CLEVER
Clean Vehicle Research

Consumer Behaviour for Purchasing Cars
Task 1.4

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1. Introduction

Two important factors have caused major evolutions and developments in the transportation and automotive sector and have stimulated the use of new technologies for our transportation modes: the availability of energy sources and the important negative effects of our transportation system on the environment (Van Mierlo et al., 2006). The dependence on fossil fuels and the environmental aspects related to our current transportation system, demand a fundamental revision of the energy supplies in general and of transport and mobility in specific. The ever more stringent emission standards for vehicles force the automotive industry to reduce the environmental impact of conventional diesel and petrol vehicles by using new technologies. Besides these improved conventional vehicles, vehicles with alternative fuels such as Liquefied Petroleum Gas (LPG), Compressed Natural Gas (CNG), bio-fuels, biogas and hydrogen or drive trains such as hybrid, fuel cell and battery Electric Vehicles (EVs) can form an attractive solution. This report reviews the impact of the environmental friendliness of the car on the car purchase decision. In the next section, we will briefly discuss the alternative fuels and technologies that we consider in this report as environmentally friendly. A large scale market introduction of these environmental cars seems to be a great challenge. It depends not only on large-scale infrastructure costs, such as refueling/recharging facilities needed on the supply side, but it depends also on the acceptance by the end-users on the demand side. It is of great interest for transport planners, policy makers and car manufacturers to know if the strong concern for the environment that we observe nowadays, will be translated into a public acceptance of green cars. In this respect, sections 3 and 4 will set-up and present the results of a review of 26 scientific publications in order to assess the importance of the environmental friendliness in the car purchase decision. Still open research questions will be formulated in the conclusions.

2. Alternative Fuels and Technologies

Alternative Fuel Vehicles (AFVs) are vehicles that make use of LPG, natural gas, bio-fuels, biogas or hydrogen. LPG is the most common alternative fuel currently on the market. At atmospheric pressure LPG is a gas, but at a pressure of 4 bar it can be liquefied. Most of the LPG vehicles that currently exist are "retrofit" petrol vehicles, but there is a tendency towards the development of specific LPG vehicles. Natural gas mainly consists of methane (80 to 99 %). The vast majority of natural gas vehicles uses CNG, but Liquefied Natural Gas (LNG) also exists. Like LPG vehicles, CNG vehicles are usually adjusted petrol vehicles. They can also use biogas, which is produced by fermentation of manure and/or organic waste. Hydrogen can be used in a fuel cell (see further) or in a combustion engine. Through some adjustments, a petrol engine can be converted to hydrogen. Hydrogen can be produced through the oxidation of gas, which is the most common production method, or it can be produced from the electrolysis of water or from biomass. Bio-fuels are "supposed" renewable fuels, made from agricultural crops, wood or organic waste. The EU has set the target that 5.75% of the total amount of used transportation fuels have to be bio-fuels by the year 2010. To that extent, the EU counts on the short term on biodiesel, bio-ethanol and to a lesser extent on biogas and pure vegetable oil. On the mid-term they count on second generation bio-fuels, such as bio-methanol, produced by the gasification of biomass.

Vehicles with alternative propulsion systems are battery, fuel cell and hybrid EVs. Battery EVs are driven by an electric motor, which obtains its energy from a rechargeable battery. At standstill, the motor does not use energy and a part of the energy during braking can be recuperated to charge the battery. Due to their limited autonomy (80-120 km at full charge), battery EVs are suitable for use in the city or to travel short distances. Their autonomy is expected to increase strongly due to the use of new battery technologies, like lithium batteries. EVs can also be equipped with a fuel cell in stead of a battery. This fuel cell uses oxygen from the air and hydrogen from a tank to produce electricity. Currently only prototypes exist, but fuel cell vehicles are expected to be ready for the market in 10 to 20 years. The current prototypes display an autonomy of more or less 300 km, but in 10 to 20 years, 600 km should be possible. Finally, hybrid vehicles comprise a collection of vehicle technologies that use two (or more) drive trains or energy sources, but usually they have an internal combustion engine and an electric motor. Depending on whether only the electric motor or both the electric motor and the combustion engine drive the wheels, it is called a "series hybrid" or a "parallel hybrid" propulsion. A combination of both also exists (e.g. Toyota Prius).

3. Review of Consumer Preferences for Green Cars

According to Cooper (1989), a research review should be designed in a systematic, objective way. To this extent, the integrative research review contains five stages as main structure. The first stage is the formulation of the problem, which will guide the research (section 3.1). The second is the determination of the data collection strategy and a selection of multiple channels in order to avoid a bias in coverage (3.2). The third stage elaborated in 3.3 will give an evaluation and selection of the retrieved data. The fourth stage contains an analysis and interpretation of the reviewed literature (3.4). Finally, section 4 will give the presentation of the results (Bontekoning et al., 2002).

