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## New transportation technology: norm activation processes and the intention to switch to an electric/hybrid vehicle

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### Abstract

Since humans' activities contribute to climate change it is important to change behavior. Switching to a hybrid/plugin/electric vehicle (HEV/PHEV/EV) for personal transport can be one way. In this study the intention to switch to a HEV/PHEV/EV is studied from the theoretical framework of the moral norm-activation theory of altruism (Schwartz, 1977) and the Value-Belief-Norm (VBN) Theory of environmentalism (Stern et al., 1999). Data was collected using a survey to three groups, alternative fuel vehicle owners (AFV, mainly E85/ethanol), fossil fuel vehicle owners (conventional vehicles, CV), and hybrid/plugin/electric vehicle owners (HEV/PHEV/EV). A SEM model was proposed, and tested on the subsamples of CV and AFV owners, of a hierarchical process of influence from the more general (e.g. values) to the more specific (e.g. beliefs, norms) and finally the intention. The results supported the proposed norm-activation model and showed that problem awareness was more influential in the AFV than in the CV group. In addition, a comparison between the three subgroups (CV, AFV and HEV/PHEV/EV) showed that HEV/PHEV/EV owners differed significantly from CV and AFV owners, in that they were more open to change, less conservative, showed a higher problem awareness, self-efficacy, and a stronger personal norm. The results from this study may have implications for future work of increasing the number of electric vehicles on the roads and thereby contribute to less direct emissions from car traffic.

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## 1. Background

It is firmly established that human activities contribute to climate change (IPCC, 2013) and it is of utmost importance to better understand what factors influence the willingness to change environmentally damaging behaviors into less harmful ones. One behavior that is environmentally questionable is the use of fossil fueled vehicles for personal transportation (EIA, 2011). As a consequence it is important to design measures that will influence travel and travel mode choice behaviors and that these measures build on research findings (e.g., Donald, Cooper, & Conchie, 2014; Haustein & Hunecke, 2013; Lavery, Páez, & Kanaroglou, 2013; Noblet, Thøgersen, & Teisl, 2014). Today the electric vehicle is developing into a strong alternative to the fossil fuel driven car, and these vehicles can be defined as an eco-innovation, that is, a new product that avoids or reduces environmental harms compared to conventional products (Beise & Rennings, 2005). However, even if some studies have been conducted on the issue (e.g. Nayum, & Klöckner, 2014), little is still known about this high involvement purchase decision (Thøgersen, 1999; Lehman, & Geller, 2004) and what psychological factors lay behind the intentions relating to the adoption of such a new electric vehicle technology.

The influence of psychological factors have been studied extensively for different types of environmentally related behaviors. It is for example known that values, beliefs, and personal norms, as depicted in the Value-Belief-Norm Theory (Stern 1992) and Norm-activation Theory (Schwartz, 1977), are of importance when it comes to choices related to pro-environmental behavior in general (Nordlund & Garvill, 2002), ecological risk perception (Slimak & Dietz, 2006), consumer purchasing behavior (Stern, Dietz, Abel, Guagnano, & Kalof, 1999), travel mode choice (Nordlund & Garvill, 2003; Nordlund & Westin, 2013), acceptability of energy policies (Steg, Dreijerink, & Abrahamse, 2005), and acceptability of travel demand management measures (Eriksson, Garvill, & Nordlund, 2006). In addition, it has been shown that such attitudinal factors (values, beliefs and norms) are of importance when it comes to the adoption of an Alternative Fuel Vehicle (AFV; Jansson, Marell, & Nordlund, 2010; 2011). Also, personal moral norms are of importance for understanding and dealing with abstract aspects of climate change (Jansson & Dorrepaal, 2015). However, more knowledge needs to be acquired when it comes to individuals' intention to switch to different types of electric vehicles.

### 1.1. Theoretical framework

Stern (2000) grouped different causal factors behind environmental behavior into four categories, that of Contextual forces, Personal capabilities, Habits (or routines), and Attitudinal factors. The study reported on here will focus on the attitudinal factors, which comprise values, beliefs, and norms. There are numerous theories dealing with environmentalism, that is "...the propensity to take action with proenvironmental intent" (Stern, 2000, p 411), and two well established theories propose a hierarchical process of influence flowing from the more general (e.g. values) to the more specific (e.g. beliefs, norms) to the intention/behavior are the moral Norm-Activation theory of altruism (NAM; Schwartz, 1977), and the Value-Belief-Norm (VBN) theory of environmentalism (Stern, et al., 1999).

