BUYING BEHAVIOUR RELATED TO HEATING SYSTEMS IN GERMANY

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ABSTRACT: The decision for buying a heating system is a long-term one, as many different aspects have an influence on this choice which were analysed in a Germany-wide, written survey. The respondents (only owners of a private house) had to answer questions about their attitude towards e. g. economic, convenience or ecological aspects related to heating systems and the respective combustibles. Using a multinomial logistic regression model the choice of the heating system is mainly explained by ecological attitudes and the estimation of different combustibles.
Keywords: characterization, decision making, heat, marketing

1 CHARACTERISTICS FOR THE BUYING OF A PRIVATE LONG-LIFE CONSUMER GOOD

According to the theory of the acquisition of information, two main, distinct aspects determine the choice of a long-life consumer good. These determinants can be distinguished into personal and situational factors [1]. The personal factors consist of socio-demographic characteristics (e. g. monthly income, educational background) and cognitive determinants (e. g. brand loyalty, shop loyalty). When buying a long-life consumer good, especially the last factor is very crucial to characterize because the lifetime of a long-life consumer good is much longer than the lifetime of a "normal" consumer good [2].

The other aspect comprises situational factors. The "number of different possibilities to choose" affects the consumers` decision. If there is only one product which can be bought, the consumer has to buy this product if he needs it. The more products are available, the longer time it takes, until the consumer decides in favour of a product [1]. This "duration for the choice" is another factor which belongs to the category "situational factors". If the consumer has to replace his old long-life consumer good with a new one, he already has an experience with his old product. This experience additionally influences the choice for a new long-life consumer good. And if the consumer realizes technical innovations - since the last time he bought his old long-life consumer good – this also influences the decision for a new product [1].

2 ANALYTICAL MODEL REGARDING THE CHOICE OF A HEATING SYSTEM

Due to these difficulties, a new approach should be used in order to understand the parameters when buying a long-life consumer good. As an example the purchasing of a private house heating system was chosen.

In Germany nearly 87 % of all residential households have installed their own heating system [3]. However, several reasons like new legal regulations (e. g. respirable dust), excessive fuel consumption or merely the old heating system´s being out of order force 2 million owners to replace their old heating system each year.

As various kinds of heating systems (e. g. oil-fired heating, gas heating, wood-pellet heating and heat pump) are available on the market nowadays, it is of particular interest for the different market participants to know why consumers choose a certain heating system. In this article results are presented of a nationwide survey carried out among house owners in Germany.

In the following the different modules of the used methodology are described. The factors influencing the buying behaviour of heating systems are identified in a first step. Secondly, a logistic regression model is developed in order to analyse the influences of different aspects for purchasing a house heating system. Finally, details of the data collection procedure are provided.

2.1 Parameters influencing the buying behaviour related to heating systems

By using around 15 expert interviews (with chimney sweepers, members of the heating industry, heating contractors) and different literary sources [4] [5] [6] [7] [8] three different main parameters [9] have been identified which influence the purchase of a private long-life consumer good in general and a heating system in particular (see figure 1):

- Characteristics of the consumer
- Situational terms
- Kind of the product

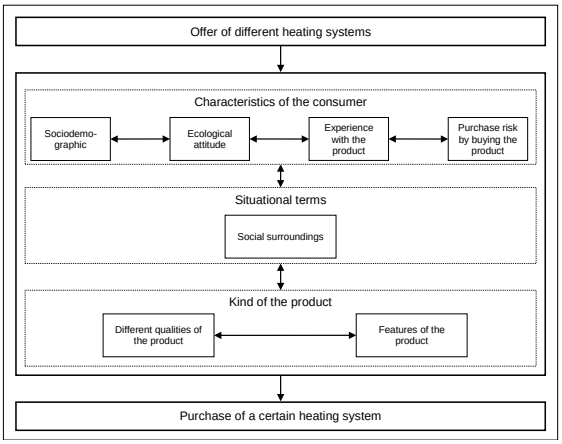

Figure 1: Used theoretical model

The first factor represents the socio-demographic characteristics of the consumers. Figures like e. g. age, income or education level have an impact on the choice of a heating system. If the average income of a household

is too low, the house owner cannot afford more expensive heating systems like e. g. a heat pump.