3.1 Formulation of the Problem

In order to assess the importance of the environmental awareness in the car purchase decision, it is necessary to get an insight into the process of purchasing itself. The consumer's decision to purchase a product is a multi-staged process. Kotler (2006) identifies that the consumer will go through five stages. Vehicle purchase behavior is fairly complex, as car purchase implies a high level of social and/or psychological involvement (Abramson and Desai, 1993). Therefore, the consumer will transit each stage of the purchase decision making process as presented in Figure 1.

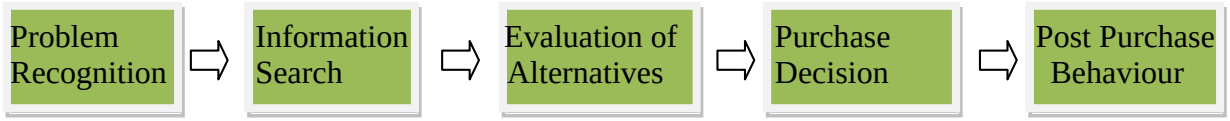

Figure 1. The purchase decision making process (Kotler, 2006)

3.1.1 Problem Recognition

The purchase decision of a new product is induced by problem recognition. This means that the buyer recognizes a discrepancy between the existing and the wanted situation (Kotler, 2006). In the case of car purchase, there can be several buying-triggers. A study of MU Consult (2000) identified several motives to purchase a new car. These motives can be, among others, reparation costs or a good exchange value for the old car.

3.1.2 Information Search

Following on from the problem recognition, the information search is the stage in which the consumer will inform himself about the product. The purchase of a car is a high involvement purchase which might mean that there will be an extensive information search. This information search may cover external or internal sources of information. An external search means gathering information from sources such as books and magazines, automobile articles, salespersons at dealerships, friends and test-drives. The consumer can also use his long-term memory or an internal information search (Punj and Staelin, 1983). Even before consumers actually consider buying a car, they are confronted with information out of advertising, television programs and articles. According to Abramson and Desai (1993), the purchase of a car is so important that the consumer attends to messages about cars continuously. As a result, at the time of actual search, the consumer does not pay extra attention to information about cars. Moreover, Abramson and Desai (1993) found out that, while car purchase is a high involvement action, the actual information search behavior is characterized by little effort.

3.1.3 Evaluation of Alternatives

Once sufficient information is gathered, the consumer moves on to the evaluation of the alternative solutions. The evaluation process of a car is complex. The consumer wants to make a well- reasoned purchase decision and will consider several car attributes when making his decision. In general, the consumer will assign different levels of importance to attributes. By use of a quantitative survey of 581 people who recently bought a car, OIVO (2004) found out that the three most important attributes consumers take into account when evaluating car alternatives are the purchase price, the operating cost and the quality of the car. Based on these attributes, consumers will select certain alternatives. Once these alternatives are selected, consumers will base their actual choice by the evaluation of other car attributes. According to Potoglou and Kanaroglou (2006a), the attributes of the car can be categorized into the monetary attributes, the non-monetary attributes, the socio-economical attributes and the environmental attributes.

Out of the monetary attributes, the purchase price is the first factor consumers take into account when purchasing a car (Cao and Mokhtarian, 2003; OIVO, 2004). Borgsteede and van Tatenhove (2004) state that consumers define in advance a certain price category to which the car of their choice has to belong. More specific, the consumer defines in advance a maximum price the purchase of a car cannot exceed. This maximum price determines which types of vehicles the consumer will choose from. The purchase price will only be irrelevant for those consumers who have a large income (Borgsteede and van Tatenhove, 2004). A second important criterion when choosing a car is the operating cost (Cao and Mokhtarian, 2003). The operating cost consists of the maintenance cost and the cost of fuel consumption. According to OIVO (2004), fuel consumption is a very important car attribute as they found that during the car purchase decision, the assessment of fuel consumption is based on the comparison of fuel consumption between vehicles of the same type, rather than on a specific analysis of the cost per kilometre. Importantly, the fuel consumption will only be taken into consideration because of the fuel costs, and not because of environmental issues (Clase, 2004; VITO, 2003).

Out of the non-monetary attributes, the quality (reliability and security) of the car is the third important car attribute (OIVO, 2004). Consumers want their car to be safe, moreover the car has to react how the consumer wants (e.g. in case of danger). However, the actual choice for a certain car is also induced by other intrinsic characteristics of the car, mentioned here after (Cao and Mokhtarian, 2003; OIVO, 2004; Borgsteede and van Tatenhove, 2004). Looks play an important role in the purchase of a car. Acceleration time, horsepower and the sound of engine are elements that are important for two reasons. First of all, certain consumers want their car to accelerate fast because they like to drive sportive. Secondly, these elements are important in terms of safety. Comfort, number of seats and luggage space play also a role in the car purchase process. A last important non-monetary attribute is brand loyalty (May, 1969; Newman and Werbel, 1973; Dowling and Uncles, 1997). According to these authors, consumers are likely to buy a car of the same brand as their previously owned car, based on their experiences with that brand.