In NAM (Schwartz, 1977), altruistic behavior is conceptualized as a response to a personal norm being activated in light of a threat (e.g. awareness of consequences or problem awareness) and an individual's own feeling of responsibility and possibility (self-efficacy) to act in order to avoid the consequence of the perceived threat. Models of norm-activation have been shown to be supported in a number of studies relating to environmentally significant behavior (Bamberg & Möser, 2007; Eriksson, et al., 2006; De Groot & Steg, 2009; Hunecke, Bömbaum, Matthies, & Höger, 2001; Joireman, Lasane, Bennet, Richards, & Solaim, 2001; Milfont, Sibley, & Duckit, 2010; Nordlund, et al., 2003; Schultz, Gouveia, Cameron, et al., 2005; Steg & De Groot, 2010; Vandenberg, 2005). In much of this research a link has been made to general theories of values (Schwartz, 1994) as the basis from which a personal norm develops. Values can be defined as the basic guiding principles, or core aspects of the self-concept that are used in all sorts of spectrums of life related decisions and behaviors (Rokeach, 1968; Schwartz, 1994). With the value-expressive function, attitudes are linked to values in a hierarchical relation whereby people develop attitudes that are consistent with their values in order to express and act on those values (Eagly & Kulesa, 1997). This hierarchical relationship, from values to beliefs and attitude has been seen in in research, stating an indirect rather than direct, effect of values on pro-environmental intentions/behavior (e.g. Nordlund, et al. 2002, 2003, 2013; Steg

et al. 2005). Schwartz, organized ten value types into two dimensions, Openness to change versus Conservation, and Self-transcendence versus Self-enhancement. Openness to change pits values emphasizing independent thought and action against the conservation values that emphasize self-restriction, preservation and tradition. Self-transcendence values on the other hand pits acceptance of others and welfare of others against self-enhancement values emphasizing own relative success and dominance over others. In the VBN, Stern et al. (1999) build on norm-activation and value theories and link them to the New Environmental Paradigm (NEP, Dunlap, Van Liere, & Mertig, 2000). NEP is defined as ecological worldview, covering views on the balance of nature, the limits to growth, and humankind's domination of nature. The VBN theory poses a hierarchical causal chain from values, beliefs (NEP, Awareness of Consequences, AC and Ascribed Responsibility, AR), and Personal Norms, PN, to intention/behavior.

There are different types of environmentally significant behaviors, and the type of interest in this study is what Stern (1992) defined as energy efficiency increasing behaviors or technology choices, of which switching from a fossil fuel vehicle to an electric or hybrid vehicle is an example. When we deal with new technology or an innovation, some are more prone to adopt this in an early stage than others; the saying is that there are innovators, early adopters, early majority, late majority, and, laggards (Rogers, 2003). The adoption of an innovation is the result of gaining an initial knowledge of an innovation, to forming an attitude toward the innovation, to making a decision to adopt or reject, to implementation of the new idea, and to confirmation of this decision.

### 1.2. Aim

The aim of this study is twofold: firstly, the aim is to investigate whether there is a norm-activation process present behind the intention to adopt a hybrid/plugin/electric vehicle. A hierarchical model inspired by the VBN perspective is applied, is proposed and depicts that intentions to switch to an HEV/PHEV/EV can be understood from a norm-activation perspective with underlying influence from values and beliefs (see Figure 1). More specifically, the proposed model states that the personal norm, from which the influence stems to the intention, is activated by values, NEP, and beliefs (problem awareness and perceived efficacy). Secondly, the aim is to investigate whether or not different sub-groups of car owners (fossil fuel vehicle owners or conventional vehicles, CV, alternative fuel vehicle owners, AFV, and hybrid/plugin/electric vehicle owners, HEV/PHEV/EV) differ in their values, beliefs and norms.

