SEGMENTING THE MARKET FOR AN ENVIRONMENT-FRIENDLY AUTOMOTIVE INNOVATION

John Thogersen[1] and Anita Garling[2]
Aarhus School of Business and Chalmers University of Technology

[1] Department of Marketing, Aarhus School of Business, Haslegaardsvej 10, DK-8210 Aarhus V, Denmark. Tel +45 8948 6440. Fax +45 8615 3988. E-mail John.Thogersen@asb.dk. (Contact person.)

[2] Department of Water, Environment and Transport, Chalmers University of Technology, SE-412 96 Gothenburg, Sweden. Tel +46 31 772 2397. Fax +46 31 189 705. E-mail Anita.Garling@wet.chalmers.se.

ABSTRACT

Dealing with the problems associated with the increasing number of vehicles in operation without curtailing peoples' freedom of movement and choice is a great challenge. Increasing interest gathers around electric-drive vehicles (EVs), which could reduce local pollution and the greenhouse emissions from the transportation system. However, these societal benefits come at high costs to the owner of the EV in terms of higher price, shorter driving range, reduced loading capacity, and slower speed and acceleration. Such a product hardly sells itself to potential customers. Besides supportive national policies, skillful marketing is needed in order for it to be accepted and diffused throughout society. Elsewhere we have proposed a two-phased strategy for the marketing of EVs, focusing in the first phase only on prospective innovators and early adopters and leaving the mass market to a second phase (Garling & Thogersen, In press). The successful persuasion of the innovators and early adopters is the key to convincing the mass market.

Persuasion, or the formation of a positive attitude, depends on how the individual perceives the new product's attributes as well as on personality traits and background characteristics (Thogersen & Garling, 2000). Different consumers may have significantly different preferences regarding specific attributes of a new product, such as an EV. There may be segments whose wants and needs can be fulfilled readily with current technology, while those of others cannot. We suggest that, with identical attitudes, it is more likely that the former than the latter adopt early. Hence, in the first phase the marketing should be targeted at them. Based on a discussion of current and expected future characteristics of EVs and on a review of research on the characteristics of early adopters, we have previously suggested that a particularly good match between private consumer needs and wants and the attributes of current generation EVs exists in the segment of environmentally concerned multi-car households (Garling & Thogersen, In press). In this paper, this and a number of theory-derived propositions are tested empirically on a random sample of car-owners in Gothenburg, Sweden, within a benefit segmentation framework and by means of multi-sample structural equation analysis. Implications for the promotion of EVs, and of environment-friendly innovations in general, are discussed.

1. INTRODUCTION

Because of its local as well as global environmental impacts, the rapid growth in automotive transportation world-wide is a source of increasing concern (e.g., Mackenzie, 1997; OECD, 1996; Tolba & El-Kholy, 1992). One response, among several, is an increasing demand for innovations that can relieve these impacts (Sperling, 1995; Trafikministeriet, 1999). Reducing the environmental impacts of our transport systems is a complicated affair, however. There is wide agreement that, rather than a simple catchall solution, a viable and effective solution must combine a wide range of regulations, system changes, and adaptations (e.g., Mackenzie, 1997; OECD, 1996; OECD/IEA, 1997; Sperling & Shaheen, 1995; Tolba & El-Kholy, 1992; Vlek, Hendrickx & Steg, 1993; Vlek & Steg, 1996). To reach a sustainable transport solution, the concerted effort of many parties is needed, notably automotive producers, governments and other public authorities, and users of transport products and services (OECD, 1996; Tolba & El-Kholy, 1992).

One of the key roles is played by the final consumers: people who in their private lives and for private purposes demand transport solutions. Person transport makes up the bulk of total transport, and increasingly and dominantly the transport is made by private cars (Tolba & El-Kholy, 1992). Part of the explanation is that during the last half century, the availability of private cars in most households – particularly in the broad middle classes that are active in the labor market and are attractive customers for all kinds of retailers – has been one of the axioms for the development of society's physical structure (infrastructure, the location of residences, jobs, shopping opportunities, all kinds of service institutions, etc.) (e.g., Carlson, Wormser & Ulberg, 1995; Kenworthy & Laube, 1996). Hence, consumers to a high degree feel that they are dependent on owning a private car in order to cope with life, as they know it.[1]

Private consumers of transport products and services are also the majority of voters in every country. Hence, in a democratic society, whatever solution one could think of to relieve the environmental and societal burdens of transport, it stands or falls with the acceptance by these individuals, either as buyers of transport products and services or in the voting booth (Schlag & Teubel, 1997; Tolba & El-Kholy, 1992). In this paper we focus on individuals in their former capacity. Since the bulk of person transport is made by individuals as private consumers, and since their dual capacity as consumers and voters makes it virtually impossible to effectively force people to change their transport behavior, much more insight is needed into how people can be persuaded to accept more environment-friendly transport solutions (Steg & Vlek, 1997; Tertoolen, Kreveld & Verstraten, 1998; Tolba & El-Kholy, 1992).

The study of the diffusion of innovations of any kind throughout society has amply demonstrated that not everyone are equally ready to adopt new products, services, or ideas (Rogers, 1995). Even more important, it has shown that when the first innovative individuals have adopted a new innovation, their sporting it has a tremendous influence on its adoption by other people, through demonstration, word-of-mouth, modeling, and imitation processes (Darley & Beniger, 1981; Rogers, 1995). Hence, the study of consumer acceptance of environment-friendly transport innovations should particularly focus on identify-

[1] For example, a Roper Survey in 1979 found that 76% of US Americans felt that they could not make do without their car. In a Roper Survey in 1993, 95% of the respondents classified an automobile as a necessity (rather than a luxury).

ing the most likely first adopters and on how they can be persuaded to finally adopt the innovation. In this paper, we demonstrate an advanced segmentation method that can be applied by means of statistical programs that are now widely available. We use the modern[2] electric-drive vehicle (EV) as the illustrative case.