A house owners` personality and attitudes affect the choice of a certain heating system. These individual attitudes can be distinguished into several main topics.

On the one hand, attitudes towards ecology, environment and sustainability in general influence the decision making process for a new heating system. This type of attitudes has been analysed with a cluster analysis (see chapter 3).

On the other hand, there are those attitudes which are directly connected to a heating system: The consumers´ experience with the product. In this case, one can differentiate between attitudes which relate to the situation before the purchase of a heating system and the attitudes when operating the new heating system. By means of a factor analysis the most relevant attitudes have been identified (see chapter 3).

The buying of a heating system is connected with huge investment costs. This means that there is a purchase risk by buying a certain heating system. The consumer wants to reduce this risk e.g. by consulting several information sources.

The situational terms play another role for the choice of a certain heating system. For this reason, it is important to know who of the family influences the decision. Another aspect is the heating system of the neighbour. Normally, the neighbour is asked about his heating system. So the neighbour impacts the decision.

Other factors influencing the purchase of a heating system are the different qualities of the product which prevail in the individual houses. The “needed power of the heating system” belongs to this group.

The last reason for the choice of a heating system are the features of the product (of the combustible) and their assessment by the individual consumer. Availability, operational reliability, level of prices, environmental emissions, handling and perceived image are some of the characteristics which influence the consumers` assessment of a combustible.

2.2 Data gathering and analysis

In spring 2007, 4,500 house owners with different heating systems (oil-fired heating, gas heating, wood-pellet heating and heat pump) were questioned in a nationwide, written survey about the choice of their current heating system as well as their attitudes towards several combustibles and environmental aspects. With 1,176 returned and useable questionnaires the survey had a response rate of 26.1 %.

Based on this survey it was analysed which of the parameters (described in chapter 2.1) influence the choice of a certain heating system (see figure 1). For that purpose a logistic regression model was defined. The basic idea of this analytical method is the calculation of the probability that a certain event occurs by fitting data to a logistic curve [10] [11].

However, carrying out a logistic regression requires completely filled-in questionnaires. Therefore, finally 775 data sets could be used for the analysis which results are presented in chapter 3.

3 BUYING BEHAVIOUR RELATED TO HEATING SYSTEMS

The distribution of the respondents with respect to their choice of a heating system was quite uniform. The group using heat pumps merely has a minor share of 13.8 % (figure 2). But this fact does not affect the quality of the logistic regressions´ result [11].

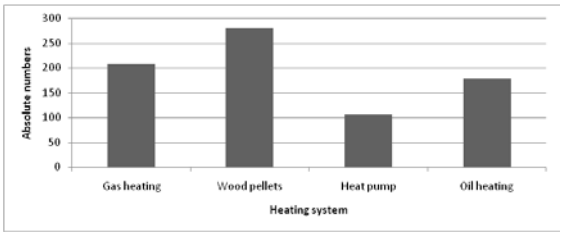

Figure 2: Distribution of the respondents according to their heating system (n =775)

The logistic regression was carried out with 27 variables of the three groups of parameters described in chapter 2.1. Except the “Ecological attitude” and the “Experience with the product” all data for the variables of the categories were directly taken from the survey (e.g. with average determination).

3.1 Experience with the product

The results of the “Experience with the product” were condensed by using factor analysis. In the survey the respondents had to answer two statement batteries in order to get the individual attitudes towards different aspects which influence the buying of a heating system (see chapter 2.1). In the first one the importance of 23 different aspects related to the time before the buying decision of a heating system should be evaluated on a five point scale ranging from “very important” to “very unimportant”. In this case, the respondents had to imagine the time before buying a heating system. Using factor analysis (KMO = 0.845 / Total variance = 60.798 / Bartlett significance = 0.000) it was possible to identify seven significant factors (see table I).