Socio – economic attributes play an important role too as a car has for many people an important image-function and carries a certain status. Consumers are inclined to choose products that communicate their role and status in society (Kotler, 2006). As consumers buy products that reflect their personality, lifestyle and the social class to which they belong, personal, social and cultural factors will have an important influence on the decision-making process. Moreover, Choo and Mokhtarian (2002) state that travel attitude, and demographic

characteristics such as age and gender play an important role too in the vehicle type choice. According to the travel attitude, workaholics or people who do not enjoy personal vehicle travel for short distance are more likely to choose large cars; people who tend to be organizers are more likely to choose mid-sized cars; people who tend to be status seeking and who travel a lot by airplane are more likely to drive luxury cars; sports cars are more frequently bought by younger, status seeking people who are not workaholics and calm people are more likely to drive minivans. Out of the demographic characteristics, the consumer's age is found negatively associated with driving small or sports cars and Service Utility Vehicles (SUV). What gender is concerned, Choo and Mokhtarian (2002) found out that females are less likely to drive pickups than other vehicle types. Males, on the other hand, are more likely to buy bigger cars (Miller, 2003). Finally, car purchase is also influenced by household characteristics. Kurani et al. (1996) state that households are the fundamental unit for decisions on vehicle purchase. This is confirmed by Kotler (2006), who says that the family of procreation (one's spouse and children) has the most direct impact on the buying behavior. As a consequence, the importance of car attributes such as number of seats, luggage space, and size will depend on the need of the household (Kurani, Turrentine and Sperling, 1996). According to Beggs and Cardell (1980), the choice of the vehicle's size depends on household size, income level and the type of vehicle which the smallest car complements in the household fleet. The larger the household's income, the more likely the household will buy luxury cars and SUV's. When the household already has a large car, it will be more likely that the second car in the household fleet will be a smaller one. Kurani and Turrentine (1995) state that households that own two or more cars can be potential buyers of environmentally friendly cars for the second or third car in the household fleet. These households are referred to in the literature as "hybrid households" (Kurani and Turrentine, 1995).

The fourth kind of attributes Potoglou and Kanaroglou (2006) defined, are environmental attributes. The question is if the consumers will take these attributes into account when purchasing a vehicle.

3.1.4 Purchase Decision

After the evaluation of several alternatives on the basis of the set of car attributes, the consumer will form his purchase intention that will result in the actual purchase decision. However, there are still two factors that can come between the purchase intention and the purchase decision. First of all, the attitude of others such as family members: the stronger their opinion and the closer related to the purchaser, the greater their influence on the purchase decision. Secondly, the purchase intention can be influenced by unexpected situational factors (Kotler, 2006).

3.1.5 Post Purchase Behaviour

The last stage within the decision making process, is the evaluation of the purchased product. The level of satisfaction will depend on the relationship between the expectations about the product and the perception of the product performance (Kotler, 2006).

3.2 Determination of the Data Collection Strategy

For the data collection, a computerized search was used. The use of electronic sources may involve a risk of having a bias in the data coverage towards more recent articles. Literature from the early ’80s is often not accessible from electronic resources. Due to this inconvenience, the review could only treat 3 papers from the early ’80s. Nevertheless, the short period of coverage will not produce a significant coverage bias in this review, as we presume that the majority of the papers involving the demand for environmentally friendly vehicles were published in the ’90s. The review covers the period 1980-2007 as much as possible. The articles were mainly retrieved by tracking cited references and by tracking e-catalogues. Several sources were used in the search for literature in order to avoid a bias in coverage. This includes the web-based search tools (V-spaces, article database; “web of science” and other e-sources) and the VUBIS library e-catalogue from the university library of the Vrije Universiteit Brussel (VUB). Also ordinary web-search robots such as google were used to track cited references and to find publication titles. The search was conducted during May 2007, using the general search terms such as “alternative fuel vehicles” “environment” and “purchase behaviour”.

3.3 Evaluation of the Retrieved Data

By using the above described methodology, 26 publications were collected. The reviewed articles show first of all divergences in the treated research field according to the research period. Studies in the ‘80s and ‘90s focused mainly on the potential demand for battery EVs (Beggs and Cardell, 1980; Beggs et al., 1981; Segal, 1995; Kurani and Turrentine, 1995; Kurani et al., 1996; Chéron and Zins, 1997; Gould and Golob, 1998a,b), while more recent studies rather focused on cars with alternative fuels (Bunch et al., 1993; Brownstone et al., 1994; Sperling et al., 1995; Brownstone et al., 1996; Bunch et al., 1996; Brownstone et al., 1997; Ewing and Sarigöllü, 1998; Tompkins et al., 1999; Ewing and Sarigöllü, 2000; Dagsvik et al., 2002; Mourato et al., 2004; Potoglou and Kanaroglou, 2006a,b; Lundquist et al., 2006). There was only one article (Mourato et al., 2004) that assessed the potential demand for fuel cell EVs.

