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Adoption of Alternative Fuel Vehicle Fleets - A Theoretical Framework of Barriers and Enablers

Abstract

This paper synthesises and analyses factors affecting firms' adoption of Alternative Fuel Vehicles (AFVs). Our theoretical framework on Firm Adoption of Sustainable Technologies (FAST) integrates several technology adoption models with the attribute of 'perceived risk'. On the basis of the FAST theoretical framework, we review and analyse 53 studies on the adoption of AFV fleets. We find that the primary enablers for firms to adopt are linked to efficiency, environmental, economic, and strategic gains. The primary barriers to adoption are limited knowledge, organisational policies, as well as operational and economic factors. Overall, the AFV fleet adoption literature suggests that large firms are more likely to become early adopters, which is largely due to their willingness to accept financial risks in exchange for first mover advantages. We suggest further research avenues particularly on policy and emotions and on the linkages between these two factors.

Keywords: Alternative Fuel Vehicles; Commercial Fleets; Theoretical Framework of Technology Adoption; Policy; Emotions; Literature Review.

1. Introduction

The transportation sector is the primary source of air pollution in European cities (European Commission, 2019). When compared to 1990 levels, the transportation sector in Europe remains the only sector where greenhouse gas (GHG) emissions have increased (EEA, 2018). Consequently, alternative fuel vehicles (AFVs) are currently being presented as a solution to reduce the amount of carbon emissions and our reliance on fossil fuels. AFVs are defined as vehicles that run on fuel other than traditional petroleum-based fuels (petrol or diesel), or any technology powering an engine which does not solely involve petroleum. These include hydrogen, electric, solar-powered, ethanol, and biodiesel vehicles (Yeh, 2007). AFVs have several benefits for the environment and public health, when compared to internal combustion engine (ICE) vehicles. To elaborate, ICE vehicles produce hazardous emissions that cause air pollution, such as nitrogen oxides (Krzyżanowski et al., 2005, EEA, 2016). On the other hand, hydrogen vehicles, for example, only emit warm air and water (AFDC, 2020). Likewise, because electric vehicles (EVs) are charged by the electricity grid, they produce zero pipeline emissions (IEA, 2020). Compared to ICE vehicles, EVs are quiet vehicles, causing a reduction in noise pollution (OECD, 2018). However, despite governments' efforts, we still witness a slow growth of AFVs. For example, in 2017, the global share of AFVs was a meagre 4.4% of the total number of vehicles in circulation (Middleton, 2017). This low figure highlights the need for institutional and governmental action to increase the diffusion of AFVs.

Scholars studied the adoption of AFVs from an individual's perspective (Egbue and Long, 2012, Schuitema et al., 2013, Sierzchula et al., 2014). Adoption of AFVs, from a firm perspective, has so far received less attention in the literature[1]. This is surprising, since over half of the vehicles on the road today are part of commercial fleets (Brand et al., 2017). Moreover, scholars such as

[1] A firm perspective refers here to the diverse group of vehicles owned by business, ranging from white vans to taxis, buses and heavy goods vehicles (HGVs). Multiple cars owned by business are known as fleets.

Nesbitt and Sperling (1998), Gnann et al. (2015), Wikström et al. (2014), and Kaplan et al. (2016) agree that commercial fleets make ideal 'early adopters', since businesses tend to drive higher mileage than individuals overall, and tend to buy vehicles in bulk (Sierzchula, 2014). Rogers' theory on the diffusion of innovations explains that adopters of a new technology fall into five categories: innovators, early adopters, early majority, late majority, and laggards (Rogers, 1995, 2003). Specifically, early adopters play a critical role in affecting the decision of potential adopters (Rogers, 2003). In fact, Rogers (2003) argues that early adopters possess the highest degree of opinion leadership, which can help trigger mass adoption. Additionally, Arthur (1989; 116) explains that "complex technologies often display increasing returns to adoption meaning the more the technology is adopted, the more experience is gained and the more they are improved". Therefore, in the context of fleets, if firms were seen to drive and adopt more AFVs, the speed of adoption and diffusion of AFVs is more likely to increase. Thus, in essence, we argue that the first step to widespread adoption of AFVs is the adoption and diffusion of AFV fleets by firms.

To our knowledge, a review of the combination of factors affecting the adoption of commercial AFVs using an integrated framework does not exist. Technology adoption is a highly complex phenomenon that requires a collective understanding of contextual, emotional and cognitive factors that affect adoption (Straub, 2009). As such, Oliveira and Martins (2011) believe that to gain a better understanding of how innovative technologies are adopted, researchers should combine several theoretical models. To address the complexity of technology adoption, we develop the 'Firm Adoption of Sustainable Technologies' (FAST) theoretical framework obtained by connecting insights from different technology adoption models with the attribute of perceived risk. Our objective is to provide a comprehensive theoretical framework that is able to provide an overview of factors affecting the adoption of sustainable technologies from a firm perspective. To the best of our knowledge, no existing technology adoption model has integrated and analysed these theories collectively with the added dimension of perceived risk. We, therefore, contribute to the well-established literature of technology adoption by developing the FAST theoretical framework, which allows us to provide new insights on firm adoption of sustainable technologies.

Our contribution to the literature is three-fold. First, we build a comprehensive theoretical framework that identifies factors affecting Firm Adoption of Sustainable Technologies (FAST). This framework can assist future researchers and practitioners to understand the factors that affect firms when adopting a new sustainable technology. Second, we use FAST to check if elements from the theoretical framework emerge from the AFV fleet adoption literature. FAST enables us to identify and evaluate any existing patterns within the literature. Lastly, we use our theoretical framework to identify gaps and limitations in the existing AFV fleet adoption literature. Through our framework, we advance the AFV fleet literature by highlighting important avenues for future empirical research.

Our review of the AFV fleet adoption literature is able to aid transportation policy makers, since we provide a comprehensive and structured overview of the literature thus far. Policy makers are able to use this information to overcome documented barriers, and place stronger emphasis on the enablers of adoption through policy and educational campaigns.

The remainder of this paper is structured as follows. In section 2, we briefly discuss each of the models and the attribute of perceived risk. We also outline how we develop the FAST theoretical framework by integrating the well-established technology adoption models and the dimension of perceived risk, which allows us to present a comprehensive taxonomy of barriers and enablers to adoption. In section 3, we explain our method to conduct a literature review; we identify and analyse 53 academic studies on AFV fleet adoption. In section 4, we use FAST to check if elements from the theoretical framework emerge from the AFV fleet adoption literature, and we present detailed results on a taxonomy of AFV fleet adoption barriers and enablers. In section 5, we present a discussion on our findings, contributions of our results, suggestions for future research and the strengths and limitations of our paper.

2. Technology Adoption in a Firm Context

The adoption of sustainable technologies in a firm context relates to broader issues of how decisions are made in a firm. The theory of the firm provides a perspective that underpins our development of FAST and our literature review in which the firm is the unit of analysis. Although different approaches exist within the theory of the firm, they share the idea that the firm "constitutes a specific entity in its own right" (Weinstein, 2007; 29). Firms are not simply the sum of components readily available on the market but rather a unique mix of individuals and assets (Zingales, 2000). The theory of the firm analyses relations between the firm or owners of the firm, its managers and employees, and argues that coordination among individuals within the firm takes place through hierarchy, the exercise of the power of authority, employment and relational contracts (Coase, 1937, Simon, 1951, Weinstein, 2007). Cyert and March's (1963) behavioural theory of the firm places emphasis on the decision-making process that occurs within a firm in relation to resource allocation, price, and output. This theory recognises the firm as a coalition of individuals or groups of individuals, such as owners, managers, and employees, that all have an influence on a firm's decision-making process. Taking the firm as the unit of analysis, and recognising that managers and employees make decisions as a member of a firm, we develop the FAST theoretical framework by relying on adoption models that allow for a firm perspective.