2. THE CASE

From a consumer point of view, the EV has the advantage that it is (roughly) compatible with the infrastructure and physical design of current societies. Hence, unlike other possible solutions to the transport-related environmental problems, its adoption does not entail major lifestyle changes. Still, substituting the internal combustion engine of a conventional car by a battery powered electric one makes the car effectively a zero-emission-vehicle (ZEV), which would remove a large part of the local air pollution that currently poisons the lives of people in cities and towns all over the globe. If the electricity is produced by renewable energy sources, the use of the vehicle no longer contributes to global warming either. Car manufacturers work on other new technologies that may potentially reduce emissions from cars, but currently the only truly ZEVs on the market are EVs. Hence, the EV seems to be an appropriate case for studying consumer acceptance of environment-friendly automotive innovations.

Seen from the consumers' point of view, the EV represents an innovative motor technology that changes a number of attributes of the car and leaves other unchanged. It offers not only a more environment-friendly car, but also lower fuel and maintenance costs and higher driving convenience (low noise, no gearshift). However, its drawbacks compared with a similar internal combustion engine car (an ICV), are numerous. The EV has slower acceleration and top speed. Because of the batteries, the loading capacity is a bit smaller. However, probably the most important drawback is that an EV can go only somewhere between 60 and 200 km between recharging its batteries (which takes several hours). Transport studies show that this is rarely a problem in the everyday use of the car (Garling, Johansson, & Garling, 1998), but it severely limits its usefulness for leisure and vacation purposes. In addition, not all car manufactures offer EVs, and those that do only have EV variants of one or two models in the low (cost, size, and luxury) end of the range. Hence, much less variation is offered to the prospective EV customer than to the conventional car customer.

3. DETERMINANTS OF ADOPTION

Variations in the propensity to adopt a particular new innovation must be attributed to variations in characteristics of individual adopters, their receptivity towards the marketing of the innovation, and in their perception and evaluation of the innovation and its defining characteristics. Among others, Hauser and Urban (1977; Urban & Hauser, 1993) argue that the probability of adopting an innovation ultimately depends on the individual's percep-

[2] In the current wave of EV innovations, most of the early contenders were light vehicles, designed to transport only one or two persons, and neither very fast nor very far (Harms & Truffer, 1998). In this study, we focus on what one might call the second generation, namely normal (albeit typically small) size cars built by large car manufacturers and basically being one (or some) of their conventional model(s), but with an electric-drive engine substituting the combustion one. Maximum speed is typically about 90 km/hour and maximum driving-range between recharging of the batteries at least 60 km.

tions about product attributes and on other beliefs, experiences, and feelings that the individual may have about the innovation. In the process of reaching a decision of whether to adopt or not, individuals try to integrate the information they have about the innovation. Hauser and Urban call this information integration "compaction," others talk about attitude or intention formation (Fishbein & Ajzen, 1975; Holak, 1988; Levin, 1981). According to Hauser and Urban, the attitude (compaction) and its structure (Eagly & Chaiken, 1993) is the key to understanding individual decision-making as well as to the segmentation of potential adopters into groups with differing product preferences and adoption probabilities. Bagozzi (1983) has demonstrated how structural equation modeling can be used to study consumer response to innovation, based on Hauser and Urban's (1977) conceptual model.

In accordance with the cited predecessors, we suggest that analyzing the attitude and its antecedents is the key to understand intrinsic drivers and impediments to adoption as well as to group adopters into segments with different adoption probabilities as well as product design and communication requirements. Our analysis of drivers and impediments is presented elsewhere (Thogersen & Garling, 2000). Here, we show how attitude structure – or attribute perception – data can be used to segment the EV market.

4. SEGMENTATION

Not all potential adopters will respond equally favorably to attempts to market any new product. Presented with the characteristics of a leading edge EV, some consumers may respond with a positive attitude towards and interest in buying one, while others may not. Everything else being equal the most likely early adopters of an EV are those holding the most favorable attitudes and buying intentions. However, by the very nature of the matter attitudes and intentions expressed prior to actually starting the process of adopting a really new product are not precise. They are responses to an incomplete image that probably resemble a generic product more than any specific brand and version. This lack of precision may cause the attitude-to-behavior process to break down if not everyone have the same preferences as regards the characteristics of an EV and how it is communicated, distributed, priced, etc. It is not hard to imagine that all potential adopters are not served equally well by the same bundle of product attributes (or other elements of the marketing mix such as price, communication, and distribution) (e.g., Bagozzi, 1981; Hauser & Urban, 1977; Urban & Hauser, 1993), of course. If this is the case, a multivariate analysis based on a random sample from the population of interest will reveal the (weighed) "average" preferences, but may not adequately reflect the exact preferences of anyone. Differences in the weighing of product characteristics only show up as unexplained variance. In other words: Tailoring products to the idiosyncratic needs and preferences of each individual customer is usually a costly affair. Hence, faced with heterogeneous demand most companies seek to identify segments of potential customers with reasonably homogeneous preferences that are also accessible and can be served profitably by the company.

The segmentation of customers (for instance potential adopters of an EV) according to differences in attribute importance weights is called benefit segmentation (Haley, 1968). Since importance weights contain the key information used to determine managerial trade-offs in the attributes of a new product or service, this type of segmentation is particularly attractive in new markets (Hauser & Urban, 1977; Urban & Hauser, 1993). There are basically two approaches to benefit segmentation: an exploratory and a confirmatory approach.