Secondly, most literature on the demand for environmentally friendly vehicles is carried out in America. Out of the 26 reviewed articles, 14 were carried out in California, 5 were elaborated in Canada and 4 in other States of the US. In contrast, Europe was represented with only 2 papers and Asia with only 1. The bias towards California as the geographical focus of attention in most of the publications may be explained on the one hand by the heightened awareness of air pollution due to local conditions and the press attention (Glazer et al, 1995). On the other hand, it can be explained by the Californian regulations and state programs that not only require semi-annual vehicle emission checks, but also the instauration of emission packages when a new car is bought in the state (Gould and Golob, 1998a).

Thirdly, the reviewed studies differed in their applied research methodology[1] in order to assess the consumer preferences for green cars. In the ‘80s, attitudinal surveys were a common used research methodology to assess the consumer preferences for green cars. As a result of the use of electronic sources, the risk of a bias in the data coverage towards more recent articles is illustrated by the fact that only 2 publications out of the 26 made solely use of an attitudinal survey. This minor representation can also be explained by the fact that

[1] For a description of the applied research methodologies, see section 4.

attitudinal surveys, widely used by the car industry to understand environmentally conscious purchase behavior, are often not publicly available (e.g. the Dohring Company (1994), Kirchman (1993), Buist D.R. (1993)). Nowadays, we see a tendency towards the use of experimental design, representing 6 out of the 26 publications, and especially towards the use of preference valuation techniques, representing 18 out of the 26 publications. However, there must be said that within these studies, attitudinal surveys are often used in a first phase in order to develop the survey instrument or to obtain in-depth qualitative information about the consumer's attitudes on environmental issues.

3.4 Analysis and Interpretation of the Literature

Based on the criteria such as the title, abstract, keywords and the type of media, a pre-selection of the articles was made. Starting from this pre-selection, the publications were first divided according to the publication year in order to have a good representation of the different research periods and the resulting research field. Secondly, the publications were classified according to the used research methodology.

4. Presentation of the Results

In this section, the findings of the publications will be presented in order to give an answer to the central question of this review: will the environmental friendliness of the car play a role in the car purchase decision? As explained in section 3.3, we can make a classification according to the research methodology that has been used. The overview of publications in this section is given according to these different research methodologies, namely attitudinal surveys, experimental analysis and preference valuation techniques or a combination of all three. First, a brief definition of the methods will be given, followed by an overview of the findings giving an answer on the previously formulated question. An overview of common cited critics on the research method will close each section by highlighting their limitations.

4.1 Attitudinal Surveys

4.1.1 Definition

Although there are many definitions of attitude, we will use in this paper the definition suggested by Eagly and Chaiken (1993). Attitudes are "tendencies to evaluate an entity with some degree of favor or disfavor, ordinarily expressed in *cognitive*, *affective*, and *behavioural* responses". In transportation studies, cognitive attitudes are related to information and understanding, e.g. sensitivities to transportation costs. Affective attitudes are related to feelings and concerns, e.g. sensitivity to the environment, while behavioural variables reveal tendencies towards different situations, e.g. "will you buy a green car to help the environment?" (Parkany et al., 2003). Attitudinal surveys will evaluate consumer preferences for green cars by using new utility demonstrations or hypothetical constructs. The latter will measure the attitude through indirect indicators such as verbal expression or overt behavior (Zikmund, 2003).

4.1.2 Overview of the Results

Tedeschi et al. (1982) elaborated a study to clarify the relationship between variables -such as knowledge on environmental issues, environmental concern, perceptions of personal or environmental control and self-interest - and the actual environmental behavior. A sample of 106 American drivers, of which 43 persons participated voluntarily in an inspection of their cars for excessive exhaust emissions, was presented a survey on environmental problems. Overall, the drivers who attended the voluntary car emissions inspection were found not to differ from the non-participants according to their levels of knowledge or in their attitudes regarding air pollution. In order to enhance the individual responsibility for pollution control, Tedeschi et al. believe that heightening the awareness of the direct effects of pollution on people's lives may be effective. A recent study by Wang et al. (2007) conducted an attitudinal survey amongst thousand Chinese citizens to investigate the potential consumers' attitude towards micro battery EVs. These micro EVs are characterized by a driving range of maximum 100 km, a vehicle speed of 30-50 km/h and a considerable low purchase price of on average 2925 euro. It was found that 75% of the investigated people would purchase this competitively priced micro EV, and use it especially for driving short distances. This EV purchase decision is, according to Wang et al. (2007), also influenced by the age, education, environmental attitude and the living area (such as local traffic conditions, regulations) of the consumer.