2.1. From a Taxonomy to a Theoretical Framework

A critical review of the technology adoption literature revealed that the prevalent technology adoption models do not fully capture all the important factors such as cognitive, emotional, and contextual factors, which collectively influence technology adoption (Straub, 2009). The understanding and evaluation of these factors in a firm context is important, because employees are vital to the adoption and acceptance of technologies (Davis, 1989, 1993, Venkatesh and Davis, 2000, Venkatesh and Bala, 2008, Venkatesh et al., 2003). Additionally, technology adoption models do not simultaneously capture organisational and social factors that influence adoption of technologies in a firm context. By using a combination of attributes from numerous technology adoption models and insights from prior research, we develop a comprehensive taxonomy that classifies adoption barriers and enablers. From this taxonomy our theoretical framework emerges, aiming at improving our understanding of how sustainable technologies are adopted by firms; we refer to the theoretical framework as Firm Adoption of Sustainable Technologies (FAST). We use the following theories to build FAST: the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003), the extended model of UTAUT (Dwivedi et al., 2019), the Technology, Organisation and Environment (TOE) model (Tornatzky and Fleischer, 1990), a theory of organisational emotions towards adoption (Choi et al., 2011), along with the attribute of perceived risk (Ho et al., 2017). One way of developing a taxonomy is "to start with the conceptual approach and then to examine empirical cases to see how they fit with the conceptualization" (Nickerson et al., 2013; 339). We followed this process when developing our taxonomy. We started with a conceptual approach by combining the various technology adoption models and the attribute of perceived risk, and then used empirical data from the articles in our review to see how the data fits with the conceptualization. The taxonomy is a first step in the development of the FAST theoretical framework that explains how the comprehensive overview of factors, such as organisational, environmental, social, cognitive, emotional, and perceived risk factors, affects adoption. Below, we provide a brief discussion on each of these models and the attribute of perceived risk.

2.1.1. Unified Theory of Acceptance and Use of Technology (UTAUT)

UTAUT[2] was developed to explain technology adoption in a firm context, and specifically, to explain employee adoption decisions on behalf of the firm (Venkatesh et al., 2012). UTAUT uses four primary constructs to explain adoption intention and adoption: 1) performance expectancy[3], 2) effort expectancy, 3) social influence and 4) environmental factors[4]. To empirically test the model, Venkatesh et al. (2003) use data from 4 firms over a period of 6 months. They find that UTAUT increases the explanatory power significantly and to a larger extent than any of the 8 models integrated in UTAUT individually. Khechine et al. (2016) also confirm the robustness of UTAUT through a meta-analysis using 74 studies, and find that UTAUT explains behaviour intentions towards technology adoption in numerous contexts. UTAUT has also been used to explain the adoption of a variety of sustainable technologies such as electric bikes (Wolf and Seebauer, 2014) and sustainable household technologies (Ahn et al., 2015). However, it seems that UTAUT is yet to be used to explain firm adoption of AFVs.

The extended UTAUT model (Dwivedi et al., 2019) includes the attribute of ‘attitudes’ and highlights the relationships between 1) environmental factors and intentions to adopt, 2) environmental factors and attitudes, 3) social influence and attitudes, 4) performance expectancy and attitudes, 5) effort expectancy and attitudes, 6) attitudes and intentions to adopt and 7) a direct relationship between attitudes and adoption. Since Dwivedi et al.’s model is an extension of the original UTAUT model it also explains technology adoption at a firm level by understanding employee decisions made by a firm (Venkatesh et al., 2012).

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[2] The following eight theories form UTUAT: The Model of PC Utilisation (Thompson et al., 1991), Theory of reasoned action (Fishbein and Ajzen, 1975), TAM (Davis, 1989), The Motivational Model (Davis et al., 1992), Theory of Planned Behaviour (Ajzen, 1985), Diffusion of Innovation (Rogers, 1995), Social Cognitive Theory (SCT) (Bandura, 1986), Combined model of technology acceptance and planned behaviour (C-TAM-TPB) (Tayor and Todd, 1995).

[3] Table 1 provides all the definitions of the constructs that form FAST. Appendix 1 provides the original definitions from each of the theoretical models.

[4] UTAUT also refers to this factor as facilitating conditions (Venkatesh et al., 2008).

2.1.2 Technology, Organisation and Environment (TOE)

The TOE model explains adoption of new technologies from a firm level (Tornatzky and Fleischer, 1990), and includes three aspects that influence the adoption of a technological innovation: technological context, organisational factors, and environmental factors (Tornatzky and Fleischer, 1990). This model enables the researcher to evaluate the internal and external factors that affects a firm's decisions to adopt a new technology.

2.1.3 Theory of Organisational Emotions

Choi et al. (2011) theory of organisational emotions explains a firm's collective decision to adopt an innovation using four linear stages: contextual factors, cognitive appraisal, emotional reactions, and adoption. Contextual factors include management involvement and training for a specific innovation (Table 1). These factors significantly affect employees' cognitive appraisal of an innovation, which "refers to employees' cognitive evaluation of the innovation based on the assessment of the innovation and implementation situation" (Choi et al., 2011; 109). In turn, cognitive appraisal significantly explains employees' emotional reaction. Employees' collective emotions, positive or negative, significantly affect the adoption of an innovation. To elaborate, if employees hold the same positive emotions towards an innovation as management, it is more likely that they will develop favourable attitudes towards the innovation. Choi et al. (2011)'s study confirms that a firm's collective emotional reactions (positive and negative) are direct predictors of firm adoption of new technologies.

2.1.4 Perceived Risk

Due to external and internal pressures, it is imperative for firms to become sustainable (Lubin and Esty, 2010, Deng and Ji, 2015). However, firms often view the adoption of sustainable technologies as very risky and uncertain. Switching from traditional to sustainable technologies is a complex process since firms tend to be hindered by a number of barriers such as financial and technological risk (Ashford, 1993, Ghisetti et al., 2017). Firms also tend to be hindered in adopting sustainable innovations due to the high degree of uncertainty associated with how the innovation will impact their business processes and employees routines. These add to the complexity of the innovation due to the infancy of the new technology (Ghisetti et al., 2017). Although studies within the sustainable technology adoption literature often refer to the work by Knight (1948) on risk and uncertainty, to distinguish between known and unknown probabilities respectively (Wiedmann et al., 2011), the definition of perceived risk that is most often used in this literature is the one by Bauer (1967). Perceived risk is "a combination of uncertainty plus seriousness of outcome involved" (Bauer, 1967; 15).

Perceived risk refers to the subjective dimension of risk which relates to factors such as financial, social, safety, psychological, and operational risks (Stone and Grønhaug, 1993). Several scholars have underscored the importance of understanding perceived risk in the context of firm adoption of innovations and sustainable innovations (Gao et al., 2012, Corral, 2003). Gao et al. (2012) for example, specifically evaluate risk perceptions of industrial firms when adopting discontinuous innovations finding that perceived risk significantly affects intentions to adopt. In particular, Corral (2003) finds that perceived risk factors affect firm's adoption of cleaner technologies.

2.2 The Development of the Firm Adoption of Sustainable Technologies (FAST) Theoretical Framework

We use UTAUT as the base of our theoretical framework (see the red box in Figure 1) for several reasons. First, UTAUT is a comprehensive framework formed by a combination of eight of the most dominant theories of technology adoption to understand employee acceptance and use of technology in the context of the firm. Second, UTAUT includes performance measures, such as performance and effort expectancy, and output quality, all of which are important for the adoption of EVs (Sovacool, 2017), which is likely to be applicable to our setting.

We also add Dwivedi et al. (2019)'s extended model of UTAUT, since it includes the attribute of 'attitudes', highlights the relationship between environmental factors and intentions to adopt, as well as the direct relationship between attitudes and adoption (see the green box in Figure 1). In addition, the constructs in Dwivedi et al. (2019)'s extended model of UTAUT collectively influence the attribute of attitudes. The extant literature finds that these factors and their relationships influence firm adoption of new technologies (Tornatzky and Fleischer, 1990, Frambach and Schillewaert, 2002, Mun et al., 2006, Unsworth et al., 2012).