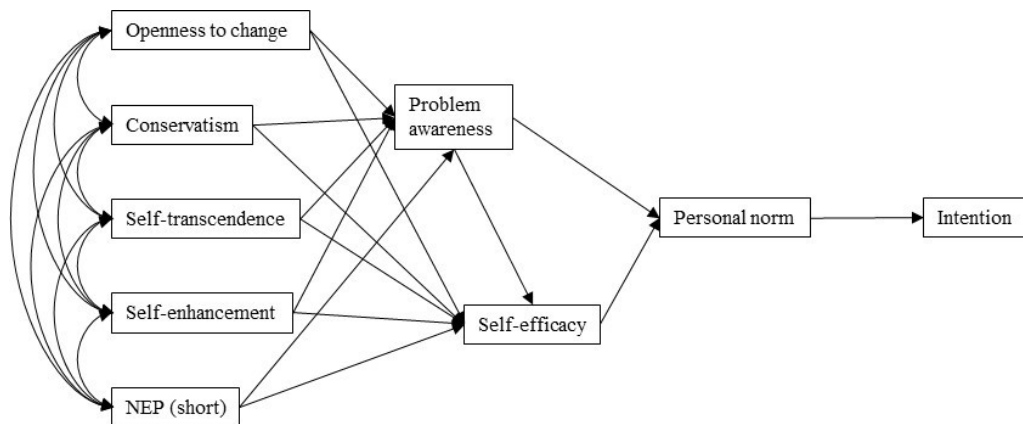


Fig. 1. Proposed path model of a hierarchical norm activation process in relation to the intention to switch to a hybrid/plugin/electric vehicle.

## 2. Method

This survey study was conducted on a sample of 3,000 car owners in Sweden in the age range of 20-75 years, with three sub-groups consisting of owners of a hybrid/plugin/electric vehicle (HEV/PHEV/EV), owners of an

alternative fuel vehicle (AFV), mostly ethanol/E85 and gas, and owners of a Fossil fuel (petrol/diesel) vehicle (CV). The overall response rate was 40 percent (HEV/PHEV/EV owners = 41%, n=494; AFV owners = 32%, n=386; CV owners = 26%, n=312).

The sample of respondents consisted of 64 percent men (CV = 56%; AFV = 67%, and HEV/PHEV/EV = 66%), which is representative of the pattern of car registry in Sweden. About half of the sample (54%) reported having a university degree (CV = 45%, AFV = 52%, and HEV/PHEV/EV = 60%), and 70 percent held a job (CV = 65%, AFV = 76%, and EV/HEV = 67%).

The survey questionnaire contained a variety of items, but only those relevant for this study are described here. *General values* were assessed with a short version of Schwartz social values scale (1994) and comprised of *Self-transcendence* was assessed using 5 items ( $\alpha = .76$ , Broadminded, Protecting the environment, Social justice, Helpful, Loyal), *Self-enhancement* with 6 items ( $\alpha = .69$ , Successful, Social order, Social power, Authority, Influential, Wealth), *Openness to change* with 5 items ( $\alpha = .74$ , Freedom, A varied life, Independent, Creativity, Curious), and *Conservation* was assessed with 4 items ( $\alpha = .61$ , Self-discipline, Respect for tradition, Devout, Family security).

A short version of the *New Ecological Paradigm* (NEP) scale was used (five items,  $\alpha = .77$ ). *Problem Awareness* was assessed with 3 items ( $\alpha = .68$ , Air pollution from private car use is such a serious problem that measures needs to be implemented immediately; My choice of car has a considerable effect on the use of the energy resources; My choice of car has no major effect on the environment [turned]), as was the measure of *Self-Efficacy* ( $\alpha = .74$ , It's no use I decrease my use of car since it only has a small effect on the negative consequences for the environment [turned]; Even if my contribution is small, it is important that I contribute in the effort to decrease the negative effects on the environment; My choice as a consumer can influence the car industry in a pro-environmental direction), and the measure of *Personal Norm* ( $\alpha = .83$ , To own a car that is not "green" would give me a bad conscience; Seen from my values, the right thing to do is to buy a "green car"; I feel a moral obligation to decrease the negative environmental effects of my car use).

Finally, the intention to buy or switch to HEV/PHEV/EV was assessed with 4 items ( $\alpha = .88$ , I intend to buy/switch to an HEV/PHEV/EV: in the nearest future; next time I switch car; I am convinced I will own a HEV/PHEV/EV in: 5 years; and 10 years). In the analyses of the intention to switch to HEV/PHEV/EV, only the non-adopters (AFV and CV owners) are included.