A confirmatory approach can be used when there are theoretical or practical reasons for assuming that certain registered characteristics divide the potential customers in a relevant way. For instance, innovation research suggests that individuals differing in innovativeness might also weigh product characteristics differently (Rogers, 1995). Another common segmentation base is product experience (e.g., Bagozzi, 1981; Hauser & Urban, 1977; Urban & Hauser, 1993). One of the reasons is that experience is supposed to strengthen the consumer's product knowledge or expertise, and also his or her confidence in own product knowledge, with important implications for marketing (Peter, Olson & Grunert, 1999). Since none of our subjects have first-hand experience with the product this distinction is, of course, useless here. However, there may still be marketing-relevant differences in knowledge. In order to test this possibility, we can compare individuals high and low in product knowledge.

Specifically with regard to EVs, we have argued elsewhere that the adoption decision is likely to depend on a combination of environmental concern and sensitivity to the EV's technical limitations, i.e., whether the person considers substituting an EV for the household's only car or for the second or third car (Garling & Thogersen, In press). Environmentally concerned multi-car households are likely to weigh an EV's attributes particularly favorably.

Whether splits such as these divide the population into segments that have significantly different preferences can be tested by means of multiple sample structural equation analysis, as demonstrated, for example, by Bagozzi (1983).

Even when there is no reason to expect that identifiable subgroups of consumers hold diverging preferences, it is still advisable to make sure that preferences are indeed homogeneous when planning to promote a new product. Under such conditions it is most reasonable to approach segmentation in an exploratory fashion first, which may be done by means of (exploratory) cluster analysis. When respondents have been uniquely allocated to a segment, segment preference profiles and other identifiers can be used to investigate which segment(s) is (are) most attractive in terms of accessibility and, particularly if the segmenter is a private company, profitability.

Exploratory and confirmatory segmentation obviously have different strengths and weaknesses. The major strength of a confirmatory approach is statistical rigor, but it comes with the risk of overlooking practically important segmentation bases. An exploratory approach can detect heterogeneity that is outside the researcher's imagination (as long as it is reflected in the data), but at the expense of statistical rigor. There is also a greater risk of capitalizing on chance when an exploratory approach is applied. Because we have a solid basis for formulating hypotheses about likely segments we use a confirmatory approach in this case.

5. DATA, MEASUREMENT SCALES, AND ANALYSIS METHOD

Current EVs are most appropriate for shorter trips and their environmental superiority is most obvious in city traffic and when they substitute ICVs. Therefore, we focus on current car owners in a metropolitan area: the greater Gothenburg area in Sweden. Mail-back questionnaires were administered in two waves to a random sample of registered car owners in this area. Wave 1 was administered in September 1998 to 300 registered car owners

and their spouses and wave 2 in December 1998 through January 1999 to 1,600. A total of 165 fully completed questionnaires were returned in wave 1 and 787 in wave 2. The response rates calculated on target persons (i.e., not including responses from spouses, since we have no registration of their total number) were 37.3 and 34.6%, respectively. This is low, but not uncommon for mail surveys. If there is any systematic non-response bias, it is likely that individuals who are interested in and favorably disposed towards EVs are over-represented. The most serious implication of such a bias is that it may make it more difficult to distinguish individuals in the most favorable segment(s) from the rest due to statistical indicators of distinctions being attenuated. However, since our interest is to identify the most likely early adopters, a non-response bias of this kind does not pose any substantive problems for the present study. The questionnaires included questions about perceptions, knowledge about, and attitudes toward EVs, innovativeness, environmental concern, demographic and background variables, and a number of other issues not relevant for this study. The questionnaire used in wave 1 also included questions about purchase willingness of an EV. Because of concerns unrelated to the present purpose, the survey instruments differed in other important ways as well (see Thogersen & Garling, 2000).

We use multi-sample structural equation modeling (SEM) for the confirmatory segmentation analysis.[3] The most important advantages of this procedure are that it allows correction for measurement error (if we have more than one indicator, or observed variable, for a theoretical, or latent, construct) and that it is possible to specify and test very precise hypotheses about how assumed segments differ. In the following we describe our measures briefly. The scale development procedure is discussed in more detail in Thogersen and Garling (2000).

5.1 Innovativeness

A person's "innate innovativeness" has been conceptualized as a general personality trait reflecting "the degree to which an individual makes innovative decisions independently of the communicated experience of others" (Midgley & Dowling, 1978, p. 235). However, empirical research has tended to reject that such a general personality trait exists or at least that it has any significant behavioral implications. Instead it has been suggested that "innovators must be identified and characterized on a product category basis" (Gatignon & Robertson, 1985, p. 861). Following Goldsmith and Hofacker (1991, p. 211) we apply a concept of domain specific innovativeness, defined as a trait reflecting "the tendency to learn about and adopt innovations (new products) within a specific domain of interest." Using their procedure and criteria – maximizing coefficient alpha and producing a unidimensional result when factor analyzing the items – we extracted an instrument consisting of five items from a larger item-pool. Cronbach's alpha for the domain specific innovativeness scale is .79, indicating an acceptable internal reliability. The (translated) items are shown in Appendix Table A1.

5.2 Knowledge

In wave 2 we measured consumer knowledge about the state-of-the-art in EVs by means of a battery of five multiple-choice questions. The number of correct answers reflect how

[3] Using LISREL version 8.30 with ML estimation based on normalized scores (Joreskog, et al., 1999). Other popular and widely distributed SEM software products are EQS, which is a stand-alone application like LISREL, and AMOS, which is a module in SPSS.

much a person actually knows about EVs and is, hence, a measure of what is often called objective knowledge (Brucks, 1985; Ellen, 1994). However, we prefer to use the terms product (Peter, Olson & Grunert, 1999) or factual (Thogersen, 2000) knowledge when referring to this concept.