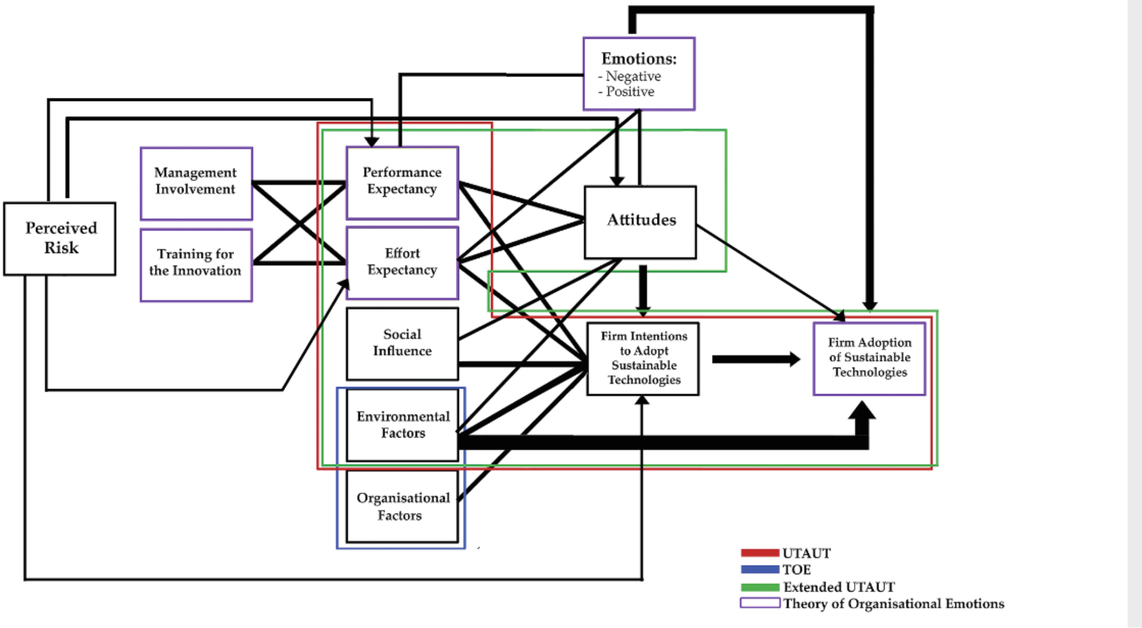
We also draw from the Technology, Organisation and Environment (TOE) model for several reasons (Tornatzky and Fleischer, 1990) (see the blue box in Figure 1). First, although UTAUT was originally developed to understand firm adoption (Venkatesh et al., 2012), it does not explicitly include an organisational context (e.g. firm size, managerial structures, and organisational slack). Second, the TOE model offers details on environmental factors of a firm, such as the role of government regulation (e.g. policy and legislation), industry characteristics and market structure. Additionally, the technological context of the TOE model refers to the technological characteristics of the innovation defined by Rogers (1995) including relative advantage, complexity and trialability. Relative advantage is already integrated into the performance expectancy (PE) construct in UTAUT. It is defined as "the degree to which the innovation is perceived as better than the one it supersedes" (Rogers, 1995; 212). Also, complexity is already integrated in the effort expectancy (EE) construct in UTAUT. Complexity refers to the level of difficulty in understanding and using the innovation (Rogers, 1995). We integrate trialability, which is the degree to which adopters are able to experiment with an innovation (Rogers, 1995) into the environmental factor (EF) construct in our theoretical framework. Demonstration projects have been shown to be important for the adoption of sustainable energy products (Bossink, 2017). Considering the TOE model in our theoretical framework provides a more realistic overview of the environment in which firms operate and the organisational factors that have an influence on firms when adopting a new technology.

Zehetner et al. (2012) find that firm adoption decisions are not always rational nor are they exclusively based on cost-benefit criteria, highlighting the important role that emotions play in a firm's adoption decisions. The theory of organisational emotions recognises that employees' collective emotions significantly affect the adoption of an innovation (Choi et al., 2011). They argue that management involvement and training for the innovation inform the performance expectancy (PE) and effort expectancy (EE) constructs from UTAUT (see the purple boxes in Figure 1). Thus, we believe that Choi et al. (2011) theory of organisational emotions offers important insights into explaining firms' collective emotions towards adopting an innovation.

Empirical research on firm purchasing decisions indicates the importance of evaluating perceived risk (Sweeney et al., 1973, Peters and Venkatesan. 1973, Hawes and Barnhouse, 1987, Greatorex et al., 1992). More specifically, perceived risk - a psychological factor that influences attitudes (Huijts et al., 2012) - is documented to have a significant influence on intentions to adopt a technology in the general technology adoption literature at an organisational level (Ho et al., 2017). However, it seems that perceived risk is yet to be incorporated into a technology adoption model that is able to explain social, cognitive and emotional factors collectively (e.g. perceived risk, attitudes and emotions) at a firm level. Therefore, we argue that perceived risk is a factor that should be considered when understanding the adoption of sustainable technologies by firms. Thus, we complement FAST by adding the attribute of perceived risk. The sustainable technology adoption literature identifies perceived risk as a psychological factor that influences attitudes (Huijts et al., 2012). Additionally, scholars using technology adoption models previously linked perceived risk to performance and effort expectancy constructs (Faqih, 2013, AlSoufi and Ali, 2014). Featherman and Pavlou (2003). Featherman and Pavlou (2003) document that perceived risk has a negative and statistically significant effect on the intentions to adopt. For these reasons, in FAST, perceived risk informs performance expectancy, effort expectancy, attitudes and intentions to adopt.

FAST is here used as a lens to analyse the AFV fleet adoption literature at a firm level. It enables us to provide a novel interpretation of the AFV literature, thereby highlighting existent gaps and research needs. In Figure 1 we present a visualisation of our theoretical framework and illustrate how the different models including 'perceived risk' are integrated. Moreover, in table 1 we define the constructs of the FAST theoretical framework.

Figure 1: Firm Adoption of Sustainable Technologies (FAST) Theoretical Framework



Source: Adapted by the authors based on: Tornatzky and Fleischer (1990), Venkatesh et al. (2003), Dwivedi et al. (2019) & Choi et al. (2011).

Table 1: Definitions of FAST Constructs

Construct	Definition
Perceived Risk (PR)	Firm perception of uncertainty plus the seriousness of outcome involved.
Management Involvement (MI)	The ability of firm managers to convince and explore effective ways to engage employees in using a new sustainable technology.
Training for Innovation (TI)	Information, knowledge, and skills enhancing a firm's understanding and technical readiness for the adoption of a specific sustainable innovation.
Performance Expectancy (PE)	Factors affecting a firm's beliefs that using a new sustainable technology will help attain performance gains.
Effort Expectancy (EE)	Factors hindering a firm's ease of use of a new sustainable technology.
Social Influence (SI)	The degree to which a firm perceives that the social context influences it to use a particular sustainable technology.

Environmental Factors (EF)	Factors external to the firm, such as government regulations and the industry in which a firm conducts its business.
Organisational Factors (OF)	Characteristics and resources of the firm, such as firm size, managerial structure and organisational slack.
Attitude	Managers' and employees' positive or negative feelings about adopting a new sustainable technology.
Emotions	Managers' and employees' collective emotional reactions towards the adoption of a sustainable technology.
Firm Intentions to Adopt Sustainable Technologies	A measure of the strength of a firm's intention to adopt a sustainable technology.
Firm Adoption of Sustainable Technologies	Continuous firm use of an environmentally friendly technology.

Note: Appendix 1 provides all the original definitions that form FAST.

Source: Adapted by the authors based on: Tornatzky and Fleischer (1990), Venkatesh et al. (2003), Choi and Chang, 2009, Dwivedi et al. (2019) & Choi et al. (2011).

3. Method

This paper adopts a snowballing literature review method, which is a "search approach for systematic literature studies" (Wohlin, 2014; 1). This method provides researchers with an adequate search strategy to find relevant, peer-reviewed journal articles within the field of study, thereby enhancing the credibility and validity of reviews (Wohlin, 2014). The process requires the use of backward and forward citations. The former entails searching the reference list (backward snowballing), and the latter entails looking at the citations of each paper (forward snowballing) (Badampudi et al., 2015). Greenhalgh and Peacock (2005) suggest that the advantage of this method lies in its reliability to pinpoint prominent research papers. However, the snowballing literature review method has a key limitation. Jalali and Wohlin (2012; 36) identify "identical authors risk" as a potential threat of the snowballing method. To elaborate, the researcher may find numerous papers from the same authors, since their previous research tends to be highly relevant and cited. Thus, this method could cause bias in over representing particular authors' research. Another potential limitation of this method is that new academic papers or papers only cited in other fields might be neglected using this search approach, and such papers would therefore be excluded from our review. Nonetheless, we rely on several databases to perform searches for relevant research papers. Thereby minimizing the effect of these limitations. Moreover, to ensure the traceability of our results, we use iterative backward and forward snowballing approaches four times until no new studies arose (Badampudi et al., 2015).

We use the databases Science Direct, Wiley, Sage, Springer, Web of Science, and Scopus to establish a tentative start set of papers and to reduce author bias (Wohlin, 2014). When searching for journal articles we did not specify the years, thereby ensuring the inclusion of all relevant publications. Moreover, we use a combination of keywords pertaining to AFV fleets and firm adoption to help facilitate our search including: 'Alternative Fuel Vehicle Fleets', 'Corporate Fleet', 'Electric Commercial Vehicles', 'Electric Commercial Fleets', 'Electric Vehicles', ‘Company Adoption’ ‘Firm Adoption’, ‘Organisation Adoption’, ‘Organisation Acceptance’, ‘Government Adoption’, ‘SME adoption’, ‘Fleet Adoption Behaviour’, and ‘Fleet Adoption Intention’.