4.1.3 Critics on Attitudinal Surveys

Attitudinal surveys often have mixed success in predicting the purchase of green cars. Due to the fact that many people do not have any familiarity with the new technologies, those studies rather reflect consumer ideals for socially desirable values (e.g. environmental benefits) than their real purchase intentions. As a result of the "feel good" answers for the green and progressive technologies, these studies tend to overstate the demand for environmentally friendly vehicles (Gould and Golob, 1998a; Kurani et al., 1996). In order to avoid these social desirable answers, one can measure the implicit attitudes of respondents towards green cars. Implicite attitudes are attitudes of which the consumers are not aware of, but nevertheless influence the behaviour and choices of the consumer. Implicit attitudes can be measured by the Implicit Association Test (IAT) (Greenwald et al., 1998). This will be investigated in more detail during the following work packages.

4.2 Experimental and Quasi- Experimental Studies

4.2.1 Definition

Experimental research is defined by Zikmund (2003) as a research method in which conditions are controlled so that causal relationships among variables can be evaluated while all other variables are eliminated or controlled. The essence of experimental and quasi-experimental designs is to put individuals (experimental group) in a natural setting -field experiment- or in an artificial setting -a laboratory experiment- and to observe their reaction that will be measured against a group of individuals not exposed to the experimental treatment (control group).

4.2.2 Overview of the Results

Turrentine et al. (1992) predicted the potential demand for green cars by executing AFV test-drives for 236 Californian drivers and by using several methods such as pre- and post-test surveys, focus groups and structured interviews. They found out that people who belong to environmental organizations do not have higher purchase intentions for green cars. Further research of Kurani and Turrentine (1995) extended this research and focused on electric vehicles. A large amount of information such as travel diaries, maps and informational material were provided. Although they found a strong association between the idea of "moral choosing" and the likeliness of purchasing EVs, there was little evidence that households were willing to pay more for them. They did find a greater Willingness To Pay (WTP) for EVs displayed by households that own two or more cars. This gives an indication that in a hypothetical two-vehicle household, they will combine the EV and gasoline vehicle in their stock to satisfy the different travel needs of the various household members. Subsequently, Kurani et al., (1996) confirmed previous findings and found that although environmental awareness may not lead to the purchase of an EV, it may encourage households to seek out and evaluate EVs for purchase consideration. Gould and Golob (1998a, b) made use of personal vehicle trials in California to overcome the problem of consumer's lack of frame-of-reference for the evaluation of EVs. The experimental design consisted of an inboard travel logger, a fill-in travel diary and pre- and post-trial attitudinal questionnaires. Although the opinions about the environmental efficacy showed improvement after the trial of the EV, the participants mentioned that they are likely to select an EV on the basis of other factors (e.g. technology) than the environmental benefit.

A quasi-experimental study was elaborated in Los Angeles by Urban et al. (1994). In this study, a multi-media workshop was organized where the consumers were placed in a virtual buying environment. The experimental design simulated the types of information available to the consumer at the time a purchase of an EV is made. One of the preconditions was that the participants accepted the idea of an environmentally friendly car. Although the EVs were rated highly in terms of environmental attributes, the concern about the environment was the lowest rated issue when purchasing a vehicle. This supports the conclusion that consumers do not want to give up other car attributes for environmental benefits.

4.2.3 Critics on Experimental Studies

Experimental designs such as vehicle trials may impose some limitations. First of all, trials may evoke the "Hawthorne" effect, indicating that people will produce upward biased estimates of interest in green cars since they receive special attention. As a result, fewer people than those who expressed a purchase intention are likely to purchase a green car. Secondly, there may arise several measurement problems related to the duration and length of time of the trial. According to the duration of the trial, more regular patterns will arise over time as the novelty factor declines. Due to the limited length of trials, the consumers' experience of the technology is truncated, vis-à-vis everyday use. Finally, trials may provide reactions to a specific category of product because of the opportunity that the participants have to experience competing technologies (e.g. conventional gasoline cars) (Gould and Golob, 1998a, b).

4.3 Preference Valuation Techniques

4.3.1 Definition

Preference valuation studies are often used by economists to analyze the potential demand for a product or service by measuring the consumer preferences for those products/services. The reviewed papers used two methodologies in the assessment of consumer preferences for green cars: stated and revealed preference techniques.