### 3. Results

The first aim of this study was to test whether there is a norm-activation process present behind the intention to adopt a HEV/PHEV/EV. The proposed model (see Figure 1) was tested in a path analysis in the software Amos (Arbuckle, 2013). The second aim, to investigate whether or not different sub-groups of car owners (fossil fuel vehicle owners, CV, alternative fuel vehicle owners, AFV, and hybrid/plugin/electric vehicle owners, HEV/PHEV/EV) differed in their values, beliefs and norms, was tested with One-way ANOVA analyses.

#### 3.1. Path analyses

In this study a SEM (Structural Equation Modeling), more specifically a path model, was tested in which values, beliefs, and norms are ordered in a hierarchical manner, thus stipulating that the effect of values and beliefs, on the intention to switch to an electric vehicle, is mediated by an activated personal norm. The proposed model (see Figure 1) was tested in the sub-groups containing fossil fuel vehicle owners (CV) and alternative fuel vehicle owners (AFV).

The proposed model was estimated in the two sub-groups and showed moderate to reasonable goodness of fit (see Figures 2 and 3). In the sub-group CV owners, the estimated model showed a moderate goodness of fit (CMIN/DF = 3.70, AGFI = .89, RMSEA = .093 [.065 - .123]). The goodness of fit in the sub-group AFV owners, was better showing a reasonable fit (CMIN/DF = 2.75, AGFI = .93, RMSEA = .067 [.041 - .095]).

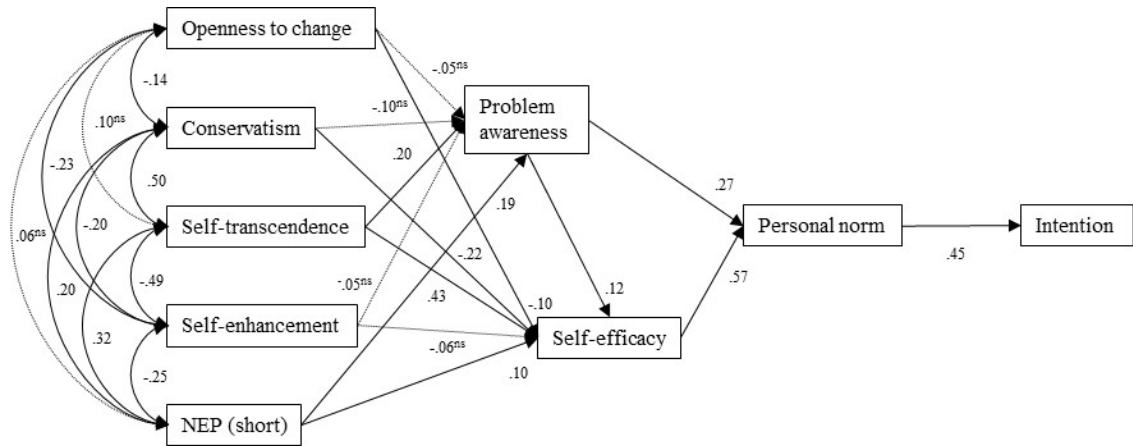


Fig. 2. Estimated path model of the influence of norm activation on the intention to switch to a hybrid/plugin/electric vehicle among CV owners.

The results in the sub-group CV owners, show that norm-activation is present, which explains 21 percent of the variance in the intention to switch to electric vehicle (see figure 2). The personal norm was directly influenced by problem awareness and a sense of self-efficacy, and these concepts were in turn influenced by NEP, self-transcendence, and conservatism (self-efficacy). The influence from NEP and Self-transcendence was positive, while the influence of Conservatism was negative. Thus, being more collective in your value base and not conservative, having an ecological worldview, being aware of the problems caused by private car use, such as air pollution the effect on the use of the energy resources, and the effect on the environment, and experiencing that your car use has an negative effect on the environment, feel it is important to contribution to the decrease these negative effects, and the feeling that you as a consumer can influence the car industry, is of importance for the personal norm to be activated. Notably, the value type Openness to change and Self-enhancement did not influence the beliefs as predicted, however these were related to the other value types and NEP.