5.3 Environmental concern

Environmental concern is a key explanatory variable in studies of consumer willingness to adopt new "green" products or behaviors (e.g., Berger, 1993; Ellen, Wiener & Cobb-Walgren, 1991; Grunert & Juhl, 1995; Henion, Gregory & Clee, 1980; Marell, Davidson & Garling, 1995; Minton & Rose, 1997; Roberts & Bacon, 1997; Schahn & Holzer, 1990; Tarrant & Cordell, 1997). This may be viewed as a special case of the finding in innovation research that the acceptance and diffusion of an innovation depends on its compatibility with potential adopters' values (Labay & Kinnear, 1981; Rogers, 1995).

We define environmental concern as a disposition to do the (environmentally) "right thing" even when it conflicts with one's own, shortsighted interests. For the development of an appropriate measure, we took our point of departure in a pool of 18 items developed by Dahlstrand and Biel (1997). A nine-point agree-disagree scale was used. In the same way as with innovativeness, we use factor and item analyses to extract a short, reliable and unidimensional measure of environmental concern from the item pool. Exploratory factor analysis with oblique rotation showed that the items in the pool reflect three correlated dimensions (with an eigenvalue above 1). However, the first factor captures the lions share of explained variance (33% of total variance). An inspection of the items loading on the factor reveals that it reflects an overall environmental attitude or norm with a moral orientation (Heberlein, 1972), i.e., environmental concern as we define the concept. Cronbach's alpha for the nine items that have a loading of more than .35 is .88. By removing the four items with the lowest factor loading, alpha increases to .89, which is its maximum. Hence, these five items are used as the instrument for measuring environmental concern in this study. The (translated) items are shown in Appendix Table A2.

5.4 Perceptions about product attributes

Innovation research has identified a number of dimensions of perceived product attributes that seems to be particularly important for a person's propensity to adopt an innovation. These dimensions are: (1) relative advantage, (2) compatibility, (3) complexity, (4) trialability, (5) observability, and (6) perceived risk (Bauer, 1960; Labay & Kinnear, 1981; Ostlund, 1974; Rogers & Shoemaker, 1971). Our operationalization of these variables is described in the following.

Relative advantage. EVs differ from traditional ICVs on many of the attributes that consumers use to evaluate cars, such as (1) speed, (2) acceleration, (3) loading capacity, (4) operating costs, (5) price, and (6) ease of maintenance. Other attributes that have been found to influence the evaluation of EVs are (7) driving range, (8) recharge time, and (9) environment-friendliness (Garling, et al., 1996; Harms & Truffer, 1998). The perceived relative advantage (or disadvantage) of an EV is measured by means of items registering the importance of each of these nine attributes. A nine-point important-unimportant scale was used. A factor analysis of the items produced a two-factor solution with five items (1, 2, 3, 7, and 8) loading on the first and four (4, 5, 6, and 9) on the second factor. Cronbach's alpha for the first factor is .69. This scale seems to reflect the perceived importance of the

EV's (inferior) technical performance. Cronbach's alpha for the second factor is .67, but it increases to .81 if the two items with the lowest loading are removed. The final scale reflects the importance of the financial costs of buying and owning an EV. The two removed items (environment-friendliness and ease of maintenance) are treated as single-item measures in the analyses.

Compatibility. The perceived compatibility of an EV with the person's lifestyle is measured by means of five items rating a described EV's usefulness for: (1) work trips, (2) shopping, (3) giving others a lift, (4) vacation trips, and (5) irregular short trips (e.g., to the doctor, to sport). A five-point agree-disagree scale was used. A factor analysis of these items produced a two-factor solution with all items except usefulness for vacation trips loading on the first factor. Hence, not unexpectedly, it is particularly the limited driving range of the EV (between recharging) that influences people's evaluation of its usefulness for various purposes. Cronbach's alpha for the first factor is .78.

Complexity and perceived risk. A number of items were included in the questionnaire in order to measure the perceived complexity and some aspects of the perceived risk of driving an EV. These items refer to: (1) ease of maintenance, (2) ease of driving, (3) traffic safety, (4) noise level, (5) risk when recharging, and (6) risk of radiation from the batteries. Again, a five-point agree-disagree scale was used. A factor analysis of these items produced a two-factor solution with the first three items loading on the first and the last three on the second factor. Cronbach's alpha for the first factor is .66, but it increases to .74 if the item with the lowest loading (traffic safety) is removed. This scale seems to reflect the perceived complexity of using an EV. Traffic safety is included as a single-item measure in the analyses. Cronbach's alpha for the second factor, which seems to reflect the perceived risks associated with operating an EV, is .63 and it cannot be improved by removing any item.

5.5 Attitude toward EVs

The attitude towards EVs is measured by means of three items: (1) the EV is attractive, (2) if the price is the same I would rather buy an EV than an ICV of the same brand and model,[4] and (3) to own an EV gives a feeling of luxury. A five-point agree-disagree scale was used. Cronbach's alpha is .70.

5.6 Buying intention

In wave 1, buying intention was measured and buying intention, product attribute perceptions, and the attitude were all measured at the same specification level. Buying intention is operationalized as interest in buying an EV with leading-edge technical characteristics and a price similar to an otherwise similar ICV. A simple Yes-No scale is used.

6. SEGMENTATION ANALYSIS

It is unlikely that all potential adopters will respond equally favorably to attempts to market an EV. Presented with the characteristics described in this study, some consumers respond with a positive attitude towards the EV and interest in buying one, while others do not. It seems reasonable to assume that those most interested in buying an EV, i.e., pre-

[4] Not included in wave 1.

sumably the most likely early adopters, are also those holding the most favorable attitudes towards it. Table 1 presents a summary cross-tabulation of the attitudes towards and buying interest/intention expressed in survey 1.[5] As shown, attitude responses can be used to divide the consumers into groups with widely differing buying interest/intention. Notably, among the 16% that hold the most favorable attitudes towards EVs, 88% express buying interest/intentions, compared to 58% of the total sample.