The Stated Preference (SP) technique is a survey-based technique that allows researchers to uncover how people value different product/service attributes. The most common SP techniques used in transport studies are the Choice Modeling (CM) method and the Contingent Valuation Method (CVM). CM originates from the conjoint analysis. It uses a choice experiment, where consumers are asked to express their preferences for hypothetical vehicles described by specific attributes. Subsequently, via statistical techniques, the analysis will derive a value for each of these attributes and thus express the relative preferences among vehicle attributes (Segal, 1995; Dagsvik et al., 2002). CVM asks respondents their maximum WTP for an increase or their minimum Willingness To Accept (WTA) for a decrease in environmental quality. In the dichotomous CVM design (yes/no answers), respondents accept or refuse a payment for a change in the quality or the quantity of a good at a given cost (Mogas et al., 2006). In contrast to the SP technique, the Revealed Preference (RP) technique uses real market data from observations on actual choices in order to measure the consumer preferences.

4.3.2 Overview of the Results

Within the reviewed papers, most preference valuation techniques have been used for the valuation of non-environmental attributes (e.g. driving range, recharging time) while there has been little work on the valuation of the environmental attributes of cars (e.g. less emission, zero noise). Therefore, a distinction will be made across the studies that did not include an environmental attribute in their design, and the studies that did include one.

Out of the publications that excluded the environmental attribute in their design, Beggs and Cardell (1980) and Beggs et al. (1981) assessed the potential demand for battery EVs amongst multi-vehicle households in the Baltimore area. They assumed that EVs could become a niche market for small car buyers in multiple vehicle households. An ordered logit model was applied to the data gathered from an SP survey in which the participants were asked to provide rank orderings for 16 car designs which differed over 9 attributes such as price, operating cost, range, recharging time, performance, size and air conditioning. The findings show a small market share for EVs as a result of the high negative valuation of the limited range and the long recharging times. Similar results have been found by Segal (1995), who used a conjoint analysis for the prediction of a potential market for battery EVs in California. The contingent rating questions included each 7 attributes such as recharging/refueling attributes, range, fuel attributes and cost of the vehicle. The main finding of this study is the prediction of a very low market share for battery EVs as a result of the high purchase price and the inconvenience associated with the EV ownership after sale. The greatest WTP for the EVs was expressed by the multi-vehicle Californian households. Also, Chéron and Zins (1997) made use of the conjoint forecasting method to identify the most determining factors in blocking a viable market for battery EVs in Montreal. The conjoint analysis consisted of an experimental design combining the following attributes: range, maximum speed, recharging time and cost and delay in case of a dead battery. The study concludes that an EV will not be accepted by the market because of the concern over battery charge duration. So, unless the driving range and the recharging time are comparable to conventional gasoline vehicles, there will be no market potential for EVs. Moreover, Chéron and Zins doubt that that these factors can hardly be compensated by the greater cleanliness of EVs. Finally, Dagsvik et al. (2002) made an assessment of the potential Norwegian household demand for AFVs by using several alternative structural demand models based on the obtained SP data. The included attributes were the purchase price, driving range between refueling/recharging, top speed and fuel consumption while attributes such as refueling/recharging time and availability, emission level and size of vehicle were not taken into account in the choice sets. Their results confirm the findings of Chéron and Zins (1997) by stating that there will be an low WTP for AFVs unless their attributes - especially the purchase price and the driving range- become fully competitive compared to conventional gasoline vehicles.

Out of the publications that included an environmental attribute in their design, Bunch et al. (1993) and Golob et al. (1993) made use of multinomial logit models applied to SP vehicle choice data to predict the market penetration of AFVs in California. The vehicle attributes included in the SP design were purchase price, fuel cost, range, performance, fuel availability and vehicle emissions. The main finding is that consumers are willing to pay $9000 or 6074€ more for a vehicle with reduced emission levels of up to 90%. Brownstone et al. (1994) and Brownstone et al. (1996) forecasted the demand for AFVs in California by applying a vehicle transaction choice model based on SP data conditional on the vehicles currently held by the household. They discovered that households with children attached a greater value to emission reduction than households without children. Moreover, 2-vehicle households with children under 21 years expose the greatest WTP for a reduction in emissions. Sperling et al.