To ensure we captured the relevant studies for our review, we applied several inclusion criteria: 1) the articles relate only to the adoption of AFVs within fleets, 2) the articles study firm-level decisions and employees/managers making decisions on behalf of the firm and 3) they are published in peer-reviewed journals, books, and book chapters. We excluded non-academic studies (Wicherts, 2016). Our sample runs from the years 1997 to 2019. We stopped collecting academic papers in December 2019.

The data analysis approach involved the use of content analysis, or “objectively and systematically identifying specified characteristics of messages” (Holsti, 1969; 14). We use this approach to conduct a review of the literature since it “uses a set of procedures to make valid inferences from the text” (Weber, 1990; 9). As part of our content analysis, we employ category selection and material evaluation (Mayring, 2008). During the category selection phase, we utilise FAST to structure the review. During the material evaluation phase, we analyse academic studies based on our FAST theoretical framework to interpret the results. FAST is employed as a lens through which we explain the final set of articles. Appendix 2 provides a summary of the 53 articles used in this review. The studies included in this review are largely based on the US and Europe. Additionally, most studies tend to employ government fleets or demonstration/trial projects as their sample. Also, most studies are based on EVs and AFV passenger vehicles. Moreover, we find that the majority of studies adopt quantitative methods. Figure 2 illustrates the methods used in the AFV fleet adoption literature for each of the factors of FAST. Figure 3 illustrates the frequency of each factor studied. We find that effort expectancy is the most studied construct in the AFV fleet literature, while emotions are the least researched factor.

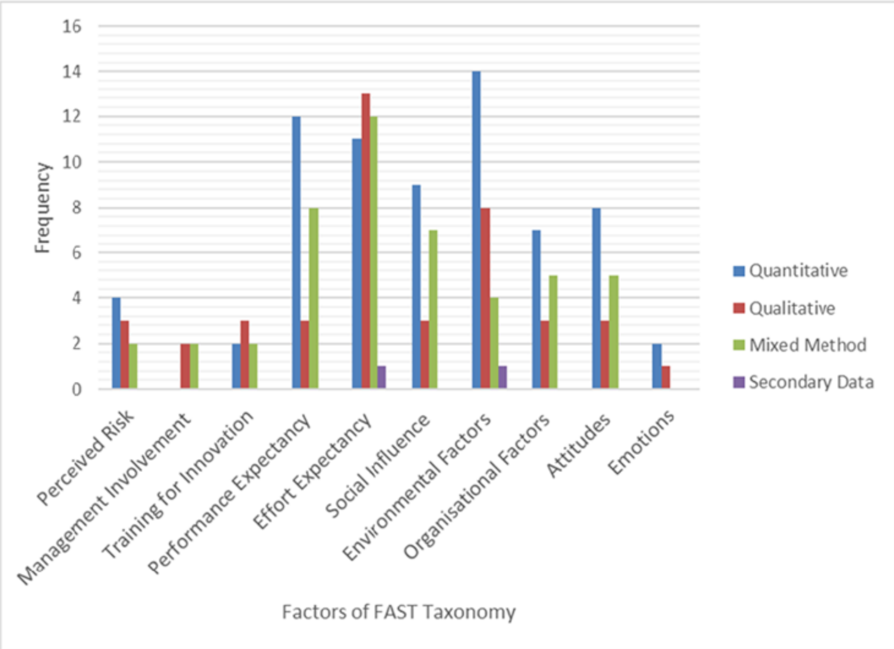


Fig. 2. Factors of FAST: An Overview of Methods (by number of papers).

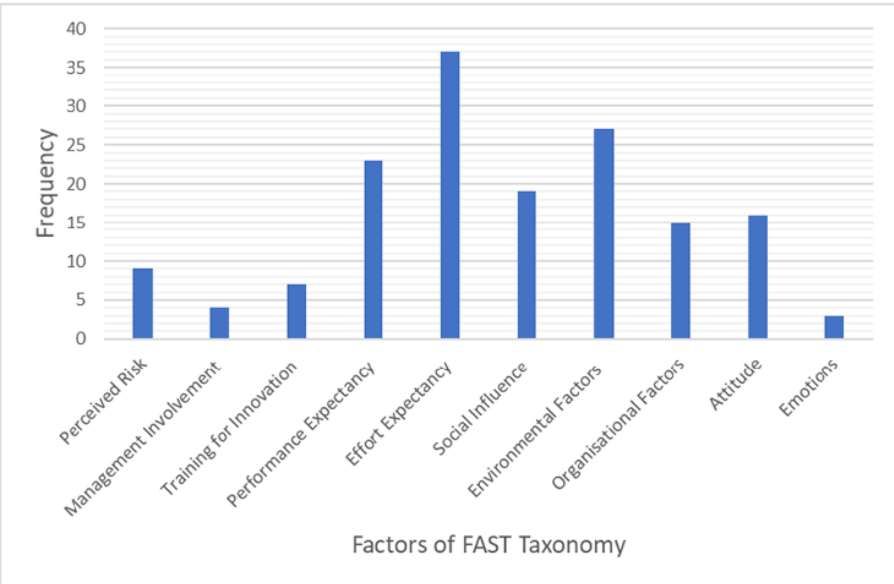


Fig. 3. Frequency of Factors Mentioned in the AFV Fleet Adoption Literature (by number of papers).

4. Findings

In this section we use FAST to check if adoption factors from our theoretical framework emerge from the AFV fleet adoption literature. This allows us to identify the main barriers, enablers, research gaps, limitations within the existing body of research and highlight future avenues of research. In Table 2 we summarise our findings.

4.1. Perceived Risk

Our review uncovers mixed results on how 'perceived risk' affects a firm's intention to adopt AFVs. Evidence suggests that three forms of perceived risk hinder a firm's intentions to adopt: technological risk, operational risk, and financial risk.

Technological risk refers to the risk associated with current technical barriers such as range and charge time compared to an internal combustion engine (ICE) (Wikström et al., 2014, Lebeau et al., 2016, Mohamed et al., 2018, Valdez et al., 2019). Canadian bus companies, for example, have been slow in purchasing e-buses because of high levels of perceived risk in being the first to adopt and experience the new technology (Mohamed et al., 2018).

Operational risk, also known as performance risk, refers to factors that hinder the operation of the vehicles e.g. lack of charging infrastructure. Fleet managers who believe that purchasing low emission vehicles would carry high levels of operational risk are less likely to adopt (Bennett, 2015, Denstadli and Julsrud, 2019). Denstadli and Julsrud (2019) state that one way to overcome operational risk is to ensure easy access to charge points for e-vans.

Financial risk refers mainly to the substantial start-up capital of switching to an AFV fleet. One study finds that German trucking companies perceive paying in cash for the vehicles as a high risk, in terms of liquidity and liability. To lower the financial risk, regardless of firm size, firms choose to lease or finance their vehicles (Seitz et al., 2015). Zhao and Malenia (2006) advocate that large organisations are in a better position than small firms to take on such financial risk.

Some studies, however, find perceived risk to not be significant. For instance, Wolff and Madlener (2019) find perceived risk to be statistically insignificant for commercial drivers' acceptance of EVs. Denstadli and Julsrud (2019) also find that perceived risk does not have a significant effect on the adoption of e-vans by SMEs. To address the issue of perceived risk, Bennett (2015) argues that policies are required to focus on providing information campaigns designed to lower perception of risks.

4.2. Management Involvement

In the AFV fleet adoption literature, most studies highlight the importance of top and middle management, such as fleet managers, in the procurement process of AFV fleets (Boutueil, 2016, Wikström et al., 2016b, Skippon and Chappell, 2019, Hagman and Langbroek, 2019). However, evidence seems to suggest limited ways in which managers encourage employees in using the innovation. We find two studies where management involvement is shown to enable firms' adoption of AFVs (Boutueil, 2016, Wikström et al., 2016b). Boutueil (2016) studies degrees of management involvement with reference to 22 decision-makers in large firms. The author argues that management involvement through efforts such as deploying tracking technologies influences firm adoption. Firms deployed tracking technologies for many reasons. First, firms were able to gain valuable information about the drivers' accelerometer data. This enabled fleet managers to decrease operating costs by reducing vehicle downtime through better planning of vehicle maintenance and reduction on fuel expenses. Second, through better planning, fleet managers were able to reduce overall emissions of the firm. Fleet managers believe that information gained through tracking technologies reduce the complexity of fleet decision making, which would ultimately foster firm adoption of AFVs. Wikström et al. (2016b) find that Swedish fleet managers use two deployment strategies to encourage employees to use EVs. One strategy consists of purposively allocating EVs to specific employees in an effort to increase usage and overall satisfaction rates. The other involves the use of EVs as pool vehicles and appeal to new users who find the technology valuable. This, in turn, enhances accessibility and visibility of the vehicles. However, Wikström et al. (2016b) highlight that the latter strategy is shown to be less successful than the former (Wikström et al. 2014, Wikström et al. 2015). Wikström et al. (2016b) also find two ways in which EVs are promoted within a workplace. First, fleet managers can implement an internal vehicle policy promoting use of EVs. Second, managers may rearrange parking for EV users, to ensure users have easy access to parking. The success of these strategies assists in the collective adoption of EVs within public fleets.

