



Innovative alternatives take action – Investigating determinants of alternative fuel vehicle adoption



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ABSTRACT

Alternative fuel vehicles (AFVs) as environmentally friendly alternatives to conventional internal combustion engines have gained increasing attention in general public. While empirical studies have begun to explore product-specific factors that drive consumer adoption of AFVs, an integrative framework of a comprehensive set of AFV adoption factors and its theoretical foundation as well as empirical validation is still missing. By drawing on theory of innovation adoption and theory of reasoned action we show that consumers' perceptions of AFV attributes lead to a general attitude formation towards AFV. In conjunction with consumers' subjective and personal norm, this in turn determines AFV adoption behavior. Concerning AFV attributes, compatibility, design, and relative advantage of AFVs exhibit the strongest influence on consumers' attitude formation toward AFV. We derive implications for future research and policy makers. The latter include suggestions on how to develop and communicate AFV in order to stimulate AFV adoption.

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1. Introduction

Environmentally friendly innovations such as alternative fuel vehicles (AFVs) hold the potential to solve a number of environmental challenges that relate to emissions caused by transportation (Graham-Rowe et al., 2012; van Bree et al., 2010; Campbell et al., 2012). More and more consumers pay attention to AFVs as environmentally friendly alternatives to the conventional internal combustion engines (ICEs) (Eggers and Eggers, 2010; Lane and Potter, 2007; Mills, 2008; van Bree et al., 2010). Moreover, AFV sales are predicted to further increase in the future (IEA, 2011). Hence, automobile manufacturers are forced to develop new technologies and produce automobiles with increased fuel economy and lower exhaust emissions to define a future market for AFVs, stay competitive, and gain consumers' attention (Axsen et al., 2010; Hodson and Newman, 2010; James, 2009; Hackney and De Neufville, 2001; Karplus et al., 2010). Different types of AFVs (e.g. electric, hybrid) have emerged over the past decades and the automotive industry has already spent an increased amount of resources on the development of AFVs (Dagsvik et al., 2002; Ewing and Sarigöllü, 2000; James, 2009; Struben and Sterman, 2008). Nevertheless, AFV adoption and diffusion is still in its infancy (Lane and Potter, 2007; Wiedmann et al., 2011; Yeh, 2007). To better adjust AFVs to fit various consumer preferences and to stimulate AFV adoption and diffusion, companies need precise knowledge about what constitutes consumers' AFV evaluation and subsequent adoption decision (Mills, 2008; Yeh, 2007; Kurani et al., 1996; Zhang et al., 2011). While empirical studies have begun to explore factors that drive

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consumer adoption of environmentally friendly products (Menon et al., 1999; Oliver and Rosen, 2010; (Calfee, 1985), an integrative framework of AFV adoption factors, its theoretical foundation, and empirical validation is still missing.

First of all, theoretical work on the adoption of AFVs is scarce. Even though, theoretical aspects have commonly been discussed in the field of sustainable consumption (Jackson, 2005) or environmentally driven individual behavior (Stern, 2000; Jansson et al., 2011; Huijts et al., 2012; Jansson, 2011), a theory based integrative adoption model for AFVs is still missing. With respect to empirical research, the majority of studies focus on examining a narrow assortment of product-related characteristics of AFVs (Mills, 2008), but fail to integrate a comprehensive set in one integrative model to determine the relative importance of each product-related characteristic for AFV adoption (Golob, 2001; Jansson, 2011). Moreover, previous studies primarily focus on product-related characteristics of AFVs (Brownstone et al., 2000; Bunch et al., 1993; Byrne and Polonsky, 2001; Dagsvik et al., 2002; Hidrue et al., 2011; Karplus et al., 2010; Mau et al., 2008; Meyer and Winebrake, 2009; Potoglou and Kanaroglou, 2007; Sims Gallagher and Muehlegger, 2010), often overlooking psychological and behavior-related aspects that play a substantial role within the adoption of environmentally friendly innovations (Axsen and Kurani, 2011; Eggers and Eggers, 2010; Jansson, 2011; Oliver and Rosen, 2010; Axsen and Kurani, 2010; Kurani et al., 2007). While studies in the context of AFVs exist that focus on socio-demographic aspects of the consumer (e.g. income level, age, gender) (e.g. Hidrue et al., 2011; Potoglou and Kanaroglou, 2007; Campbell et al., 2012; Ziegler, 2012) or stress consumers' environmental awareness or attitudes (e.g. Ewing and Sarigöllü, 2000; Lane and Potter, 2007; Mills, 2008; Oliver and Rosen, 2010; Xenias and Whitmarsh, 2012; Thesen and Langhelle, 2008; Ziegler, 2012), attempts to combine a broad set product-related characteristics with psychological and behavior-related aspects in one integrated model are scarce (Jansson, 2011; Schuitema et al., 2012).