The pattern is both similar and different in the sub-sample of AFV owners (see Figure 3). Again, norm-activation is present, which explains 20 percent of the variance in the intention to switch to an electric or hybrid vehicle. The personal norm was directly influenced by Problem Awareness and a sense of self-efficacy, and these concepts were in turn influenced by NEP, Self-transcendence, and Conservatism. Again, the value types Openness to change and Self-enhancement were not significantly influencing the beliefs as predicted, and again these values were related to other values types and NEP. One notable difference, besides the better goodness of fit, was the stronger influence from Problem Awareness to Self-efficacy in the AFV group. Thus, in the group that have taken the step from fossil fuel to an alternative fuel, albeit not electricity, the relationship was stronger between being aware of the environmental problems associated with the use of cars and their own feeling of power as persons in the solution to these problems.

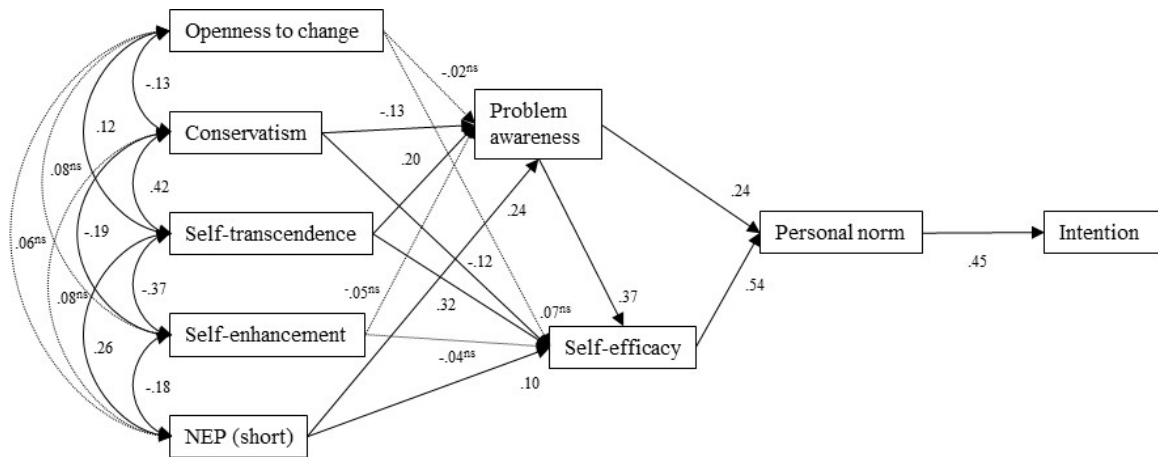


Fig. 3. Estimated path model of the influence of norm activation on the intention to switch to a hybrid/plugin/electric vehicle among AFV owners.

3.2. Differences between adopters and non-adopters

A second aim of this study was to investigate whether there were differences present in the involved values, beliefs and personal norms between those who already have made the switch to a HEV/PHEV/EV and those who have not. A series of One-way ANOVA analyses was conducted on the measured indexes in the three groups: CV owners, AFV owners, and HEV/PHEV/EV owners (see Table 1).

Table 1. Means and Standard deviations (in brackets) for involved values, beliefs, and personal norm in the three sub-groups. Different sub-scripts (a, b, c) indicate significant group difference. F-values are indicated as significant at  $p < .05$  (\*) and  $p < .001$  (\*\*\*)

	CV owners	AFV owners	HEV/PHEVEV owners	F-value
Self-transcendence	7.00 (1.19)	6.88 (1.11)	7.04 (1.04)	2.43
Self-enhancement	5.18 (1.12)	5.01 (1.03)	5.15 (1.08)	2.55
Openness to change	6.61 (1.24) <sub>a</sub>	6.50 (1.23) <sub>a</sub>	6.82 (1.12) <sub>b</sub>	8.21***
Conservation	6.89 (1.12) <sub>a</sub>	6.65 (1.10) <sub>b</sub>	6.69 (1.14) <sub>b</sub>	4.50*
NEP (short)	5.18 (1.12)	5.09 (1.07)	5.19 (1.25)	0.99
Problem awareness	4.54 (1.35) <sub>a</sub>	4.57 (1.38) <sub>a</sub>	5.03 (1.43) <sub>b</sub>	16.32***
Self-efficacy	5.15 (1.44) <sub>a</sub>	5.24 (1.37) <sub>a</sub>	5.74 (1.25) <sub>b</sub>	24.05***
Personal norm	3.93 (1.67) <sub>a</sub>	4.28 (1.67) <sub>b</sub>	5.00 (1.62) <sub>c</sub>	44.29***

