The motivational determinants in adopting sustainable products

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Abstract: In the context of sustainable development, product developers and engineers often tend to adapt existing products towards more sustainable products. Ehrenfeld (2008) and Manzini (2009) argue, however, that a sustainable future is not reached by diminishing 'unsustainability'. Instead, they claim that sustainability requires a radical change in thinking and being in the world. Product design should contribute to this new paradigm. How does this new designers' concept relate to established frameworks on new product adoption such as the Decomposed Theory of Planned Behaviour (Taylor and Todd, 1995)? The introduction of an electric vehicle, which is projected to be a new more sustainable transport system, is taken as a case to explore the integration of these viewpoints. The purpose of this paper is to develop a conceptual framework of the factors that impact the decision to adopt an electric vehicle, based on previous conceptual models of the adoption of an innovation and a preliminary qualitative research on electric vehicle acceptance. This framework will be applied in follow-up research to contribute to the development of sustainable products.

Key words: sustainability, changing consumer behavior, product design, Decomposed Theory of Planned Behavior, Electric Vehicle

1. Introduction: Sustainable product development and well-being.

Product development plays a key role in our economic system. About 30% of our GDP results from the sales of products that were developed during the last 5 years. One of the key drivers to embark on product development is the response it should give to a changing environment. This changing environment can be socio-cultural, it can be an evolution of customer demands, changing legislation or new technologies, etc. Product developments can also be triggered by growing concerns about the changing resources needed to produce and use the target product. This is the domain of sustainable product development. "Sustainable development' is a constructed merger of the economic, the ecologic and the social paradigm (the triple bottom-line of sustainability, (Elkinton, 1994). It is one of the goals of our post-modern society (Shin et al, 2008). Brundtland (1987) defines sustainable development as: "the use of goods and services that respond to basic needs and bring a better quality of life, while minimising the use of natural resources, toxic materials and emissions of waste and pollutants over the life cycle, so as not to jeopardise the needs of future generations (WCED,1987). Thoughtleaders in the fields of industrial ecology and industrial design as Ehrenfeld (2008) and Manzini (2009) argue that the tendency to adapt existing products towards more sustainable products is not enough. ' …the transition towards sustainability must

see the germination and consolidation of a new idea of well being and a new production system that will make it possible to live better while reducing the weight of our activities on the environment. We must also regenerate the physical, social and cultural quality of places and the physical, social and cultural quality of the planet as a whole. All this can be imagined as a huge co-creation phenomenon, where different individuals and communities interact in a vast process of social learning and innovation '(Manzini, 2009). In this more fundamental approach, the key element becomes '**sustainable well-being**'. This concept is supported in some literature. In line with this 'sustainable well-being' concept, GDP was theoretically and empirically criticized as a social welfare and progress indicator (Van den Bergh, 2009). Van den Bergh (2009) argues that removal of the information failure which GDP represents in monitoring economic progress and guiding public policy will lead to decisions and developments being more in line with improving human well-being. Also a range of studies have demonstrated that environmental problems are frequently appraised as threatening or damaging to personal well-being and especially to personal health (Dunlap et al. 1993, Kuckartz and Grunenberg, 2003, Lai et al. 2003). Manzini (2009) and Ehrenfeld (2008) consider a number of steps in generating sustainable products. This starts by formulating needs, wants and desires and imaging the products (services) we really want. The adaptation of the product often goes far beyond the adaptation of the product features. The big challenge will be to move towards more sustainable consumption behavior. 'Altering consumption patterns is one of humanity's greatest challenges in the quest for environmentally sound and 'sustainable development', (Sitarz, 1994, p. 39). It is difficult to change daily routines and consumers' perceptions of, sometimes unattractive, environmentally friendly products. Moreover, generally speaking consumers want attractive, usable products, thereby often disregarding higher consumption levels of energy and materials. Product developers and designers, therefore, in their efforts towards developing sustainable products, require a thorough understanding of consumer desires and perceptions and of ways to change consumer behavior through product development. Thinking and writing on sustainable wellbeing in the field of design is still relatively young and few empirical studies are known. Theories on consumer behaviour, in contrast, have been developing in the last forty years and numerous studies were conducted. In this paper we will attempt to enrich approaches towards sustainable well-being and towards sustainable design by combining recent frameworks in design with more general frameworks from consumer behaviour. This will be illustrated by zooming into the field of personal mobility and more specifically the factors affecting the adoption of electric vehicles.