Table I: Rotated Component Score Coefficient Matrix: Before the purchase of the heating system (Principal Component Analysis; Varimax Rotation); (n=775)

		Factors						
		Economy	Ecology	Questions about the fuel	Comfort	Questions about the delivery of the fuel	Information about the heating system	Public subsidies for the purchase of a heating syste
Statements	Costs for replacements	0.711						
	Amortization time	0.668						
	Low capital expenditure	0.642						
	Operating costs	0.641						
	Spatial conditions	0.536						
	Longevity of the system	0.482						
	Health aspects		0.772					
	Low dust emmissions		0.731					
	Climate protection		0.7					
	Transportation risk of the fuel		0.579					
	Low fuel price			0.731				
	Price security of the fuel			0.73				
	Wood as renewable resource			0.638				
	Regionally available heating material			0.529				
	Failure-free operation of the system				0.755			
	Low maintenance requirements				0.723			
	Personal controllability of the system				0.547			
	Uncomplicated delivery of the fuel					0.816		
	Supply security of the fuel					0.802		
	Competent consultancy						0.826	
	Competent heating contractor						0.786	
	Image of the heating system						0.559	
	Public subsidies for the purchase of a heating system							0.775

In the second statement battery the respondents were asked to assess the importance of eight different statements dealing with the operation of the heating system (using the same scale as for the first statement battery). Out of these eight statements (see table II) three significant factors were identified using a factor analysis (KMO = 0.745 / Total variance = 62.524 / Bartlett significance = 0.000).

Table II: Rotated Component Score Coefficient Matrix: During the operation of the heating system (Principal Component Analysis; Varimax Rotation)

		Factors		
		Personal contact to the craftsman etc.	Questions about the fuel	Comfort
Statements	Personal contact to the producer	0.784		
	Personal contact to the retailer	0.749		
	Personal contact to the craftsman	0.715		
	Price of the fuel		0.86	
	Quality of the fuel		0.797	
	Low operating stress			0.837
	Convenient supply of the fuel			0.573
	Compliance with the service interval by the craftsman			0.525

3.2 Ecological attitude

The findings of the "Ecological attitude" were achieved with the help of a cluster analysis (ecology cluster membership). Furthermore - again on a five point scale ("I strongly agree" until "I do not agree") - the respondents had to evaluate several statements dealing with environmental aspects. The statements deal e. g. with climate warming, sustainability, pollution or species extinction. Due to the high amount of respondents a hierarchical cluster analysis was impossible. Thus, in order to determine the "right" number of clusters, a two-step cluster analysis was applied revealing five different clusters. Following a K-Means cluster analysis was run in order to achieve a detailed description of the groups. According to their ecological attitudes the "environmental indifferent consumers", "environmental nihilistic consumers", "ecological-minded, active altruists", "ecological-minded, active egoists" and the "stingy pseudo environmentalists" can be distinguished.

The ANOVA-table shows that every statement has high F-values and a very low sig.-level. Therefore, it seems that the results of the cluster analysis are quite good.

The distribution of the consumers within the clusters is very evenly (see figure 3). Every cluster has more than 100 members.

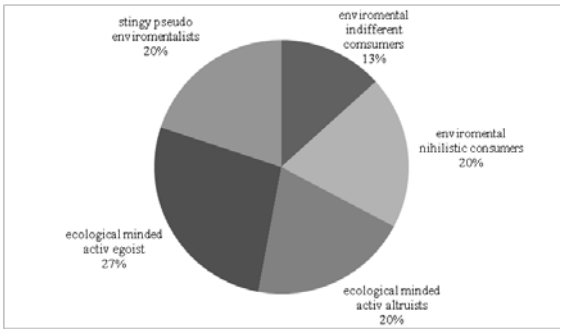

Figure 3: Distribution of the respondents in the different clusters (n =775)

In the following the groups "ecological-minded, active altruists" and "ecological-minded, active egoists" will be described in more detail as these two clusters will pose a very significant influence on the choice of a heating system.

The difference between these two groups appears mainly in the completely different way of estimating two statements. While the "ecological-minded, active altruists" do not think that they harm themselves by acting pollutive, the "ecological minded, active egoists" estimate antipollutive products to be more expensive than pollutive products (see figure 4).