The results of the One-Way ANOVAs showed that the group of HEV/PHEV/EV owners in the study did differ significantly from the two non-adopters groups (AFV owners and CV owners). HEV/PHEV/EV owners did express stronger openness to change values as compared to both AFV and CV owners. HEV/PHEV/EV and AFV owners did to a small degree express weaker conservative values than CV owners. A higher level of problem awareness, self-efficacy, and a stronger personal norm was seen among the HEV/PHEV/EV owners. On the other hand the results showed that the subgroups neither did differ in the strength of their ecological worlds view (NEP), nor in their collective (Self-transcendence) or individual (Self-enhancement) values.



#### 4. Discussion

The aim of this study was on one hand to test whether the intention to adopt vehicle HEV/PHEV/EV can be depicted and understood from a value-belief-norm theoretical perspective, and on the other hand, to investigate whether or not different sub-groups of car owners (CV owners, AFV owners, and HEV/PHEV/EV owners) differ in their values, beliefs and norms. The results support the proposed models in general, thus indicating that a norm activation process is at work and that this feeling of moral obligation to go green was influenced by the individuals' problem awareness and their sense of self-efficacy, which in turn was influenced by their ecological worldview (NEP) and their collective and conservative values. The results thus support earlier findings showing that even when the requested action is of a high involvement character (Jansson et al. 2010; 2011), such as the purchase of an electric vehicle, the intention is based on values, beliefs and norms. The results are also in line with research on less financially demanding behavioral choices, such decreased use of car, travel mode choices, and acceptability of TDMs (Nordlund et al., 2002; 2003; Eriksson et al., 2006; Eriksson, Garvill, & Nordlund, 2008; De Groot, Steg, & Dicke, 2008), energy conservation in the household (Steg et al., 2005; Steg, 2008; Ibtissem, 2010; Abrahamse & Steg, 2011), recycling (Aguilar-Luzón, Garcia-Martinez, Calvi-Salguero, et al., 2012; Chan & Bishop, 2013), and sustainable consumption (Aertsens, Verbeke, Mondelaers, et al., 2009; Jansson et al., 2010; 2011). Current research has also shown that the choice to act pro-environmentally, not only elicits a positive feelings about yourself for acting in accordance with you held values and norms, but actually elicits a literal warm glow, manifested in higher skin temperature and perception that the surrounding is warmer in temperature (Taufik, Bolderdijk, & Steg, 2014). This further accentuates the importance of the moral reasoning around environmentally relevant behaviors and the consequences of acting on your personal norm.

In addition, the results show that the three sub-groups (CV, AFV and HEV/PHEV/EV owners), differed in the values, beliefs, and norms, indicating that those that have made the switch already (HEV/PHEV/EV owners) were more open and less conservative in their set of values, were more aware of the environmental problem associated to transportation, experience themselves as having the power to make a difference to a larger degree, and to higher degree demonstrated the moral obligation to go green in the realm of their own transportation choices. It would thus be possible to state that these early adopters of HEV/PHEV/EVs, in this Swedish sample, do have a somewhat greener profile; something that could or should be used to benefit the market breakthrough in the rest of the population. Since the level of environmental awareness generally is high in Sweden and the rest of Europe (Eurobarometer Survey, 2014) and climate change is a concept widely used in traditional and modern forms of media (Hanson-Easey, 2015), one interesting result in this study is that CV, AFV, and HEV/PHEV/EV owners did not differ with respect to their ecological world view (NEP). This could be the result of the rather large degree of coverage the environmental issue has had in different communicative forums in the recent 20 years, or so. Based on this reasoning it is of great importance to establish a more topic-specific environmental awareness, related to the issue of car use, and eliciting a feeling of power to influence their surroundings, in this case the car industry, in order for the personal norm to activate into a feeling of personal moral obligation to switch from fossil fuel to electricity in the vehicle sector. The greener profile of the early adopters (the HEV/PHEV/EV owners) could be used as a good example of what you can do and that the HEV/PHEV/EV technology works for some, which possibly could attract new adopters of HEV/PHEV/EVs with medium to high levels of ecological world views.