2. Conceptual frameworks of new product adoption by individuals

The Decomposed Theory of Planned Behavior was developed by Taylor and Todd (1995) and offers a suitable integrated framework to study the drivers of the adoption of a new technology (Cauberghe and De Pelsmacker, 2008). One of the contributions of Cauberghe and De Pelsmacker to the innovation acceptance literature is the causal link they found between different motivational components and their antecendents (cognitive beliefs). In the Decomposed Theory of Planned Behavior, Taylor and Todd (1995) integrate three important frameworks that are widely used for studying adoption processes. These basic frameworks are discussed here.

Innovation Diffusion Theory

Rogers' (1983, 1995) Innovation Diffusion Theory (IDT) describes a classification of consumers into five categories according to the speed of new product adoption. After a slow start (innovators and early adopters), a

growing amount of consumers picks up the new product (early majority). The amount reaches a top (late majority) and falls down again (laggards). According to Rogers (1995), the decision to adopt or reject an innovation is affected by five innovation attributes: observability, relative advantage, compatibility, triability and complexity. The first four of these attributes are positively related to the rate of adoption, while complexity is asserted to be inversely related to the adoption rate of an innovation. These five basic drivers were subdivided by Darley and Beniger (1981) to make predictions about the diffusion of more environmentally friendly innovations. Instead of Rogers' concept of relative advantage, they proposed two more specific sub-dimensions: capital cost of the innovation and capital savings of the innovation. They subdivided compatibility into attitude and lifestyle compatibility. Furthermore they added three new attributes: certainty of savings, dissatisfaction with the existing situation and efforts and skills involved in installing the innovation.

Theory of Planned Behavior

The Theory of Planned Behavior is an extension of the earlier Theory of Reasoned Action, (Fishbein and Ajzen, 1975) and has often been used as a theoretical framework for analyzing environmentally related behaviors (Jones, 1990; Goldenhar and Connell, 1992; 1993, Bamberg and Schmidt, 1999; Kaiser et al. 1999; Cheung, et al. 1999; Lam, 1999). One of the advantages of applying the theory of planned behavior is that it delivers clear theoretical and operational definitions of the used constructs and organizes these constructs in terms of causal processes by which they affect behavior. The theory of planned behavior (TPB, Ajzen, 1985, 1991) tries to explain the underlying mechanism of the adoption process based on three general dimensions; the **attitude** toward the behavior, the **social influence** (subjective norm) on the behavior and the **perceived behavioral control** in conducting the behavior. These three dimensions are in turn influenced by specific cognitive beliefs about the behavior. Decision making is guided by a rational evaluation of behavioral consequences. The sum of the perceived positive and negative consequences and the evaluation of these consequences determine the global attitude towards a behavioral option**.** Social influence is defined as 'the person's perception of the expectations of important others about a specific behavior (Pavlou and Fygenson, 2006, p. 117)'. Perceived behavioral control can be defined as 'a person's perception of how easy or difficult it would be to carry out a behavior (Ajzen, 1991, Pavlou and Fygenson, 2006, p. 119). This is affected by the perception of one's own skills but also by the eventual constraints or facilitators in the context. Many contextual factors may facilitate or constrain environmental behavior and influence individual motivations (Ölander and Thøgersen, 1995; Stern, 1999; Thørgersen, 2005, Van Raaij, 2002). Several studies showed evidence (e.g., Santos, 2008; Van Diepen and Voogd, 2001; Vining and Ebreo, 1992) that an individual's engagement in pro-environmental behaviour is affected by contextual factors such as the availability of recycling facilities, the quality of public transport, the market supply of goods, or price setting. Contextual factors such as physical infrastructure, technical facilities, the availability of the product and the product characteristics, are of crucial importance in consumer behaviour.