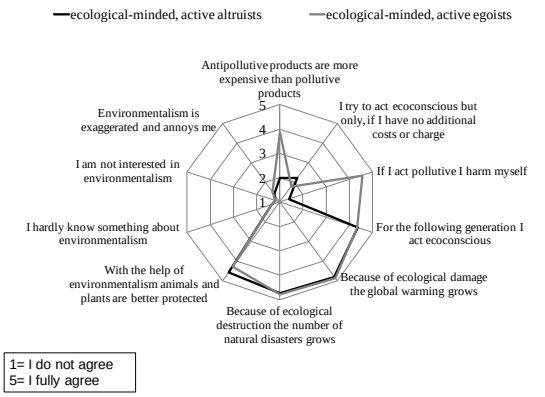

Figure 4: Comparison of the clusters "ecological-minded, active altruists" and "ecological-minded, active egoists" (n =775)

3.3 Parameters influencing the purchase of a domestic heating system

In the statistical program SPSS it is possible to run a multinomial logistic regression in order to find the variables which describe the model optimally. The variables were successively included using the method "forward entry". With this procedure, 17 (out of 27) variables could be identified which have a significant influence on the choice of the heating system (see table III). The other 10 variables have only a minor influence. Different information sites for example have no influence on the buying of a heating system. Thus it does not matter where and how often the consumer gets information about a heating system. The two variables with wood log have a minor influence, too. This is not surprising. No one of the respondents has a wood log heating system.

Table III: Primary and chosen (marked) variables for the multinomial logistic regression

Characteristics of the consumer	Situational terms	Kind of the product
Size of the household	Power/m²	Evaluation of natural gas
Age		Evaluation of fuel oil
Educational status		Evaluation of electric power
Monthly income		Evaluation of wood log
Ecology cluster membership		Evaluation of wood pellet
Crucial economic aspects		Price development of natural gas
Crucial ecological aspects		Price development of fuel oil
Needs towards the combustible		Price development of electric power
Convenience aspects		Price development of wood log
Delivery of the combustible		Price development of wood pellets
Advisory service		Heating-system of the neighbor
Subsidies		Influence of the family
Contact to the heating craftsman		
Questions about the fuel		
Comfort aspects		
Amount of different information sites		

The adaption of the multinomial logistic regression with the 12 variables demonstrates a very good adaption. The significance of the likelihood-ratio-test is 0.00. This implies that the null hypothesis can be rejected and that the model separates the consumers very well in accordance to their heating system. Other figures for the quality of the model are also excellent with the "Nagelkerke-factor" being 0.891 and the factor of McFadden being 0.663.

In the following the results of the multinomial logistic regression are described using the Exp (B)-level. "The value of Exp (B) is an indicator of the change in the odds resulting from a unit change in the predictor" [12].

With a multinomial logistic regression every parameter value of the dependent variable (choice of the heating system) is compared with every other parameter value [11]. In this case 4 different reference categories ("oil-fired heating system", "gas-fired heating system", "wood-pellet heating system" and "heat pump") exist.

The results for the reference categories "oil-fired heating system", "gas-fired heating system" and "heat pump" are quite similar. Thus, in the following not the results of all four different reference systems are shown. Only the two most interesting ones ("oil-fired heating system" and "wood pellet heating system") are presented. Also, only the three most interacting variables of each comparison regarding content are shown in the following figures (the level of significance of all chosen variables is lower than 0.05).

Comparing firstly the reference group "owners of an oil-fired heating" with the other three groups it is shown that the membership in the cluster "ecological-minded, active altruists" has a big influence on the choice for a heating system (see table IV) and that it separates the different segments very well. The members of this cluster think and behave ecologically (independent of higher costs for e.g. environmentally-friendly products). Furthermore, this cluster is a very homogeneous one, as more than 96 % of these respondents belonging to "ecological-minded, active altruists" have a wood pellet heating system at home. Thus, it is very unlikely to be concurrently, e. g. owner of an oil-fired heating system and to be member of this cluster. Consequently, the Exp (B)-level in table IV for the variable "ecological-minded, active altruists" is very high.

The estimation of the own fuel plays an important role for every reference group. For example: mainly in the comparison of the owners of an oil-fired heating system with the users of a gas heating system the "evaluation of fuel oil" is very important (Exp (B) = 35.237). Thus, it is much more likely to own an oil-fired heating than to have e. g. a gas heating system if different aspects of oil are favourably assessed by the respondent. In comparison to users of a pellet heating system, economic aspects (e. g. amount of investments, amortization time) are more important for the owners of an oil- fired heating.