(1995) made an assessment of the potential target market for methanol in the household sector of New York and California. The dichotomous CVM was used to measure their WTP for the typical attributes -less pollution and more power- of methanol. They found a great WTP for cleaner fuels across all socioeconomic groups indicating that income is not a determining factor in the purchase of clean fuels. Especially Californians and female drivers were found to express a greater WTP for clean fuels than New Yorkers and male drivers respectively. Tompkins et al. (1999) investigated determinants of the AFV choice by the application of multinomial logit models based on data from a SP survey for the Continental US. A relative emissions variable was included in the SP design next to other non-environmental attributes such as price, range, fuel cost, and fuel efficiency. As in Sperling et al. (1995), only the Californians expressed a WTP for AFVs. Mourato et al. (2004) made use of the CVM to assess the preferences of London taxi drivers for fuel cell taxis. Within the CVM questionnaire, a section concerning attitudes to general environmental and transport issues (e.g. congestion, noise or exposure to air pollution) as well as a valuation section where the taxi drivers' WTP for participation in a fuel cell taxi pilot project was included. Despite the environmental concerns and a supportive attitude towards green cars, the WTP in the short term to participate in the pilot project was mainly determined by financial considerations (i.e. reduced running costs). However, environmental considerations are found to affect the vehicle purchasing decisions in the longer term as the taxi drivers state that they are willing to invest in a greener car fleet. Ewing and Sarigöllü (1998) carried out a survey over 1500 commuter households in Montreal. The survey included choice experiments, in which emission levels were included to examine the role of the environmental concern on the vehicle choice. The main conclusion was that there might be a large market potential for AFVs if these can compete with conventional vehicles in price and performance. These results were extended and supported by Ewing and Sarigöllü (2000), who assessed the consumer preferences for AFVs, including low-emission vehicles and zero-emission vehicles, by a combination of an SP choice experiment for the vehicle-specific attributes (purchase price, repair and maintenance cost, cruising range, refueling time, acceleration and polluting emissions) and a separate assessment of attitudes towards the environment and technology. Although a strong preference was found for AFVs, the vehicle performance characteristics are, according to the authors, critical for their acceptance. A more recent study by Potoglou and Kanaroglou (2006a, b) used a nested logit model based on a SP internet survey to asses the household demand and the WTP for alternative fuelled vehicles by inhabitants of Montreal. The SP design consisted of 8 choice sets with each 3 kinds of attributes: the monetary, the non-monetary and the environmental attributes, where the pollution level was introduced to assess the perceived vehicle cleanliness. They pointed out that consumers are sensitive to incentives such as paying no tax and to significantly reduced pollution levels of vehicles. However, the personal and household characteristics as well as the cost and performance characteristics of the vehicle seem to be crucial in the selection of a certain vehicle technology. Finally, Lundquist et al. (2006) developed a theoretical and empirical framework by use of a vehicle choice experiment in Maine to model vehicle choice decisions under eco-labeled conditions and to evaluate the effectiveness of eco-information in altering consumers' attitudes towards environmentally friendly vehicles. The authors believe that the understanding of individual perceptions and social standards is essential to understand the success of environmentally friendly initiatives. They conclude that consumers will consider eco-information, when provided, in their purchase decision but that the consumers' reaction to eco-labeling will be differently due to their personal characteristics.

4.3.3 Critics on Preference Valuation Techniques

Economists have been sceptical towards the use of SP data. One possible problem with hypothetical choices is that this may not reflect the real purchase intentions of the respondents (Brownstone et al., 1994). Another criticism is that consumers can not have preferences for attributes that they have not directly experienced and therefore they do not have constructed preferences for them (Gould and Golob, 1998). Moreover, respondents tend to give socially desirable responses, such as "feel good" responses for environmental benefits or they may provide in contrast anti-environmental survey responses (Kurani et al., 1996). As a result, they may signal their preference for provision of less pollution, although in reality they would not spend any extra money on purchasing an AFV. Also Ewing and Sarigöllü (2000) mentioned that people who are highly concerned about the environment may have a higher motivation to return the surveys. Finally, Kurani et al. (1996) state that surveys usually question one person from a household, while vehicle purchases are often made jointly by the whole household.

In contrast, RP data or market data do not have the possibility for confusion or unstated assumptions. But the main problem in predicting a market for green cars by using RP data is the absence of actual choice observations since only a small market share of hybrid and AFVs is currently available (Potoglou and Kanaroglou, 2006a, b). Furthermore, using RP data makes it difficult to observe the effect of large variations in the variables of interest. Finally, RP data may often produce strong correlations between the variables (multicollinearity) and may evoke difficulties in measuring the vehicle attributes (Abley, 2000).

5. Conclusions

To understand the public acceptance of the new green vehicle technologies, it was first of all important to come to a definition of environmental cars, as given in section 2. Section 3 considered the design of the review. In order to investigate the importance of the environmental awareness in the car purchase decision, it was useful to get an insight into the process of car decision making itself. The overview of the different car attributes in the evaluation of vehicle types showed that the purchase price, followed by the operating cost (maintenance and fuel cost) and the quality (reliability and security) of the car are the first factors consumers take into account when purchasing a vehicle. Based on these attributes, consumers will already select certain alternatives. In this respect, it can be useful to focus in further research on the Life Cycle Cost (LCC) of the conventional as well as the green cars. From a consumer's point of view, the LCC of a car is the total cost related to the life cycle of a car. This LCC includes the purchase price, the fuel costs, the insurance costs, several taxes and the maintenance cost. As the purchase price is found to be the prime attribute in the assessment of a new car, a transition towards mass production and cheaper materials could lower the purchase price and thus increase the consideration of green cars in the car purchase decision. The results of Wang et al. (2007) confirm this hypothesis as they found out that a large number of consumers would purchase a micro battery EV as a result of its considerable low purchase price. The final choice will be made by the evaluation of other attributes of the car such as the intrinsic characteristics of the car -looks, acceleration time, horsepower, comfort, number of seats, luggage space and brand loyalty- and the socio-economical attributes like personal, social, cultural factors and household characteristics.