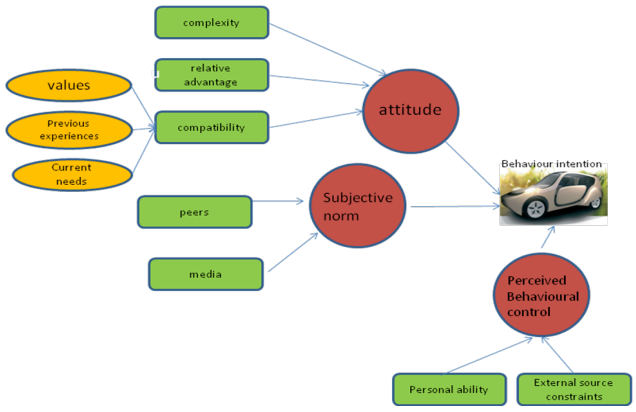
Technology acceptance model

The Technology Acceptance Model (TAM) (Davis, 1989) mainly focuses on the cognitive beliefs based on the characteristics of the innovation that influence the attitude towards using the innovation. The TAM assumes that a person's attitude and behavioral intention towards using a new technology are influenced by the perceived usefulness (PU) and the perceived ease of use (PEOU) of the innovation (meta-analyses e.g. King and He, 2006;

Schepers and Wetzels, 2007). However the TAM does not incorporate the influence of the social system surrounding the individual as proposed by the Theory of Planned Behavior. Therefore, Venkatesh and Davis (2000) incorporated the influence of the social norm in the TAM 2. They found that the subjective norm had a direct effect on the behavioral intention of individuals. This compliance effect occurs because people choose to perform an action when one or more important people in their environment say they should, independent of whether they like it or believe in it. In TAM 2, the subjective norm also has an indirect effect on the behavioral intention through PU and PEOU. This internalization process represents the tendency of people to believe the information of others as reality.

Decomposed theory of planned behavior

Taylor and Todd (1995) introduced the Decomposed Theory of Planned Behavior (Fig. 1), which decomposes the three main antecedents of behavioral intention as proposed in the Theory of Planned Behavior (attitude, subjective norm and perceived behavioral control) into a set of salient beliefs based on the Innovation Diffusion Theory and the Technology Acceptance Model (see earlier). Decomposing the **attitude** construct integrates the three most stable innovation characteristics defined by the innovation diffusion theory (Moore and Benbasat, 1991; Tornatzky and Klein, 1982): **complexity, relative advantage and compatibility** (Taylor and Todd, 1995). Complexity is similar to the PEOU construct of the TAM and relative advantage is comparable with PU of the TAM (Davis, Bagozzi and Warshaw, 1989, Moore and Benbasat, 1991; Plouffe, Hulland and Vandenbosch, 2001). Compatibility is the degree to which the innovation fits with the potential adopter's existing values, previous experiences and current needs" (Rogers, 1983). **Subjective norm** is decomposed into different reference groups. A reference group can be defined as a group, which serves as a comparison point and who's meaning is perceived as important for the individual (Shibutani, 1955). For **perceived behavioral control**, Taylor and Todd (1995) follow Ajzen's (1980, 1991) conceptualization. This is based on Bandura's notion of self efficacy (Bandura, 1986) and is related to the perceived ability and the external source constraints. All the components in this model are in turn influenced by specific cognitive beliefs about the behavior.