Table IV: Comparison of owners of an oil-fired heating system with owners of the other three heating systems (n =775)

		Significance	Exp(B)
Users of a gas heating system	Evaluation of fuel oil	0	35.237
	Evaluation of electric power	0.004	1.917
	Cluster: Ecological-minded, active altruists	0.66	1.775
Users of a heat pump	Evaluation of fuel oil	0	23.31
	Cluster: Ecological-minded, active altruists	0.040	3.615
	Size of household	0	2.13
Users of a pellet heating system	Cluster: Ecological-minded, active altruists	0	339.432
	Evaluation of fuel oil	0	11.078
	Crucial economic aspects – at the time of buying	0	4.289

If the reference group consists of the owners of a wood pellet heating system, a completely different picture is painted as one can observe in table V. In this case the membership to an ecological-orientated cluster has a much lower influence on the decision for a certain heating system. In analogy to the other reference groups, the consumers` assessment of wood pellets is a very important factor for owners of a wood pellet heating system. They assess "their" fuel better than other fuels like oil, gas or electric power and thus it is more likely that they choose a wood pellet heating system. Another very important distinguishing variable describes the importance of the needs towards the combustible. Before a consumer buys a heating system, he has to think about the requirements regarding the fuel. The delivery of the combustible should be quite easy or one needs enough storage capacity for oil or wood pellets. The importance of these questions is merged into the variable "needs towards the combustible – at the time of buying". For owners of a pellet heating system this variable is more important than for the other groups. With reference to the delivery or the storage of wood pellets it is not that easy as with oil. Thus, if one wants to buy a wood pellet heating system, he has to satisfy these needs towards wood pellets.

Table V: Comparison of owners of a wood pellet heating with owners of the other three heating systems (n =775)

		Significance	Exp(B)
Users of a gas heating system	Needs towards the combustible - at the time of buying	0	7.087
	Evaluation of wood pellet	0	3.425
	Evaluation of fuel oil	0.001	3.181
Users of a heat pump	Needs towards the combustible - at the time of buying	0	4.552
	Cluster: Ecological-minded, active egoist	0.049	3.186
	Evaluation of wood pellet	0	3.000
Users of an oil-fired heating system	Needs towards the combustible - at the time of buying	0	5.033
	Evaluation of wood pellet	0	4.814
	Subsidies for the heating system	0	3.182

The described variables show the highest influence on the choice of a heating system. Besides, each of the 17 independent variables included in the model has a more or less impact, but to describe all of them would go beyond the scope of this article.

As already shown, the results of the multinomial logistic regression model are significant. Using the logistic regression model 83.0 % of the respondents (see table VI) are correctly classified in terms of their heating system. The mathematical expectation of the dependent variable ("choice of the heating system") was 27.6 % (see figure 2). Thus, by means of the logistic regression there is a gain in explanation of more than 55 %.

Table VI: Classification

		Predicted				
		Gas heating	Wood pellets	Heat pump	Oil-fired heating	Correct percentage
Observed	Gas heating	170	8	13	17	81.7%
	Wood pellets	8	257	9	7	91.5%
	Heat pump	16	6	73	12	68.2%
	Oil-fired heating	23	5	8	143	79.9%
	Overall percentage	28.0%	35.6%	13.3%	23.1%	83.0%

4 CONCLUSION

With the help of a developed multinomial logistic regression model including 17 independent variables explaining the choice of a heating system, it was possible to correctly allocate 83.0 % of the respondents in accordance to their choice of a heating system which documents the high quality of the applied model. Mainly the membership to different ecological clusters influences the choice of a certain heating system. Also the assessment of the different combustibles plays a major role for the decision.

For producers of heating systems the results can supportively influence their marketing activities, like for instance their product policy. They understand e. g. the reasons why consumers buy an oil-fired heating and not a wood-pellet heating system. Therefore, it is possible for them to diversify their product portfolio or to tailor their marketing activities towards the needs of the consumer. For example: Producers of a wood-pellet heating system should focus their marketing activities on ecological aspects.

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