Table 1. Summary cross tabulation of attitudes towards and intention to buy/interest in buying an EV

	Buying intention				
	Yes	No	Total	Row total in pct. of all	Yes in pct. of row total
2-6	15	37	52	33	29
7-13	54	28	82	52	66
14-18	22	3	25	16	88
Total	92	70	159	100	58

In Thogersen and Garling (2000) we trace attitude responses back to differences in how the product attributes of the EV are perceived, in more general consumer traits, and in background variables such as sex, income, and number of cars in the household. To the degree that attribute preferences are homogeneous, such an analysis is all that is needed to identify and describe the most likely early adopters of the EV in a way that can be used by producers for developing a marketing strategy for targeting potential buyers and by public authorities for developing policies aimed at facilitating consumers' adoption of EVs. However, as already mentioned, we do not perceive the homogeneity assumption to be realistic. Based on the high degree of differentiation among traditional ICVs, we find it more likely that there are segments in the population that have significantly different preferences regarding some product characteristics. Faced with heterogeneous preferences, marketing success depends on identifying segments of potential adopters with reasonably homogeneous preferences that are also accessible and can be served effectively and, crucial for producers of EVs, profitably. Benefit segmentation (Haley, 1968), i.e., the segmentation of consumers (for instance, potential adopters of an EV) according to differences in attribute importance weights, is particularly attractive in new markets (Hauser & Urban, 1977; Urban & Hauser, 1993).

In the introduction, we mentioned that previous research suggests that, in general, differences in preferences should be expected in relation to differences in innovativeness and knowledge. We also mentioned that it has been suggested that potential EV adopters should be segmented according to car ownership (whether the EV is considered as the only or just as one among more car(s) in the household) and environmental concern (Garling & Thogersen, In press). Multiple sample structural equation analysis provides a rigorous test of whether segments defined by these, or other, variables differ in attribute preferences.

[5] For this purpose, an attitude scale was constructed by summing the two attitude items.

6.1 Innovativeness and knowledge

Table 2 shows the results of segmenting by innovativeness and product knowledge separately,[6] and by innovativeness and product knowledge combined.

Table 2. Test of differences between segments formed by splitting the sample according to product knowledge, innovativeness, and a combination of product knowledge and innovativeness

	Product knowledge				*Innovativeness*				*Innovativeness and product knowledge*			
Step[#]	χ^2	df	$\Delta\chi^2$	df	χ^2	df	$\Delta\chi^2$	df	χ^2	df	$\Delta\chi^2$	df
1	518.8	226			540.4	253			895.1	559		
2	509.1	216	9.6	10	534.1	243	6.3	10	875.4	529	19.7	30
3	446.8	201	62.3*	15	517.0	228	17.1	15	777.7	484	97.7*	45
4	437.2	191	9.6	10	504.2	213	12.8	15	732.9	439	44.8	45
5	433.5	186	3.7	5	490.7	207	13.6*	6	694.5	421	38.4*	18
6	427.8	185	5.7*	1	490.4	206	0.3	1	690.2	418	4.3	3

* Significant at $p < .05$.

1: All parameters equal. 2: Factor loadings free to vary between groups. 3: Error variances free to vary. 4: Covariances of latent independent variables free to vary. 5: Paths from independent to dependent variable(s) free to vary. 6: Error of equation free to vary.

Each test consists of six steps. In Step 1, it is assumed that both structural and measurement parameters are identical across segments (i.e., that there are actually no differences between segments defined by these variables). In the following steps, this assumption is relaxed. In Steps 2 and 3, it is controlled whether the "observed" variables are perceived identically by individuals in different segments. In Step 2, factor loadings on the latent variables (λ), and in Step 3, the error variances of the individual measures (θ), are allowed to vary. The importance of analyzing possible differences in this respect is illustrated in the columns in Table 2 reporting segmentation according to product knowledge, among other things. Here, Step 3 produces a significant improvement in χ^2, thus rejecting the hypothesis that the observed variables are perceived identically[7] by individuals in different segments. The, not surprising, conclusion is that a person's understanding of questions about issues relating to EVs (a radical new innovation) depends on his or her prior knowledge. This implies, among other things, that if measurement error is not controlled (which it is not in the typical exploratory segmentation analysis) a found difference in attribute preferences associated with a difference in knowledge may not be substantive, but just a difference in the understanding of the questions. Hence, this result is a timely reminder of the uncertainty of measures of individuals' perceptions and evaluations, particularly when the attitude object is a new product, such as the EV.

In Steps 4 to 6, the structural parameters, i.e., the covariances of the latent independent variables (Step 4), the paths from latent independent to the latent dependent variable (Step 5), and the structural equation's error variance (Step 6), are allowed to vary between segments. The analysis rejects the proposition that product knowledge influence attribute pref-

[6] In the cases of product knowledge, innovativeness, and (later) environmental concern the sample is split at the mean of the index (after summing items used to measure the construct).

[7] The test indicates that the segments defined by these splits agree about the basic meaning of the observed variables (step 2 did not produce a significant improvement in □[2]), but that they do not hold their perceptions about these meanings with equal certainty.

erences. However, as indicated in step 6, attribute perceptions explain significantly more of the variation in attitudes among high (the error of the equation, ζ = .14) than among low knowledge individuals (ζ = .28).[8] In other words, the less knowledge potential adopters have about EVs, the less their attitude is founded in attribute perceptions. Only when innovativeness is the criterion, and more strongly when combined with product knowledge than alone, do segments with significantly different attribute preferences appear (as indicated by a significant drop in χ^2 in step 5). Table 3 shows the structural parameters resulting from Step 6 in segments defined by a combination of product knowledge and innovativeness.

