and my questionnaire, because instead of "Have you ever heard about …?" types of questions I have formulated more specific questions, about the mixture rate of biofuels and the suitability of the car for using biofuels. In my opinion, by using questions that are more specific we may explore more deeply the willingness for use. Another important element of using biofuels is the willingness to pay. According to the results of my survey, the Hungarian population does not want to pay more for fuels that contain bio components. Based on the results of domestic and international research results, I examined the impacts of demographic features on the willingness for use and willingness to pay. As a result of the cross table analysis, significant difference was detected between age, gender and the region o residence in all the questions, in my database formulated in 2011, but the correlation was medium strong or weak. An exception was found the strong and significance between the gender and the question about the gender and the question about the fuel components. Therefore, my $\mathbf{H_{2.2}}$ hypothesis were accepted, but a further analysis is needed, because I could not find these correlations in the databases of 2012 and 2013.

According to my $\mathbf{H_{2.4}}$ hypothesis, there is a correlation between the energy conscious attitude and the habits for vehicle use, and based on the literature sources, I determined three possible consumer groups by the low or high level of these two attitudes. I was not able to verify these groups by using factor analysis and cluster analysis, therefore I reject this hypothesis. Based on the results of my research, I determined seven factors and two clusters. Considering the attitudes of the population towards biofuels and vehicle use habits, I concluded that the main motivation for changing the habits is not the environmental protection, but the cost reduction. As additional results, I would like to mention that according to my analysis, there is no correlation between the global problems and the biofuels or the environmental protection, therefore this field should be explored in the future. Although I should have reject the correlation between the environment and energy conscious behaviour, as a result of the factor analysis I concluded that the energy conscious habits are the prerequisite of the attitudes towards using renewable energy sources (such as biofuels).

A core concept of my research work was to combine the results of the attitude-analysis with the investment appraisal calculations in such way, that the consumers' attitude is considered as a risk factor of the investments. Therefore, I tried to find such variables, which can formulate factors apart from the used factor extraction method and the characteristics of the database (binomial or based on Likert scale). I consider my $\mathbf{H_{2.3}}$ hypothesis as verified, because I could find such variables, which are independent from the factor extraction method and the database features, which I called permanent variables. Their stability is derived from the strongest correlation between these variables.

For the elaboration of my initial research idea – i.e. to detect the changes of the consumers' attitudes – a set database should be formed for 10-15 years, which could be the topic of a new research programme in the future.

The goal of my last economic analysis of my PhD research ($\mathbf{C_3}$) was to explore the key factors of the biofuel production and the impact of their changes on the characteristics of the investment return. For the analysis based on the risks, I used the variable of statistical deviance, which method was used successfully in the evaluation of the risks of securities. As a result of my calculations, I stated that changes in the technological efficiency and in the ratio of the raw material content will influence differently the raw material prices per unit of the biodiesel and the bioethanol production.

Based on the evaluation of the individual and the complex impacts, I determined the optimum point at company level by using statistical deviance, which will not represent the lowest cost level, but it will mean the minimum level of the changes in raw material prices, which is influenced by the individual or the complex effects of all the three factors. Therefore, the minimum of the deviance of the raw material prices will represent the raw material mix with the lowest risk. It is important to underline, that on my evaluation, the risk cannot be reduced, but the risk of the decision may be detected. Based on these findings, I accept my $\mathbf{H_{3.1}}$ hypothesis.

My $\mathbf{H_{3.2}}$ hypothesis may be considered as the most complex one, because for its verification or rejection the results of the literature review, the calculations on investment appraisal and the raw material costs were needed. The bioethanol and the biodiesel are different in their raw materials, their production technology, the chemical processes, and their utilization. It is very important that the production process may be disrupted, in case of bioethanol at the dehydrating process of the crude alcohol[9], and in case of biodiesel, prior to the estherization process. Until this point, the process may be considered as a food producing process; therefore, it may be connected rather to the agricultural or food production process than to energetics.

In the course of my investment appraisal calculations, I could examine the impact of the disruption of the technology in case of the biodiesel production, and I concluded that the economic indicators were more favourable of those production plants, which carries out only the estherization process based on crude vegetable oil. According to my calculations and based on the results of raw material cost calculations and the evaluation of the technological efficiency, the use of sunflower is suggested. The biodiesel production using rapeseed oil was not supported by either the statistical analyses or my economic calculations. This was the most significant deviance between the EU priorities and the real processes: despite the rapeseed has a significant role in biodiesel production policies, its leading role was not represented in the real processes of the agriculture and the world economy. Finally, I accept my hypothesis, namely, "*I proved by investment appraisal calculation methods, that the production of biofuels may be considered as a returnable investment, but several risks and their combinations may influence its success*". The development of this model may be the topic of a further research; because my model is not appropriate for considering the forecasts of price changes, therefore it should be developed and completed by dynamic investment appraisal methods.

My $\mathbf{H_{3.3}}$ hypothesis, ("*The regions of Hungary represent different environmental risks for the investment on biofuel plants using first generation technology*") was verified by my research results.

For the characterization of the regions I used and transformed the regional indicators of the database of the Hungarian Central Statistical Office. The transformation process was conducted for clearing the distortions and to allow the further comparison. The indicators were chosen based on the findings of literature sources and the statistical databases. From this aspect, a possible direction of the research could be a factor analysis based on the statistical data, by which homogenous indicator groups could be formed. For this work a wide range of databases would be needed, which is – in my opinion – is uncertain at the present.
During the formulation of the scenarios, I determined the importance of the risk groups by changing their weight, while the regional balance point could be explored by linear programming method.

As a last step of the evaluation of the regions, I considered the consumers' attitude as a possible social risk factor. Based on my research results I concluded, that there is a significant difference between the citizens' willingness to use and willingness to pay values and the production facilities in the Central Hungarian region, in Southern Transdanubia and Southern Great Plain regions. In order to improve the results, it is suggested to repeat this survey in the abovementioned regions. It is also suggested to repeat the survey in the Northern Great Plain and the Western Transdanubia regions, if significant changes may be detected in "Raw material supply" or "Production risk" groups particularly in the performance of the animal husbandry sector.

[9] Bioethanol is dehydrated alcohol.

6. RELATED PUBLICATIONS

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