[Fig. 1: The Decomposed Theory of Planned Behavior (Taylor and Todd (1995)]

3. The Decomposed Theory of Planned Behavior and sustainable consumer behavior

Taylor and Todd (1995) constructed a framework (DTPB) that is embedded in conscious behavior. Consumers are considered as thinking about the consequences of the specific intended behavior. For learning new behavior (more environmentally friendly behavior) in this point of view, information about the consequences of that behavior is crucial. This information can be emotional, cognitive or action based. The information can be given by significant others, by the object that is dealt with or by the self (experience, self evaluation). Human beings maximize opportunities and learn by acquiring knowledge. According to Ehrenfeld (2008) consumers are a bundle of concerns. Our mind is seen as a big database we access for action. We learn by doing, by **acting** in the world. Understanding in this view is more important than acquiring knowledge. He assumes that we should be driven by '**caring**', which is also fundamentally human, instead of being driven by needs. Needs are a bases for unconscious, conditioned behavior. This caring concept was explored earlier by philosophers as Heidegger. Caring is a concernful action in all domains: caring for oneself, caring for others and caring for the word. Ehrenfeld sees these drivers as a key towards more sustainability. Caring can be learned by breaking through the unconsciousness of our daily use of products. Unconsciousness is installed by repetition of a behavior that after a while becomes a habit. **Habits** can sometimes take the form of addictive patterns.

'Unsustainability' is an unintended consequence of the addictive patterns of modern life. Breaking through the unconsciousness is a similar idea of what Lewin (1951) described as 'unfreezing' habits.

An explorative test was set up to find out whether or not there are some anchorpoints between these new ideas about sustainable behavior and the DTPB. This research was conducted by means of an electric car, which can be considered as a sustainable product development.

4. The electric car as an example of sustainable product development

Personal mobility is part of a more comprehensive transport issue. The transport evolution is in strong contradiction with striving towards a sustainable society. Smith et al. (2008) claim that the need to change over to a sustainable transport system is a matter of urgency: 'Rising transport demand is likely to be the biggest hurdle to reducing our greenhouse gas emission.' Furthermore, the biggest part of the energy used in transport comes from burning petrol products. The situation is similar in all developed economies and transport demand in developing counties is growing by 10% or more every year. Transport share of petroleum product consumption has risen from 32% in 1980 to 70% in 2004 (Department of business enterprise and regulatory reform, 2008). One of the options to counter these trends in transport is the partial or complete shift to electric vehicles. Expectations concerning the transition from a fuel-based automobile model to electric mobility are currently high among policy-makers, scientists and the private sector. The automotive sector is making serious efforts to introduce electric cars as large car companies (Toyota, Renault, Nissan, BMW, Mitsubishi, Subaru and General Motors) plan to launch electric cars (especially plug-in hybrids) in the near future. Brands less known to the general public, such as: Tesla (2003) and Reva (1994), DIVA (2009), developed fully electric car alternatives that are already for sale.

Apart from infrastructural issues (charging points) and battery issues (weight, safety, mileage), consumer issues (perceptions, acceptance) need to be addressed. Traditionally, the advantages of electric cars are perceived to be

predominantly socially related and the disadvantages more individually related. In the long run it may be better for the society as a whole, but it takes a lot of effort from the individual to choose for this alternative because of the inconveniences, especially in the introduction phase of this new product (e.g. Van Lange et al. 1998, Joireman et al., 2001). Therefore, it can be expected that policy measures will be used to make the use of electric vehicles more attractive, such as subsidies, lower taxes, lower kilometer charges for electric vehicles, and higher taxes, higher kilometer charges for regular cars, and fees for entering city centers with regular cars (Schuitema and Steg, 2008, Verhoef, et al. 2008).

From the literature, we know that technological innovations, in particular those needing major infrastructure changes, tend to fail because of lack of acceptance, unless the benefits to the consumer outweigh the costs (e.g. Feitelson and Salomon, 2000). What will make or break the successful introduction of electric mobility in the real world is consumer acceptance (Verhoef et al. 2008). Therefore insights in the impact of motivations and barriers of this acceptance are important knowledge for a successful introduction of the electric car.

5. Applying the Decomposed Theory of Planned Behavior to the domain of electric cars.

A first explorative qualitative research was held taking into consideration both the components as proposed earlier in the Decomposed Theory of Planned Behavior and the recent ideas about sustainability.