Table 3. Path coefficients from attribute perceptions to attitude for segments formed by splitting the sample according to product knowledge and innovativeness

	Low innovativeness, low product knowledge	*High innovativeness, low product knowledge*	*Low innovativeness, high product knowledge*	*High innovativeness, high product knowledge*
Vacation	0.32 (5.97)	0.11 (2.30)	0.18 (2.76)	0.33 (4.67)
Short trips	0.19 (2.54)	0.27 (3.16)	0.12 (1.01)	0.09 (1.04)
Performance	-0.41 (-2.93)	-0.35 (-2.71)	-0.54 (-3.31)	-0.49 (-3.14)
Ease of using	0.03 (0.42)	0.05 (0.64)	0.10 (0.81)	0.36 (3.25)
Costs	0.24 (3.19)	-0.06 (1.03)	0.16 (1.89)	0.09 (1.23)
Easy maintenance	0.01 (0.22)	0.18 (3.40)	0.07 (1.10)	0.04 (0.59)
Error of the equation, ζ	0.21	0.26	0.18	0.08

Note: t-values in parentheses.

Consistent with the results in Table 2, it appears that product knowledge has a stronger influence than innovativeness on the strength of the relationship between the attitude towards EVs and attribute perceptions. The attitude seems particularly strongly rooted in attribute perceptions among consumers that score high on both, however. By definition, the high knowledge/high innovativeness segment consists of (relatively) well-informed consumers who have taken a stance for or against EVs based on a high interest in alternative fuelled vehicles. Its average attitude towards EVs is slightly positive (3.21 on a 5-point scale with 3 as the neutral point and 5 as the positive extreme). The importance attached to the EV's technical performance has a strong influence on the attitude in all segments, but particularly in those defined by high product knowledge. Perceived usefulness for longer trips (vacation) also influences the attitude in all segments. Among the high knowledge segments, this variable has a stronger influence when high knowledge is combined with high than with low innovativeness. In addition, the high knowledge/high innovativeness segment is the only one where the expected ease of using an EV influences the attitude. The only attribute perceptions that influence the attitude in the high knowledge/low innovativeness segment are the importance attached to the EV's technical limitations and the evaluation of its usefulness for longer trips, the former being by far the most important. On average, this segment holds the least favorable attitude towards EVs (2.55 on a 5-point scale).

The segment where the attitude towards EVs is most weakly rooted in attribute perceptions consists of those that score high on innovativeness, but low on product knowledge. This is also the segment with the most favorable attitude of all, on average (3.37 on a 5-point scale). It also appears that the EV's technical limitations are less important for the attitude

[8] Due to space concerns the parameter estimates are not shown, but they – as well as the analyzed correlation matrices – can be acquired from the first author.

in this than in other segment(s). On the other hand, the significant influence of perceptions about the EV's usefulness for short trip (also in the other low-knowledge segment) indicates that lack of knowledge leads to unjustified prejudice against the EV among some. A special finding for this segment is that the importance attached to easy maintenance, but not beliefs about how easy the EV is to use, influences the attitude. These findings all have high face validity for a group whose attitudes are based on interest and ideal perceptions, rather than on factual knowledge. It also adds to the picture that this is the segment with the highest share of women (68%).[9]

The low innovativeness/low knowledge segment on average holds a slightly negative attitude towards EVs (2.67 on a 5-point scale). More than in any other segment, the attitude depends on the perceived costs of driving an EV. The sign is positive, meaning that the attitude is more positive the more important costs are. This indicates that the EV is considered a cheaper alternative, which is true if only the fuel costs are counted in. Hence, it seems that these consumers tend to be unaware of the high price of the EV. Besides costs, perceptions about the EV's technical limitations play an important role for the attitude in this, as in the other segment(s).

6.2 Car-ownership and environmental concern

As previously mentioned, we have argued elsewhere that the decision to adopt an EV depends on a combination of environmental concern and sensitivity to the EV's technical limitations (operationally whether the person considers substituting an EV for the household's only car or for the second or third car) (Garling & Thogersen, In press). Specifically, we argued that environmentally concerned multi-car households are likely to weigh an EV's attributes particularly favorably. The confirmatory procedure can be used to test this proposition if one is willing to assume that current multi-car households are also those that may consider substituting an EV for the second or third car. When applying this procedure, we find that segments of drivers defined by one of the mentioned two criteria alone do not differ in EV attribute preferences, but when segments are defined by the criteria used in combination they do (Table 4, Step 5).

Table 4. Test of differences between segments formed by splitting the sample according to car ownership and environmental concern and a combination of car ownership and environmental concern

	Car ownership				*Environmental concern*				*Car ownership and environmental concern*			
Step[#]	χ^2	df	$\Delta\chi^2$	df	χ^2	df	$\Delta\chi^2$	df	χ^2	df	$\Delta\chi^2$	df
1	463.7	197			445.8	148			1003.8	623		
2	459.4	188	4.3	9	440.8	140	5.0	8	993.0	593	10.8	30
3	448.8	180	10.6	8	437.1	134	3.7	6	933.7	548	59.3	45
4	437.2	170	11.6	10	433.6	128	3.5	6	864.3	485	69.4	63
5	427.8	165	9.4	5	428.0	124	5.6	4	830.2	464	34.1[*]	21
6	427.7	164	0.0	1	427.9	123	0.0	1	826.1	461	4.1	3

[*] Significant at $p < .05$.

[#] 1: All parameters equal. 2: Factor loadings free to vary between groups. 3: Error variances free to vary. 4: Covariances of latent independent variables free to vary. 5: Paths from independent to dependent variable(s) free to vary. 6: Error of equation free to vary.

[9] The share of women in the other three segments are: low innovativeness/low knowledge: 50%, low innovativeness/high knowledge: 22%, high innovativeness/high knowledge: 25%.