One interesting result was the lack of, or even negative effect, from the value type openness to change on the beliefs and subsequent norm and intention. One could reason that an openness in the value set should be expected to be associated with a positive outlook on new innovations, but the results show that openness to change is not related to the level of problem awareness and negatively related to self-efficacy. Thus, the more open an individual is, the less this person feels they have the power to make a difference using behavioral choices. There is no obvious explanation for this result, but generally only the collective vs. individual value dimension (self-transcendence and self-enhancement) is included in research on environmentally significant behavior. The result from this study however indicate that we need to include all the value dimensions, in order to learn more about their potential positive, negative and/or lack of effects.

As is common in research on environmentally significant behavior, only a portion of the variance in the intention or behavior is explained by the model of choice, as can be seen here in the 20 percent level of explained variance. This makes a discussion about what the remaining variance is about important. Such aspects can be the perception

of the instrumental attributes of the vehicle, which is related to its functionality, the hedonic attributes of the vehicle which is related to the emotional experience of using the vehicle, and the symbolic attributes connected to the sense of self and social identity (Voss, Spangenberg, & Grohmann, 2003; Roehrich, 2004; Schuitema, Anable, Skippon, et al., 2013, Rezvani, Jansson, & Bodin, 2015). Another aspect of importance is the fact that the HEV/PHEV/EV vehicle is a more expensive alternative than the CV and AFV vehicle, and fewer used cars in this segment is available simply due to the still quite short time on the market. So even if a norm-activation is present and the norm is activated in a CV owner, the financial cost of purchasing an HEV/PHEV/EV is a barrier, leading us to confirm that personal capabilities are of importance (Jansson et al., 2010).

Is it possible to say anything about whether we should expect there to be a switch from the conventional car to an alternative fuel car (not electric) in the first hand, and then on to the HEV/PHEV/EV vehicle? From the standpoint of this data set the answer is no, that is not possible, but some interesting aspects to discuss are present. The fact that the data indicates a positive increase from the CV owners (lowest), AFV owners (medium) and HEV/PHEV/EV owners (highest) in the expressed personal norm, might indicate that the AFV owners have acted upon their personal norm already. Perhaps so even before the HEV/PHEV/EV market offered the wide range of models and brands as it is seen to do today. Based on this reasoning it can be speculated that the AFV owners might be the first ones to also adopt HEV/PHEV/EV when replacing the AFV. Further studies in this area would be valuable to substantiate these speculations.

#### *4.1. Limitations and further research*

In essence there are three limitations of this study that are important to have in mind when examining the results. Firstly, due to the relatively low market penetration rate of pure Electric Vehicles (without other types of engines or range extenders) at the time of the study it was necessary to treat the intention and owner groups for different types of EVs (HEV/PHEV/EV) as one and the same although the attitudes and behaviors related to each of these types of cars might be different. In spite of this the results clearly indicate that there are differences between this group and the CV and AFV groups. However, further studies, when the market is more mature, would be wise to separate the intentions and owners into different groups. A second limitation concerns the representativeness of the sample. Since a stratified sampling technique was used it is not possible to use this data to generalize to the population or car owners in general about the attitudes and intentions overall, it is only possible to do in the respective groups. This choice is also related to the low market penetration rate at the time of the study, and can be amended when there are more EVs on the market so a random general sampling can be conducted. Thirdly our study is correlational in nature preventing us from drawing conclusions on for example whether the attitudes and values come about before or after the actual adoption decision of the respective car is made. Future research could utilize a panel approach to follow how values and attitudes change over time especially when different cars are considered and adopted.

#### *4.2. Conclusions and application*

This study and its result aids in the understanding of different groups of consumer's at different stages in the adoption process for an eco-innovation. This knowledge is of importance for decision makers and industry when identifying target markets, positioning products and designing communication and policy measures (Wang, Dou, & Zhou, 2008).. The results suggest that policies and campaigns directed to making customers aware of norms and their own ability to make a positive change in a pro-environmental direction are likely to be fruitful to increase the adoption of less environmentally harmful transport alternatives. From a theoretical perspective the study contributes in strengthening the understanding of the importance of personal norms for pro-environmental behaviour.

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