Method

Three group discussions were held at the Amsterdam Motorshow 2009 (RAI). First the respondents discussed personal mobility and their current knowledge and expectations of the electric car. Then they were confronted with some prototypes of an electric car. They could look at it, saw a movie about a man driving the car to go to work, and they could, one by one, take place in a prototype car which simulated driving in and around the city of Amsterdam. A team of designers was at their disposal to answer their questions. Afterwards the respondents went to see various cars that are positioned as environmentally friendly: a hybrid (Toyota Prius), an electric Distribution Van (DIVA) and an innovative car concept made of intelligent textiles. During all these exposures, the respondents were observed from nearby. Afterwards the group went back to the discussion room and evaluated their experiences and their expectations. The output of this group sessions is illustrative for a reflection on the proposed frameworks. Does the DTPB (see Fig. 1.) capture all the relevant acceptance and adoption components so that we can elaborate upon it and use it in further research? Is the electric car appealing for consumers to reconsider their consumer patterns on car driving behavior?

Results

1.Attitude

1.a. Complexity

We first considered the attitude component in the proposed framework. In the discussion before exposure to the electric car, there were no important worries about the car being too *complex* (PEOU) to use. Nevertheless the respondents discussed this component spontaneously so that it is considered relevant for further investigation.

1.b. Relative advantage

The *relative advantage* (PU) is discussed profoundly. Topics here are: the contribution of the car to the environment, the contribution of the car to reaching certain political goals on lowering emissions, the expected lower energy price per kilometer for the purpose of own savings, the silence of the car as useful to lower personal stress and to have better conversations with passengers, and better quality of music, the opportunity to customize the car (everyone his own noise, every car its own interior, flexible car volume), the opportunity to

fulfill additional needs (e.g. time waste reduction by offering internet facilities while cueing) were also among the perceived usefulness of the electric car. Charging the car at home was perceived as a relative advantage under the condition that it should not be the only charging possibility. The silence has an impact on the safety for vulnerable road users as there are pedestrians and cyclists, which was perceived as a disadvantage.

1.c. Compatibility

Compatibility is also a relevant component. Owning and driving a car – nowadays possibly more than before - seem to be related to particular values and norms: 'Is it still responsible that we sit alone in our car?' 'Are we irresponsible because we are driving a big car' 'We should drive a clean car'. A car is also appealing to values of 'freedom' and 'individuality'. 'I don't like to adapt myself to schedules', ''I don't like to sit among people I don't know', 'I have the feeling that public transport is not hygienic, I feel a bit dirty after using it'. Respondents also recognized the symbolic function of their branded cars as an expression of values in line with their self-image (sporty, assertive, adventure, harmony).

The compatibility with current cars with a combustion engine is referred to as good (previous experience). Everyone sees that the proposed vehicle is a car. 'It has four wheels and a steering wheel.' The car is in line with the driving system we are familiar with. The current needs of car driving and mobility in general seem to be relevant to take into account in further research. For instance, public transport doesn't seem to be able to fulfill the need of a 'time waste reduction'. The current mobility system is stressful. 'I want to go wherever I want whenever I want, my car is my freedom,' 'I want to spent traveling time in a pleasant way.' 'I need my car to go to the supermarket as well as to go to Spain with my caravan.' One of the first questions asked to the salesman of the Toyota Prius is: 'Is this car equipped with a towbar?' They worried about the compatibility of the charging system with the current system. 'Can the car be charged in a kind of petrol station?' Other worries referred to the 'pleasure' aspect. 'How fast can we drive with the electric car?'

2. Subjective norm

Another important component proposed in the DTPB is the subjective norm. In this context we may see 'relevant others' as two important groups: the group that one knows from nearby and the group referred to as media. Everything they read about the electric car, every documentary they saw, every politician that talked about it, was referred to in the discussion. When confronted with the car, peers were referred to as well: 'I don't see myself driving in my neighborhood in that toy car.' 'Instead of a status symbol the car will tell others that you are smart and socially responsible'. Because electric cars are not yet seen in the streetscape, the tendency to copy others on that matter is not yet part of the discussion. This should be made clear by further research in later adoption phases.