Table 5 shows the path coefficients linking attribute perceptions to the attitude towards EVs for the four segments defined by these two criteria. As predicted, the EV's usefulness for longer trips (vacation) tend to influence the attitude less in multi-car households, and the importance of the EV's environment-friendliness tend to influence the attitudes of environmentally concerned individuals more, than in the reverse. Together, these influences do seem to make the environmentally concerned multi-car households a promising segment of consumers. That the EV's technical performance seems to be less important for the attitude in this segment points in the same direction. Why beliefs about the ease of using an EV have a high influence on the attitude in this segment is not clear. Perhaps it is because people in this segment are more likely to perceive the lack of infrastructure for recharging the batteries of an EV as an important barrier for adoption. Lack of infrastructure is probably only perceived as an important barrier when the EV is not rejected for other reasons.

Table 5. Path coefficients from attribute perceptions to attitude for segments formed by splitting the sample according to car ownership and environmental concern

	1 car, low environmental concern	*2 or more cars, low environmental concern*	*1 car, high environmental concern*	*2 or more cars, high environmental concern*
Vacation	0.32 (5.46)	0.12 (2.57)	0.26 (3.77)	0.22 (3.92)
Short trips	0.12 (1.33)	0.18 (2.73)	0.31 (2.53)	0.15 (1.57)
Performance	-0.35 (-2.48)	-0.65 (-4.20)	-0.45 (-2.90)	-0.30 (-2.16)
Ease of using	0.14 (1.74)	0.04 (0.63)	0.02 (0.15)	0.32 (3.67)
Costs	0.17 (1.91)	0.18 (2.39)	0.03 (0.31)	0.04 (0.46)
Easy maintenance	0.03 (0.42)	0.20 (3.70)	0.01 (0.23)	0.02 (0.31)
Environment-friendly	0.12 (1.88)	0.15 (2.73)	0.15 (1.96)	0.20 (3.05)
Error of the equation, ζ	0.29	0.17	0.13	0.19

Note: t-values in parentheses.

7. CONCLUSIONS AND IMPLICATIONS

This paper deals with the issue of how drivers can be persuaded to accept new and more environment-friendly transport solutions. A basic assumption, from innovation research, is that individuals differ in their readiness to (or resistance against) adopting a new product. This assumption is strongly supported. Another widely shared assumption, that we accept although we have no data to support it in the present study, is that the society-wide diffusion of a new product is greatly facilitated, by demonstration effects and word-of-mouth, when the first, courageous, individuals have adopted it. For this reason, the most likely early adopters and strategies for targeting them deserve special attention when studying consumer acceptance of new transport solutions. In this paper, we demonstrate a way of doing this, using the electric vehicle (EV) and its acceptance by Swedish car-drivers as the illustrative case.

Within a private-car-based transport system, the EV offers significant environmental improvements, apparently without demanding serious lifestyle changes. However, its price/performance ratio currently compares unfavorably to the traditional ICV. Hence, the EV is hardly a new product that sells itself.

Elsewhere, we have developed a theoretical model outlining the key determinants of a consumer's adoption of a new, environment-friendly (transport) product (Thogersen & Garling, 2000). Basically, we suggest that the adoption of such a product is based on elaborate

consideration, intention formation, and trial. We suggest that whether an individual's considerations about a new product results in the formation of a positive attitude depends on how he or she perceives its attributes (relative advantages compared to current technology, compatibility with values and lifestyle, etc.), as well as on personality traits (innovativeness, environmental concern, knowledge) and other background variables. We also suggest that consumers may hold significantly different preferences regarding specific attributes of a new product, such as an EV. There may be segments of potential adopters whose wants and needs can readily be fulfilled with current technology, while those of others can not. With identical attitudes towards EVs, it is more likely that the former than the latter adopt early. When acknowledging such differences in preferences, it may also be possible to honor the wants and needs of different segments, with a differentiated offer, and thus spur the wider diffusion of the new product, possibly still at a lower costs than mass marketing.

In the segmentation study we investigate whether there are segments of drivers that differ in their preferences regarding EVs and, hence, should be served differently (and some, perhaps, not at all). We tested only segmentations suggested by theory and by earlier EV research and used a confirmatory approach (multiple sample structural equation analysis) for the test.

We found significant differences in attribute preferences among segments defined by innovativeness alone and even stronger when they are defined by a combination of innovativeness and product knowledge. Alone, product knowledge does not discriminate as regards attribute preferences. We also find significant differences in attribute preferences among segments defined by a combination of car ownership and environmental concern, but not when one of these criteria is used alone. In Table 6 we have summarized the characteristics of the identified segments.

Innovativeness and knowledge. Those in the high innovativeness/high knowledge segment holding a positive attitude are probably the easiest ones to persuade to try and finally buy an EV. On the other hand, improving the attitudes of those less favorably disposed is probably difficult. A likely reason for a person in this category having a relatively unfavorable attitude towards EVs is that he or she believes more in other types of alternatively fuelled vehicles, such as hybrid or fuel-cell driven cars. If this is the case, improving their attitudes towards EVs depends on real technical and infrastructural improvements.

Those in the high knowledge/low innovativeness segment probably are the most difficult to persuade to try and to buy an EV. On average, this segment holds the least favorable attitude towards EVs. If a person is not interested in alternatively fuelled vehicles in spite of a relatively high knowledge, likely reasons are that he or she are convinced that, due to current technical or conditional limitations, it is unrealistic to buy one, or that the knowledge is acquired because of a strong interested in conventional cars. If the reason is the former, the adoption probability may be improved by means of technical and perhaps also infrastructural improvements. If it is the latter, legal restrictions on ICVs is probably needed.