4.3. Training for Innovation

Several transportation scholars investigated the effect of formal employee training on AFV adoption by firms (Mattson, 2012, Bennett, 2015, Saukkonen et al., 2017). Overall, evidence suggests a positive relationship between training for innovation and adoption of AFVs by firms. The idea is that training builds employees' knowledge of AFVs and tackles any pre-existing beliefs that they may have. John et al. (2009) find that public fleets are more likely to adopt AFVs if training was provided to their employees. Jacob et al. (2009) and John et al. (2009) both base their studies on public fleets and also find that due to the limited formal training available to employees on AFVs, employees learn about AFVs through informal channels, by communicating with other employees within the firm. Jacob et al. (2009) find that informal training reduces uncertainty surrounding AFVs, thereby improving the prospects of firm adoption. Similarly, Blynn and Attanucci (2019) find learning from peers influenced firms' decisions to adopt EV buses. Li et al. (2018) believe that involvement with utility firms and bus infrastructure firms would provide training, knowledge and experience to bus transit agencies which would ultimately influence firm adoption intentions. Bennett (2015) confirms the presence of this factor finding that educating firms on AFVs boosts adoption. Mattson (2012) argues that large firms are better equipped to provide training to employees, due to the resources available, therefore making them more likely to adopt AFVs.

4.4. Performance Expectancy

4.4.1 User Perspective: Efficiency Gains

The performance expectancy construct assesses an individual's beliefs on how AFVs "will help them to attain gains in job performance" (Venkatesh et al., 2003; 447). By doing so, this construct assesses the relative advantages of an innovation (Venkatesh et al., 2003). The AFV literature highlights that using AFVs within organisations tends to help employees attain perceived 'productivity/efficiency gains' which ultimately influence adoption (Seitz et al., 2015, Wolff and Madlener, 2019, Denstadli and Julsrud, 2019). Based on a German postal firm, Wolff and Madlener (2019; 268) find that employees perceive EVs as enablers "to get more work done in less time", thereby experiencing "efficiency gains" (p. 276). Users perceive EVs as easier to use than internal combustion engine (ICE) vehicles, due to their better acceleration and/or less vehicle noise. Wolff and Madlener (2019; 275) define efficiency gains as the perceived "smoothness of work and perceived work technology advancement". Denstadli and Julsrud (2019) explore the motives for SMEs in Norway to adopt electric vans and find that perceived gains[5] significantly affect adoption intentions.

4.4.2. Firm Perspective: Environmental, Economic and Strategic Gains

The performance expectancy literature focuses primarily on the relative advantages that AFVs provide to the firm. We classify the gains with the largest influence on firm adoption of AFVs as environmental, economic and/or strategic.

[5]Denstadli and Julsrud, (2019; 7) define perceived gains as the "relative advantage of e-vans over (internal combustion engine) ICE vans, with respect to economy and shorter run times."

AFVs provide environmental benefits such as lower emissions, lower environmental impact, and reduced noise (Nesbitt and Davies, 2013, Sierzchula, 2014, Wikström et al., 2014, Wang and Thoben, 2016, Globisch et al., 2018a, Wolff and Madlener, 2019, Anderson, 2019). Golob et al. (1997) find these benefits to be particularly appealing to public and schools' fleets, as environmental factors tend to be heavily gauged in adoption decisions compared to private organisations. On the other hand, perceived cost savings (Seitz et al., 2015, Barfod et al., 2016, Blynn and Attanucci. 2019, Denstadli and Julsrud, 2019), such as lower energy costs per kilometre (Mattson, 2012, Galván et al., 2016, Zhang et al., 2019) and lower operating costs (e.g. maintenance and fuel) (Parker et al., 1997, Nesbitt and Davies, 2013, Barisa et al., 2016, Wang and Thoben, 2016, Boutueil, 2016, Hagman and Langbroek, 2019, Skippon and Chappel, 2019) are examples of economic gains of AFV adoption. These, on the other hand, are particularly appealing to private firms. Interestingly, Haller et al. (1997) find that halfway through a conversion plan government fleets find it difficult to attain cost savings and emission reduction.

Although firms adopt AFVs for operational and economic gains, they also adopt AFVs for strategic reasons to obtain a competitive advantage over other firms. For example, the environmentally friendliness of AFVs may be used as a marketing tool (Sierzchula, 2014, Lebeau et al., 2016, Saukkonen et al., 2017). Several studies highlight that top management adopts AFVs to meet the firm's strategic goals, including its corporate social responsibility (CSR) goals (Nesbitt and Sperling, 2001, Nesbitt and Davies, 2013, Seitz et al., 2015, Zhang et al., 2019, Skippon and Chappell, 2019). In addition, Globisch et al. (2018a; 126) show that firms adopt EVs to attain "experience gains to acquire first mover advantages". However, the influence of a firm's strategy on adoption, either in terms of CSR or commercial goals, has not yet been thoroughly investigated within the fleet literature. The factors highlighted above confirm the notion put forth by Sierzchula (2014) that firms tend to adopt for firm-specific reasons, such as pursuing first-mover advantages and a compelling business model.

4.5. Effort Expectancy

The effort expectancy construct explains the barriers that hinder the perceived ease of use of an innovation and therefore the adoption process (Venkatesh et al., 2003). Although AFVs such as EVs have been around since the early 1900s (Kanger and Schot, 2016), it is only over the past two decades that the willingness to advance AFV technology and make them a practical replacement for ICE vehicles has started (Tuttle, 2001). Consequently, we find that AFVs still experience a number of complexities that hinder firms' perceived ease of use. We identify four key barriers that hinder firm adoption: operational barriers, economic barriers, limited knowledge, and organisational policies.

In brief, effort expectancy explains the complexities hindering the use of an innovation (Venkatesh et al., 2003). Although all firms tend to experience the barriers highlighted below, it is important to stress that the effect of these barriers depends on firm size: larger firms seem to be better suited to manage or overcome these barriers (Sierzchula, 2014).

4.5.1. Operational Barriers

Driving range is one of the biggest operational barriers hindering adoption (Koetse and Hoen, 2014, Wikström et al., 2015, Christensen et al., 2017, Kuppusamy et al., 2017, Globisch et al., 2018a, Blynn and Attanucci, 2019). Operational conditions, such as the use of heating systems in vehicles and a more (or less) aggressive driving style, affect the driving range of AFVs and can therefore be a barrier to AFV adoption (Wickström et al., 2014, Barfod et al., 2016, Hagman and Langbroek, 2019, Wolff and Madlener, 2019). Hagman and Langbroek (2019) uncover that there is great variability in the assessment of taxi drivers of electric vehicles in low temperatures. One respondent noted that the vehicle required charging three times more per day, while another respondent stated that the effect of low temperatures is "surprisingly small" (p. 456). Mau and

Woisetschläger (2018) find that improvements to EVs range would positively influence intentions to adopt.

Charging infrastructure is also a significant operational barrier hindering firms' adoption (Nesbit and Sperling, 1998, Nesbitt and Davies, 2013, Kirk et al., 2014, Koetse and Hoen, 2014, Xylia and Silveia, 2017, Anderhofstadt and Spinler, 2019, Skippon and Chappell, 2019). Valdez et al. (2019) believe that the current charging infrastructure is inadequate to encourage the diffusion of EV fleets, especially if EVs are considered as an exact replacement for the ICE fleet. Specifically, the authors believe that this is due to the slow pace of technical change and the change in mobility patterns associated with adoption of EVs[6].

Studies documenting infrastructure as a barrier tend to overlook the fact that firms do benefit greatly from on-site centralised refuelling stations within their workplace. Kirk et al. (2014), for example, document that the current charging infrastructure is a barrier, because firms do not benefit from centralised recharging given the cost of such equipment. Studies on firms' benefits from charging in the workplace argue that the recharging infrastructure only needs to be 'modest' to be effective (Golob et al., 1997, Wikström et al., 2014). Kirk et al. (2014) believe that refuelling within the workplace is only suitable for large organisations who can afford such stations. Nonetheless, Barisa et al. (2016) and Skippon and Chappell (2019) find that even in large organisations, employees do regard charging facilities at home as highly important.