3. Perceived behavioral control

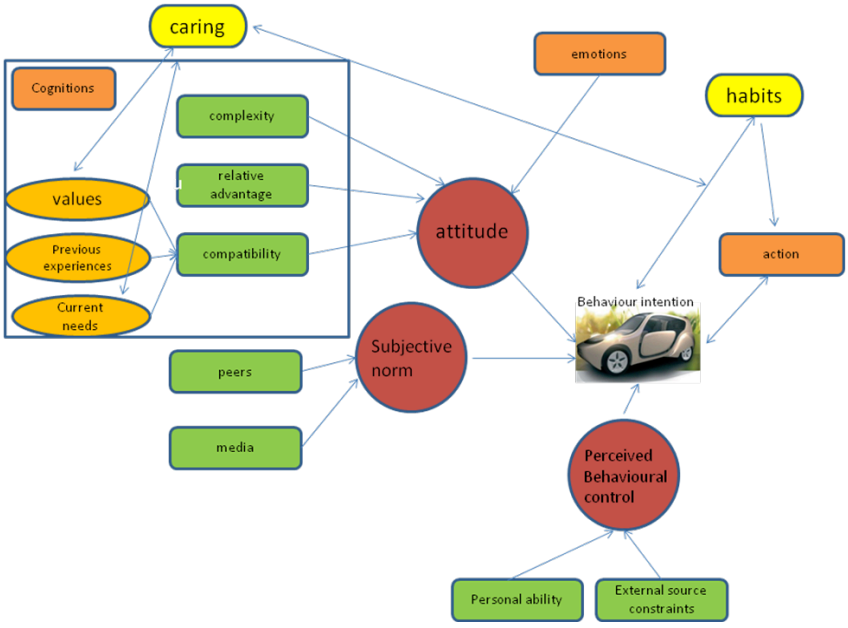
The third DTPB component, perceived behavioral control, decomposed in perceived ability and external source constraints was discussed most profoundly. The awareness of the incomplete infrastructure is a big drawback. 'There are not enough opportunities to charge batteries.' 'The charging of batteries will take so much effort and time.' 'The system will be too expensive.' 'Switching my batteries would be as switching my petrol container, It's a part of my car!' 'Will it be cheaper or more expensive after all? 'Not everyone has access to his own place for charging batteries;' 'Is it safe, when you crash and the car catches fire?' Anticipated policy measures were discussed as well. 'In the beginning the policies will support us, but afterwards they will charge us for using our home made energy.' The charging itself is perceived as very easy to do: 'just plug and play!' Before the try-out,

they all perceived their own skills of driving the car as very competitive. After the simulation test, their self confidence was much lower on this matter.

4. Proposed extensions

As mentioned earlier, the Decomposed Theory of Planned Behavior is mainly a framework of consumer behavior under relatively high involvement. But car driving is also a habit. Some important actions are taken under low involvement. By driving a car with a combustion engine, we rely a lot on the noise it makes, the feedback from the steering wheel when turning it around, all our body is responding to a lot of movements we automatically make and it automatically corrects itself when doing something inappropriate. The experience with the electric car (simulation) revealed that except for all the cognitive components of the framework, it should be extended with reflections on those consumer **habits**. Respondents felt dizzy, they crashed all the time while driving the streets of Amsterdam, they did not notice their driving speed, they felt uncertain about turning into a street. Other observations that don't fit appropriately in the DTPB framework are the **emotional reactions**. The first confrontation with the car's personality evoked emotional reactions. Once the first emotional reaction was positive or negative, later formulated attitudes were likely to be in line with these reactions, especially when the respondents had expressed their emotions. 'What a small thing it is!" 'Waw, so hip!' 'It's an I pod car!' 'Bah!' The role of emotions should be investigated in this acceptance research. Hereby we can take into account the direct emotional reaction, but also the anticipated emotions in the future (what emotions shall this car give me when I'm driving it?) (Bagozzi, R., et al. 1998).