Section 4 presented the results of the review in order to answer the central question: will the environmental attributes of a car be taken into account when purchasing a vehicle? The answers to that question are presented according to the 3 used research methodologies. According to Tedeshi et al. (1982) who made use of an attitudinal survey, the Americans are concerned about the quality of the environment, but are unwilling to accept the individual responsibility for pollution and thus unwilling to undertake individual action such as purchasing a green car. The attitudinal survey elaborated by Wang et al. (2007) showed in contrast a high acceptance of the micro battery EV, especially due to its low purchase price. This finding shows that the limited driving range and the recharging at home can be acceptable, especially when considering the case of a second car in a two-vehicle household.

Out of the publications that made use of experimental designs, most studies (Turrentine et al., 1992; Kurani and Turrentine, 1995; Kurani et al., 1996; Gould and Golob, 1998a,b; Urban et al. 1996) shared the opinion that there exists a strong concern for the environment and a strong belief that lifestyle changes are need to solve environmental problems. However, they also discovered that the environment was the lowest rated issue when purchasing a vehicle. Even people who belong to environmental organizations do not express higher purchase intentions for green cars (Turrentine et al., 1992). The greatest WTP for EVs was expressed by the households with 2 or more vehicles (Kurani and Turrentine, 1995).

Within the articles that made use of preference valuation techniques, a distinction was made between the publications that included an environmental attribute in their survey design and the ones that did not. Out of the studies where the environmental attribute was excluded, the focus was set on the potential market for EVs. The main finding of these studies is that there will be no viable market for EVs unless their attributes such as the limited range and the long recharging times (Beggs et al., 1981; Chéron and Zins, 1997), the high purchase price and the

inconvenience after sale (Segal, 1995) become fully competitive compared to conventional gasoline vehicles. Moreover, Chéron and Zins (1997) state that these factors can hardly be compensated by the greater cleanliness of EVs. However, Beggs and Cardell (1980); Beggs et al. (1981) and Segal (1995) found out that an EV could be attractive as a second household car in multi-vehicle households. Out of the publications that included an environmental attribute, the WTP for cars with reduced emission levels was especially expressed by 2-vehicle households with children under 21 years (Brownstone et al., 1994-1996), by Californians (Sperling et al., 1995; Tompkins et al., 1999) and by female drivers (Sperling et al., 1995). However, these studies also pointed out that this WTP will highly depend on the vehicle performance and price characteristics of green cars to be fully competitive with conventional vehicles (Ewing and Särigöllü, 1998-2000; Potoglou and Kanaroglou, 2006a-b) next to the personal and household characteristics of the consumers (Brownstone et al. 1994-1996; Tompkins et al., 1999; Potoglou and Kanaroglou, 2006a-b; Lundquist et al., 2006; Sperling et al., 1995 and Mourato et al., 2004).

A last interesting result found in the review is the fact that Californians express a higher WTP for green cars than other households, even within the USA. We stated first of all that this result may be due to the state programs of California that not only require semi-annual emission checks, but also the instauration of emission packages when a new car is bought (Gould and Golob, 1998a). Regulations or legislations, and especially pricing measures like subsidies or car taxation, seem to have a great influence on the purchase intentions for cars (Potoglou and Kanaroglou, 2006; Clase, 2004). People will undertake individual action such as a paying more for a greener car when everyone is subject to the legislation and the "polluter pays principle" is respected (CRIOC, 2004). Secondly, the heightened awareness of air pollution due to local conditions and the press attention for environmental issues may also have a great contribution to that result (Glazer et al., 1995). This underlines the important impact of information and environmental consciousness on the car purchase decision (Mourato et al, 2003; Kurani et al., 1996). The purchase intentions for green cars will not only be influenced when an amount of (eco-) information is provided (Lundquist et al., 2006; Urban et al., 1996), but will also differ according to the consulted information sources (Gould and Golob, 1998a). Gould and Golob (1998a) found out that people informed by mass media and conversations are less likely to purchase an EV, than when they are informed by business- and auto magazines and newspapers. Also, the environmental awareness may encourage households to seek out and evaluate green cars for purchase consideration (Mourato et al, 2003; Kurani et al., 1996; CRIOC, 2003). Therefore, it is of great interest to investigate the influence of the recent film "An inconvenient truth" on the environmental concern and car purchase behavior in Europe.

6. Reference List

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