Long charging time for AFVs (Van Rijnsoever et al., 2013, Koetse and Hoen, 2014, Barisa et al., 2016, Reis, 2019, Figenbaum et al., 2018, Skippon and Chappell, 2019), lack of standardised charging stations and equipment (Boutueil, 2016, Mohamed et al., 2018), and maintenance issues (Kuppusamy et al., 2017, Zhang et al., 2019, Skippon and Chappell, 2019) are also noteworthy operational barriers to AFV firm adoption.

[6] Changes in mobility patterns are often associated with changes in travel costs, thereby affecting the competitiveness of firms.

Lastly, the lack of available AFV models (Kirk et al., 2014, Barisa et al., 2016, Wang and Thoben, 2016, Saukkonen et al., 2017, Skippon and Chappell, 2019, Denstadli and Julsrud, 2019) and task-appropriate vehicles (Jacob et al., 2009, Nesbitt and Davies, 2013, Kirk et al., 2014, Valdez et al., 2019) lead to doubt surrounding usability of AFVs within fleets, thus hindering their adoption (Denstadli and Julsrud, 2019). Accordingly, Koetse and Hoen (2014) and Zhang et al. (2019) state that if there were more choices in AFV models, firm willingness to adopt would increase.

4.5.2. Economic Barriers

Scholars find that initial high capital investments may hinder firms' adoption (Golob et al., 1997, Van Rijnsoever et al., 2013, Nesbitt and Davies, 2013, Kirk et al., 2014, Kuppusamy et al., 2017, Mau and Woisetschläger, 2018, Globisch et al., 2018a, Reis, 2019). Bus companies perhaps feel the strain of cost the most, as a long recharging time means that more buses are necessary to fulfil the timetables (Miles and Potter, 2014) making the total cost of ownership (TCO) higher for e-buses (Mohamed et al., 2018). Li et al. (2018) suggest leasing EV batteries as one way to assist bus firms overcome the high initial cost.

4.5.3. Limited Knowledge Barrier

Knowledge barriers are frequently mentioned in the literature and comprise firms' limited understanding of environmental issues in general, the impact of ICE vehicles on the environment, attributes of AFVs including their TCO, re-sale value, and fleets' driving patterns (Nesbitt and Davies, 2013, Sierzchula, 2014, Wikström et al., 2015, Barisa et al., 2016, Klauenberg et al., 2016, Wang and Thoben, 2016, Xylia and Silveia, 2017, Saukkonen et al., 2017, Hagman and Langbroek, 2019). These studies highlight the need for more information and for information to be more accessible (Wikström et al., 2016a, Boutueil, 2016, Palm and Backman, 2017, Anderson, 2019). In fact, fleet managers highly value information regarding new technologies, yet they have little information on EVs compared to ICE vehicles. This aspect, eventually, hinders investments in EVs (Valdez et al., 2019). Margaritis et al. (2016) suggest that it is the responsibility of national authorities to provide training schemes for organisations, to increase overall adoption of AFVs.

4.5.4 Organisational Policies Barrier

Organisational policies can also hinder the adoption of AFVs in at least two ways. First, firms have insufficient green policies (Mohamed et al., 2018) and second, their purchasing policies are restricted by options available on the car list[7], thereby hindering the adoption of AFVs (Skippon and Chappell, 2019). Skippon and Chappell (2019) find that firms do not have a car list including plug-in vehicles (PIV) due to the number of barriers that PIVs still experience. These limitations deter managers from adopting AFVs (Nesbitt and Sperling, 1998, Nesbitt and Davies, 2013). Thus, Nesbitt and Davies (2013) believe that the decision-making criteria within organisations require restructuring, especially for those firms that allow employees to choose their own vehicles (Skippon and Chappell, 2019).

4.6. Social Influence

Axsen et al. (2013) find that the perception of pro-environmental technologies, such as EVs, is highly influenced by social interactions with others in the workplace. Numerous studies confirm that subjective norms[8] play a central role in a firm's decision-making process (John et al., 2009, Bennett, 2015, Kaplan et al., 2016, Klauenberg et al., 2016, Globisch et al., 2018a, Wolff and Madlener, 2019). For instance, Globisch et al. (2018b) find that subjective norms of EV users

[7] A car list refers to a list of vehicles available to employees. The vehicles on the car list tend to be selected by a firm's fleet manager (Skippon and Chappell, 2019).
[8] A subjective norm is a "person's perception that most people who are important to him think that he should or should not perform the behaviour in question" (Fishbein and Ajzen, 1975; 302).

significantly and positively affect the perceived organisational usefulness of EVs, which supports EV acquisition. In other words, firms are "strongly influenced by social pressures, particularly the opinions of EV users than by EV attributes" (p.128). In contrast, Wolff and Madlener (2019) find that intrafirm image has no statistically significant effect on the intentions to use AFVs. Intrafirm image is closely related to subjective norms and is defined by the authors as "the status of drivers who (are being allowed to) drive EVs among their colleagues" (Wolff and Madlener, 2019; 277).

Many studies suggest that firms are strongly inclined to adopt AFVs as a means to communicate a "green" image of their brand (Nesbitt and Sperling, 1998, Nesbitt and Davies, 2013, Sierzchula, 2014, Wang and Thoben, 2016, Barisa et al., 2016, Mau and Woisetschläger 2018, Denstadli and Julsrud, 2019, Skippon and Chappell, 2019). In particular, Golob et al. (1997) and Seitz et al. (2015) find that large firms tend to be driven by non-economic aspects, such as image. Firms do not adopt just to portray a 'green' image of the company, but also to improve their image in the eyes of their employees (Boutueil, 2016).

Social signalling also affects firms' intentions to adopt sustainable vehicles (Wikström et al., 2015, Skippon and Chappell, 2019). Skippon and Chappell (2019) find that at a personal level, users choose a vehicle as a status signal driven by symbolic motivation. However, within the commercial sector, it seems that symbolic meanings are under researched, unlike the individual sector where low emission vehicles are viewed as a status symbol of self-identity (Graham-Rowe et al., 2012).

4.7. Environmental Factors

4.7.1. Industry & Vehicle Miles Travelled (VMT)

The literature provides mixed results on identifying industries more likely to adopt AFVs. Some evidence suggests that governmental agencies are most likely to be early adopters of AFV fleets because they are required to set an example against climate change and air pollution (Nesbitt and Sterling, 1998, Van Rijnsoever et al., 2013, Klauenberg et al., 2016, Palm and Backman, 2017) and contribute to national and regional climate goals (Barisa et al., 2016). These add to the fact that governmental agencies tend to manage larger fleets and on-site refuelling (Golob et al., 1997). In contrast, Kaplan et al. (2016) find that governmental agencies are less familiar with EVs and are more likely to be laggards[9]. On the other hand, energy and technology firms are more likely to become early adopters, since they tend to have positive attitudes and norms towards EVs, as they are more familiar with them (Kaplan et al., 2016).

Firms operating in different industries also vary in terms of Vehicle Miles Travelled (VMT). The literature presents mixed results on the effects of VMT on firms' AFV adoption. For example, commercial fleets are more suitable to become early adopters of AFVs due to their high mileage (Nesbitt and Sperling, 2001, Kaplan et al., 2016, Globisch et al., 2018a). In contrast, some studies suggest that firms that tend to have small annual/daily VMT are more likely to become early adopters of AFVs (Golob et al., 1997, Koetse and Hoen, 2014). In an earlier study, Golob et al. (1997; 224) find that firms that operate in the "transportation and communication sectors have the highest VMT, followed by the automotive, business service sector, retail, wholesale trade sector, while schools record the lowest VMT." Hence, they conclude that retail, wholesale, and trade sectors as well as schools are the most likely sectors to adopt AFVs since they have a lower VMT. Similarly, it is believed that construction (Klauenberg et al., 2016, Christensen et al., 2017, Denstadli and Julsrud, 2019) and healthcare companies are the most suitable to adopt EVs, due to their relatively low VMT, and the high number of registered vehicles within this sector.