These extensions are shown in Fig.2.



[Fig. 2: The Decomposed Theory of Planned Behavior and its extensions]

6. Conclusions and suggestions for further research

The preliminary study checks the suitability of the Decomposed Theory of Planned Behavior in the domain of the adoption of an electric car as an example of a sustainable product. The study shows that the new ideas on sustainability lead to additional anchorpoints to this framework by introducing the components: 'caring', and 'habits'. A habit is a strong mental link between a behavioral goal and a specific situation (Verplanken and Aarts,1999). Therefore, it is assumed that because of this strong mental link, habits are automatically activated by situational cues. This link goes beyond the driving behavior, it also influences travel mode choice by reducing information seeking, by interacting directly with the behavior intention or by interacting with the subjective norm (Klöckner and Matthies, 2004, Verplanken, et al. 1997, Staats, et al. 2004, Verplanken et al., 1998). This habit formation should be dealt with by adapting the design process, according to Ehrenfeld (2008) and Manzini (2009). The key to the habit interruption should be found in their caring concept.

The preliminary study demonstrates that emotions should be taken into account as well. In addition values came to the fore as a driver for behavior in the study. This is in line with many studies, such as those by Stern and his colleagues (1992, 2000). In his Value Belief Norm theory (VBN), Stern integrated the notion of value orientation with Schwartz's Norm Activation Theory (Schwartz, 1977). Value orientation refers to clusters of prioritized values. Stern and his associates, refer to three clusters of values: egoistic value orientation, social-altruistic value orientation and biospheric value orientation. This three value orientations are quite similar to the **caring** concept of Ehrenfeld: caring for oneself, caring for others, caring for the world.

The comprehensive framework as shown in Figure 2 outlines relevant motivations in the context of sustainable product adoption. It can be implemented in developing sustainable policies as well as in the design of sustainable product features and product-consumption systems. Moreover it can evoke challenges to design product features and consumption systems that awake the evaluation of the behavior consequences, taking into account 'caring' for the self, the social context and the world, this as to contribute to more sustainable well-being.

The explorative research on the adoption of the electric car, rises a lot of research questions (RQ) and proposals for further research. Two of them are outlined below.

RQ 1.What are the **triggers and the barriers** for adopting sustainable products and how do they differ along the different stages of the adoption process? Consistent with a lot of research that has been done in the case of 'alternative water sources', it will be useful to identify strong accepters in an early stage and describe them by means of socio-demographic characteristics as well as by lifestyle characteristics (Dolnicar,and Schäfer, 2009). It is important to identify the early adopters (Rogers, 1995) -those who are the first to claim having an intention to buy and drive the electric car- also by their motivational components. The exploration of the Decomposed Theory of Planned Behavior reveals that these motivational components should be extended with 'emotional' 'habitual' and 'caring' – components, and can so be a suitable framework for the conception of a more quantitative research. A big contribution will be to investigate how the decision making process of consumers to adopt the electric car evolves over time, and to describe the different adopter groups in terms of socio demographic, lifestyle and values. For this matter a quantitative longitudinal research method seems appropriate.

Adopting the electric car, is about adopting an incomplete system. A lot of questions can be raised about the **external source constraints**. For some situations the car seems more appropriate than for others. On this matter

a ‘diary research’ could be held among a representative panel of car drivers. On daily base, they should take notion of all the car use moments during two times 10 days (once during the summer time, once during winter time). After this objective description, an evaluation can be made of their intention to use an electric car for the same purpose. An evaluation of the **habitual** character of the using moments can be asked for as well. This can highlight some cues for designing awakening product features in this context.

RQ 2. What product features can ‘awake us’ to be more conscious about our behavior in sense of sustainability.

Relevant product features to a standard concept of the electric car could be presented to different groups of respondents. This experimental design could reveal which product features are triggering the different motivational components of the proposed frameworks. Special attention should be given to features that have an awakening effect (Ehrenfeld, 2008), and that makes us more conscious about us driving the car.

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