Hence, there is still a lack of both a theoretical conceptualization and an empirical validation of an integrative AFV adoption model. Consequently, we address these shortcomings and seek to enhance the current knowledge of AFV adoption behavior. First, we conceptualize and design a theory-based adoption model by integrating and extending both the theory of innovation adoption (TIA) (Rogers, 2003) and the theory of reasoned action (TRA) (Fishbein and Ajzen, 1975). The established adoption model incorporates a broad typology of perceived AFV attributes as well as psychological and behavior-related aspects of the consumer. Subsequently, the integrative AFV adoption model is empirically evaluated within a large-scale consumer study. We thereby determine the relative importance of each AFV attribute for attitude formation towards AFVs (Graham-Rowe et al., 2012; Wang and Chen, 2012). Furthermore, we analyse the relative importance of attitude formation together with norms of the consumer as antecedents to consumers' intention to adopt AFVs. The relationships are simultaneously examined by using variance-based structural equation modelling. Thus, our integrative AFV adoption model offers a more resourceful approach to AFV adoption behavior than has hitherto been presented.

The remainder of this article is organized as follows. The following section focuses on the theoretical background and the introduction of our integrative adoption model. We then derive hypotheses for the relations between the model constructs. After that, we present our measures and data before we discuss our results of the empirically investigation. Finally, we conclude with implications of our study and outline directions for future research.

2. Introducing an integrative AFV adoption model

The development of our integrative adoption model is primary based on two well-established social psychological theories – the theory of innovation adoption (TIA) (Rogers, 2003) and the theory of reasoned action (TRA) (Fishbein and Ajzen, 1975). The TIA has been used to study adoption behavior of a variety of different innovations since the 1960s (Meuter et al., 2005; Venkatesh et al., 2003). Venkatesh et al. (2007) give an overview about major milestones in technology adoption research (Venkatesh et al., 2007), and Hirunyawipada and Paswan (2006) show a review of empirical studies on consumer innovativeness and adoption research (Hirunyawipada and Paswan, 2006). As a further predominant theory in the context of adoption and diffusion, TRA has a rich history (Fishbein and Ajzen, 1975). It is one of the most influential and fundamental theories of human behavior and represents a widely used framework to explain the consumer decision-making process (Venkatesh et al., 2003; Yoh et al., 2003). Research based on both the TIA and TRA has helped to understand green consumer behavior (Bang et al., 2000) and especially the adoption behavior for high-involvement innovations (Mowen and Minor, 2006; Yoh et al., 2003). Since the purchase of an AFV can be considered as one of the most involvement-intensive decisions within green consumer behavior (Jansson, 2011; Lambert-Pandraud et al., 2005), TIA and TRA seem to be tailor-made for the development of an integrative AFV adoption model.

Both TIA and TRA are inherently related. Attitudes represent a central component of the TRA (Fishbein and Ajzen, 1975) as well as of the TIA (Rogers, 2003). Moreover, both theories suggest that before a consumer engages in behaviors, an attitude toward this behavior is formed. Within this respect a central component of the TIA, namely Rogers's (2003) innovation-decision process model, further describes the psychological processes underlying attitude formation within five stages and shows how it is related to subsequent behavior. According to Rogers (2003), the innovation adoption process starts with gaining first knowledge of the innovation. Subsequently, consumers' attitudes are formed based on the perceptions of several characteristics of an innovation (Meuter et al., 2005; Rogers, 2003). According to these perceptions, a consumer develops positive or negative feelings about performing a certain behavior, which leads to a positive or negative attitude formation (Venkatesh et al., 2003; Rogers, 2003). A positive (negative) attitude formation then translates into an adoption (rejection) decision which is finally implemented in congruent adoption (rejection) behavior (Rogers, 2003; Talke and Heidenreich, 2013). Thus, TIA helps to explain how characteristics of innovations affect consumers' attitude formation toward the

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