The literature suggests that a firm's VMT is an indicator of its suitability to become an early adopter of AFVs. However, Wolff and Madlener (2019) find that the average daily distance has no statistically significant association with intentions to adopt. These mixed results support the

[9] Rogers (2003; 22) defines adopter classifications as "members of a social system on the basis of innovativeness." Rogers (1995) defines five categories of innovation adopters over time 1) innovators 2) early adopters 3) early majority 4) late majority 5) laggards.

notion put forward by Nesbitt and Sperling (1998) that analysing a firm's VMT alone is not an adequate indicator in itself to determine if a fleet should adopt AFVs or not. The adoption process is too complex to be judged based on a single variable. Other factors need to be accounted for, such as whether a firm operates on fixed daily routes, whether other vehicles could serve as replacement for occasional high mileage needs, and whether the firm would be willing to make these substitutions (Nesbitt and Sperling, 1998).

4.7.2. Government Regulation

Government regulation includes but is not limited to policy, legislation and monetary and non-monetary incentives. Examples of government incentives for AFVs include low registration fees and subsidies (Barfod et al., 2016), low emission zones, and highway toll exemptions (Anderhofstadt and Spinler, 2019). Despite the widely documented positive and significant correlation between government monetary and non-monetary incentives and adoption, the AFV literature presents conflicting findings with regards to the role of government incentives. Some evidence suggests that incentives are perceived as secondary factors supporting adoption rather than playing a central role in the adoption of AFVs within fleets (Parker et al., 1997, Sierzchula, 2014, Lebeau et al., 2016, Barisa et al., 2016, Figenbaum, 2018, Li et al., 2018, Skippon and Chappell, 2019). Overall, most organisations tend to take advantage of the government economic incentives to help reduce the costs associated with AFVs (Nesbitt and Sterling, 2001, Zhao and Melaina, 2006, Koetse and Hoen, 2014, Barisa et al., 2016, Zhang et al., 2019). The role of these incentives depends on a firm's location/country, size, industry and access to financial resources. Klauenberg et al. (2016) find that some firms purchased AFVs without government incentives, but this finding is dependent on a firm's country and sector[10].

[10] Klauenberg et al. (2016; 211) find that "around 7 out of 10 companies in Austria and nursing services and pharmacies in Germany strongly or somewhat agree that an economically viable use of EVs is possible even without direct governmental purchase subsidies. However, this opinion is less common within the German courier express parcel (CEP) sector.

Skippon and Chappell (2019) note that financial incentives can also hinder the adoption of EVs, particularly “where public contract regulations restrict contractors to acquiring vehicles from framework suppliers who do not supply EVs” (p.82). To overcome this, policy needs to be more flexible (Nesbitt and Sperling, 2001) and different policies are required for the long and short term to support AFV adoption (Zhao and Melina, 2006).

4.7.3. Trialability

Field trials, demonstration and pilot projects are being introduced to explore mobility options and test new technology. Experiencing an AFV acts as a catalyst for firm acceptance (Wikström et al., 2016a, Wolff and Madlener, 2019). Scholars document that demonstration, pilot and testing AFVs have positive effects on firms’ intentions to adopt (Sierzchula, 2014, Palm and Backman, 2017). Evidence suggests that once employees have used AFVs, they tend to form more positive subjective norms, attitudes, and experience which are likely to increase firms’ intentions to adopt (Wikström et al., 2014). This is due to the fact that through trials, demonstration projects, and/or testing the technology, employees and managers build knowledge through experiencing the innovation and therefore tackle any unease, uncertainties, or pre-existing ideas that they may have had about the vehicle (Wikström et al., 2016b, Klauenberg et al., 2016, Mohamed et al., 2018). Direct experience may counteract costs of AFVs which ultimately influences firms’ intentions to adopt. For example, Wikström et al. (2014) find that employees with more EV experience tend to charge the vehicles less and make longer trips than less experienced drivers. In addition, Wikström et al. (2015; 1937) find that lack of experience results in half of the battery being used as a “security blanket” due to range concerns. Again, testing AFVs is found to be highly important to fleet managers, particularly in those firms operating a large number of vehicles, as experiencing the new technology decreases uncertainty in fleet management. In brief, testing a new technology is likely to lead to an increase in firm adoption rates due to learning-by-doing.

4.8. Organisational Factors

4.8.1. Size

Evidence suggests that firms' size can affect decisions to adopt AFVs (Mattson, 2012, Sierzchula, 2014, Seitz et al., 2015, Kaplan et al., 2016). Large firms are more likely to adopt AFVs first, compared to SMEs (Golob et al., 1997, Nesbitt and Sperling, 1998, Seitz et al., 2015). This is due to the fact that large firms are more willing to accept the financial risks associated with nascent technologies, gain rewards from first-mover advantages, operational capabilities, and/or compelling business models (Sierzchula, 2014). Large firms are also more inclined to transform corporate social responsibility (CSR) into applied business practice (Golob et al., 1997, Nesbitt and Sperling, 1998, Nesbitt and Sperling, 2001, Zhang et al., 2019). Additionally, larger firms tend to have better access to information through their fleet managers (Bennett, 2015). Bennett (2015) states that firms with environmental policies are more likely to adopt first and larger firms tend to have organisational policies in place that include environmental attitudes and CSR in their general business framework (Seitz et al., 2015). Similarly, Skippon and Chappell (2019) find that CSR goals or business strategy can influence decisions of large British organisations to adopt low carbon vehicles. However, CSR only influences the decisions made by top-level managers.

Moreover, firms operating large fleets are more likely to adopt AFVs (Golob et al., 1997, Seitz et al., 2015). Fleet managers are able to rotate drivers and vehicle assignments of large fleets to accommodate the limited range issues (Golob et al. 1997). More precisely, Bennett (2015) explains that managers of larger fleets tend to have more opportunities to assign EVs for shorter journeys.

On the other hand, SMEs are least likely to be the first adopters. Sierzchula (2014) finds that small firms are deterred from adopting AFVs due to economic reasons and uncertainty. Lebeau et al. (2016) find that the high initial cost hinders small firms to adopt AFVs, while Klauenberg et al. (2016) and Saukkonen et al. (2017) find that fleet managers' limited knowledge impedes SMEs from adopting AFVs.

4.8.2. Organisational Slack

Organisational slack refers to the degree to which uncommitted resources are available to a firm (Tornatzky and Fleischer, 1990). Overall, evidence suggests that larger firms tend to have access to relatively more financial resources compared to SMEs. In the case of Danish municipalities Anderson (2019) finds that larger municipalities tend to have a higher number of EVs due to their larger budgets. Sierzchula (2014) finds that testing new technologies is the strongest motivator for large US and Dutch firms to adopt AFVs. Firms that initially purchased a low number of EVs for testing purposes subsequently are more likely to expand their fleet after the initial testing phase. Since AFVs are still relatively expensive, the financial risk prevents small firms with limited access to financial resources from adopting AFVs (Lebeau et al., 2016). Therefore, policy support (e.g. through financial incentives, pilot projects or to remove existing barriers) is required to assist firms, and in particular small firms, to test AFV technologies (Sierzchula, 2014, Klauenberg et al., 2016, Lebeau et al., 2016).

4.8.3. Managerial Structures

Managerial structure refers to how information is passed between different levels of the firm to achieve organisational aims. Nesbitt and Sperling (2001), through a mixed methods study of fleet purchasing behaviour, categorise fleets' decision-making processes into four structures, based on the levels of formalisation and centralisation: autocratic, bureaucratic, democratic, and hierarchic decision structures.

Autocratic decision making tends to be enacted in small firms. SMEs usually have one decision maker (typically the owner); they make decisions informally and are highly centralised. Fleet issues are not regarded as highly important and little time is spent addressing them. Firms with autocratic decision structures are unlikely to be first adopters of AFVs (Nesbitt and Sperling, 2001). However, they may rapidly follow the lead of others. Saukkonen et al. (2017) find that entrepreneurs tend to be autocratic and risk-tolerant, and therefore, their decision-making processes are open to change (Nesbitt and Sperling, 2001).

Bureaucratic decision structures are common in institutional and public fleets, such as in non-profit organisations, universities, and local government agencies. Unlike autocratic firms, organisational policies tend to direct decisions regarding fleets. Bureaucratic decisions tend to be formal and decentralised. Decision making involves numerous departments and/or numerous geographical scopes and responsibilities[11]. Although senior managers generally spearhead or champion decisions to convert to AFVs (Nesbitt and Sperling, 2001, Boutueil 2016), the promotion of such policies may come from any level (Nesbitt and Sperling, 1998, 2001, Boutueil, 2016, Skippon and Chappell 2019). Firms with bureaucratic decision structures are unlikely to be early adopters, due to their relatively slow reaction and escalation of issues through the system. However, this may exclude government and regulated utilities. These are highly exposed to legislative pressure and respond to the expectations to be seen as pioneers in the AFV market (Nesbitt and Sperling, 2001).