It is positive about the high innovativeness/low knowledge segment that its individuals are likely to be interested in information about EVs. For some of these individuals, buying an EV probably depends on an increase in factual knowledge, which moves them to the high innovativeness/high knowledge segment. Regarding this part of the segment, the marketing of EVs is a more long-term endeavor. Others in this segment are simply not interested in

the technicalities of cars, EVs or other. What they particularly need is information, guarantees, and side-services that increases their confidence that the EV will work without problems.

Table 6: Characteristics of identified segments

Knowledge and innovativeness	*Low innovativeness, low product knowledge*	*High innovativeness, low product knowledge*	*Low innovativeness, high product knowledge*	*High innovativeness, high product knowledge*
Share of sample, %	23	28	24	25
Mean attitude[1]	2.67	3.37	2.55	3.21
Woman share %	50	68	22	25
Attribute perceptions influencing the attitude	Performance and usefulness for long trips. Importance of costs and usefulness for short trips	Performance and usefulness for long trips (less than in other segments). Importance of easy maintenance and usefulness for short trips	Performance and usefulness for long trips.	Performance and usefulness for long trips. Ease of maintenance
Car ownership and environmental concern	*1 car, low environmental concern*	*2 or more cars, low environmental concern*	*1 car, high environmental concern*	*2 or more cars, high environmental concern*
Share of sample, %	28	17	34	21
Mean attitude[1]	2.80	2.65	3.20	3.09
Woman share %	30	38	50	49
Attribute perceptions influencing the attitude	Importance of costs and usefulness for long trips	Importance of environment-friendliness, ease of maintenance, and costs. Technical performance particularly important. Use fulness for short and long trips	Usefulness for short and long trips. Importance of environment-friendliness.	Importance of environment-friendliness. Downplaying technical performance. Ease of using. Usefulness for long trips

[1] 1 lowest, 5 highest
[2] Other than importance of technical performance and usefulness for vacations.

The high share of female drivers in this segment may be a hint that EV producers should pay particular attention to the needs and wants of female customers. Targeting female drivers may seem problematic because car purchase has traditionally been perceived as a male dominated area in family decision-making (Davis & Rigaux, 1974). However, gender dominance in (any area of) family decision-making is probably less clear now than it used to be. Particularly, if the family owns more than one car it seems less likely than before that decisions about both (all) cars are totally male dominated. In addition, a large and increasing number of women (and men) live single (and make decisions about car purchases alone).

It would be unwise to give individuals in the low innovativeness/low knowledge segment high priority in a marketing campaign for an EV. Because of the low interest in alternatively fuelled vehicles, individuals in this segment are difficult to reach with information that could improve their knowledge. In order to reach them, communication targeted at this segment should be entertaining or otherwise interesting in itself. Such communication may be able to improve some of these peoples' attitudes towards EVs, but only in a shallow

way. Hence, there is a long way to go before the effort would result in increased interest of trying an EV, not to mention buying one. Anyway, those in this segment who attach high importance to costs will probably resist buying an EV if it is more than marginally more expensive than a similar ICV.

Car ownership and environmental concern. The attribute perceptions of the environmentally concerned multi-car households make them a worthwhile segment to offer special attention in the marketing of EVs. In order to target this segment, the obvious strategy is to position the EV as the environment-friendly second car for multi-car households. This is, in fact, already done by some producers, such as Ford's Norwegian subsidiary Think (Anonymous, 1998). However, the pitfall is that some people may perceive dissonance between the two elements in this positioning. In addition, one should not forget that even this segment still weighs the technical limitations and usefulness for longer trips.

Variations in beliefs about how useful an EV is for short and long trips may reflect differences in needs, but considering the lack of experience with and low knowledge about EVs it is likely that it at least partly reflects differences in unjustified prejudice and goodwill. Given that modern EVs measure up with standard ICVs for short trips (Garling, Johansson, & Garling, 1998), reservations regarding its usefulness for such purposes is an indication of prejudice. If such prejudice is widespread, EV producers need to target it head-on with corrective information. On the other hand, given that EVs are indeed inferior for long trips, enthusiasm about its usefulness for such purposes may be a sign of unjustified goodwill. In such cases, more knowledge and experience may actually dampen a favorable attitude towards EVs. Of course, only realistic expectations and correct knowledge is a sustainable basis for the marketing of EVs.

The problematic thing about targeting drivers that perceive the technical limitations of EVs as relatively less important is that even they still find them important (just less). Hardly anyone finds the EVs technical limitations unimportant. This means that improving the EV technology has to be the number one priority in any long run marketing plan for EVs.

The results obtained in this study should, of course, be evaluated with a clear understanding of its limitations. The empirical study focused on car-owners in a metropolitan area in Sweden and unfortunately, response rates in the two waves of data collection were rather low. This means that one should be careful when generalizing results, particularly descriptive results such as the finding that 58% of the respondents were interested in buying an EV under certain conditions (Table 1). Fortunately, estimated relationships between measured constructs, which are much more essential than absolute means and frequencies, are also less sensitive to selection and self-selection biases. The most likely consequence of non-response bias is that indicators of discrimination between segments are attenuated, which does not detract from the conclusions drawn here.

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APPENDIX

Table A1. Items used to measure innovativeness regarding alternative fuelled cars

1.	I am among the last in my circle of acquaintances that would use a car fuelled by an alternative fuel.
2.	When I hear about cars fuelled by alternative fuels I become interested in using one.
3.	I would not like to use a car fuelled by alternative fuel.
4.	If a friend of mine has a car fuelled by alternative fuel I am interested in trying it.
5.	I would prefer to use a car fuelled by alternative fuel.

Table A2: Items used to measure environmental concern

1.	I believe that it is important that people in general protect the environment.
2.	Ordinary citizens must take responsibility for the environment.
3.	I believe that I should protect the environment.
4.	I believe that the environmental problems of our time need regulation.
5.	I think that the environmental problems of our time are alarming.

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