Democratic decision makers tend to belong to small firms that are highly decentralised and informal. Decisions tend to come from several individuals at different levels within the firm. There

[11] Local, national and international levels. Organisations with multiple locations often rely on centrally managed corporate policies that are administered locally to meet the needs of the business (Nesbitt and Sperling, 2001 and Boutueil, 2016).

is no single decision maker, although one person may be held responsible for the decisions (Nesbitt and Sperling, 2001). Democratic decision-making structures are the least likely to adopt AFVs first. This is due to group dynamics in the decision process which accommodates competing interests and internal conflicts. These typically cause long delays and little action. If these firms were looking into adopting AFVs, the final solution would be a compromise meeting every individual's needs, and in practice resulting in the path of least resistance to change.

Hierarchic decision-making structures are most common in firms with a medium to large size fleet. They are highly centralised and formalised. Decisions tend to be made by a few upper management individuals and are guided by company policies and procedures. When it comes to fleet decision making, usually detailed cost analyses are performed, particularly if the switching costs are substantial. Unlike bureaucratic firms, hierarchic firms are able to identify issues that may not fit within the existing decision-making structure, and are therefore less inclined to force decisions to comply with procedures (Nesbitt and Sperling, 2001). Nesbitt and Sperling (2001) argue that hierarchic decision-making structures offer the best circumstances for adopting AFVs due to features that appeal equally to financially inclined fleet managers and image-aware executives.

4.9. Attitudes

Individual attitudes are a significant factor influencing fleet adoption intentions. A positive attitude towards AFVs leads to adoption. Sierzchula (2014) and Kaplan et al. (2016) find that if fleet managers have positive attitudes this would often lead to AFV adoption. Klauenberg et al. (2016) find that fleet managers tend to have positive attitudes and a high level of personal interest in low carbon vehicles. This is found to hold true despite their limited knowledge (Klauenberg et al., 2016, Lebeau et al., 2016) and the size of the firm (Saukkonen et al., 2017, Globisch et al., 2018a). However, research within this area has only focused on the attitudes of top management, despite attitudes of a single employee being documented to significantly influence a firm's decision-making process (Globisch et al., 2018a).

Although several studies find a positive effect of environmental attitudes on intentions to adopt (Seitz et al., 2015, Wolff and Madlener, 2019, Denstadli and Julsrud, 2019), one study finds that environmental attitudes have a statistically insignificant effect on perceived or actual adoption of government fleets, which could be related to the limited training of employees (Johns et al., 2009). Nonetheless, some studies show that positive attitudes do not always translate into AFV adoption (Nesbitt and Davies, 2013, Bennett, 2015). Nesbitt and Davies (2013) find that the 'attitudes-behaviour gap' among managers often leads to difficulties in aligning attitudes about corporate image with adoption behaviour due to financial restrictions. Consequently, this 'attitudes-behaviour gap' impairs the decision-making process of policy makers (Bennett, 2015).

Only a few studies focus on how attitudes differ according to industry, operational barriers and type of AFV. Kaplan et al. (2016) find that attitudes differ according to industry. For example, public, forestry, fishing and agricultural firms have lower positive attitudes, while technology firms tend to have higher positive attitudes. In addition, operational barriers can negatively affect user attitudes and therefore hinder adoption. For example, inexperienced users tend to hold negative attitudes towards EVs (Wikström et al., 2016b). One way to overcome the perceived operational barriers towards AFVs is to increase potential users' experience before firm-wide adoption. Several studies find that attitudes toward the vehicle tend to change once given a positive experience (Bennett, 2015, Wikström et al., 2014, 2015, Morganti and Browne, 2018). Wikström et al. (2015) study the use of EVs and plug-in hybrid electric vehicles (PHEVs). The authors find that PHEV users have more positive attitudes compared to EV users. This is because PHEVs require minimal change in driving and charging behaviour (Wikström et al., 2015).

4.10. Emotion

The role of emotions in the adoption decision-making process has not yet been thoroughly examined in the literature. Saukkonen et al. (2017) study the emotional triggers of firms converting their fleet to natural gas and biogas vehicles for investment purposes. Their study is based on numerous Finnish firms in different industries. The authors find that top and middle management decisions to adopt AFVs are not always rational. Namely, they state that firms' decisions to adopt are influenced by subjective (e.g. feelings) and objective (e.g. facts) inputs. This confirms the idea that emotions do play an important role in firms' decision to adopt AFVs. Globisch et al. (2018a) investigate one emotional variable (perceived enjoyment) as an antecedent of the perceived ease of use construct. They find that the effect of perceived enjoyment is statistically significant but is smaller in magnitude compared to other components of their conceptual framework. Wolff and Madlener (2019) consider variables such as 'perceived enjoyment', 'EV usage anxiety', and 'technophilia' as emotional triggers to the decision to adopt. The authors find that 'EV usage anxiety,' is not statistically significant, while technophilia positively and significantly affects intentions to adopt EVs. Unlike Globisch et al. (2018a), Wolff and Madlener (2019) find that perceived enjoyment negatively affects 'perceived ease of use'.

Kaplan et al. (2016; 18) advocate that further research is required on the "linkage between the policy, cognitive and emotional motivators which are precedents to observed behaviour in order to understand the market penetration rate and potential emotional and cognitive inhibitors for the adoption of new transport-related technologies." Insights from such research would be beneficial for car manufacturers and policy makers in their effort to create, design, and support awareness campaigns to encourage majority and late adopters of AFVs.

4.11. Adoption factors and differences in vehicles and firms

The studies we review from the AFV fleet adoption literature include several types of AFVs such as passenger vehicles, vans, trucks, buses, and taxis. Consequently, the factors mentioned above affect firm adoption differently. For instance, the issue of range is likely to be a more significant issue for taxi firms, as opposed to a firm that uses an AFV as a company car for image purposes, since taxi firms tend to have a higher VMT overall. Effort expectancy factors (barriers) are also likely to affect firms differently. For example, the high initial capital costs may hinder firms that adopt buses to a higher extent than other firms. This is due to the large number of vehicles required in order to operate a fleet running on a schedule. Additionally, longer charging times are likely to hinder bus and taxi firms more than other types of firms since taxis operate as soon as a customer arrives, and busses need to operate based on a strict timetable. Moreover, our review also includes numerous types of AFVs e.g. hydrogen, electric, solar-powered, ethanol, and biodiesel vehicles. We find that EVs are the most researched AFV, as compared to others, such as hydrogen-powered vehicles. We contend that this is due to the higher adoption rates of EVs. For example, in 2019, approximately, 5 million EVs were on the road globally (making up around 0.5% of the global total). In contrast, 7,500 hydrogen vehicles were sold globally (Kane, 2020). Thus, it is likely that firms know a lot less about these vehicles, as compared to EVs.

5. Summary and Discussion of Findings

Using the FAST theoretical framework as a lens, we reviewed 53 academic articles on the adoption of AFV fleets. This review provided insights into the complexity of a firm's decision-making process, and the combination of factors that affect a firm's decision to adopt low carbon vehicles. Table 2 below provides a summary of our findings.

Table 2: Summary of Findings

Factors of FAST	Summary of findings
Perceived Risk (PR)	Technological risk, operational risk, and financial risk.

Management Involvement (MI)	The use of tracking technologies to reduce barriers. **Deployment strategies used:** employee allocation of AFVs and the use of AFVs as pool vehicles. **Forms of promotion:** vehicles policy, and rearranging parking for charging access.
Training for the Innovation (TI)	Formal and informal communication.
Performance Expectancy (PE)	**Employee perspective:** user efficiency gains **Firm perspective:** environmental gains, economic gains and strategic gains.
Effort Expectancy (EE)	Operational, economic, limited knowledge and organisational policy barriers.
Social Influence (SI)	Social interactions, subjective norms, environmental image, and social signalling.
Environmental Factors (EF)	Industry, vehicles miles travelled (VMT), government regulations, and trials/demonstrations.
Organisational Factors (OF)	Size of the firm, size of the fleet, organisational slack and managerial structure.

Attitudes	Attitudes change after experiencing an AFV, attitudes of a single employee influence firm adoption decisions, attitudes differ according to industry, positive attitudes of management tend to lead to firm adoption, environmental attitudes influence adoption and operational barriers negatively affect attitudes.
Emotions	Perceived enjoyment, and technophilia.

5.1. Contributions of our Results

Based on the conceptually derived taxonomy upon which we base our theoretical framework, we developed FAST by identifying attributes that are empirically documented to affect firms adopting sustainable technologies. Our review makes the following contributions to the AFV fleet adoption literature. First, we find that the factors that influence AFV fleet adoption have been understood by transportation scholars from different perspectives. Through our theoretical framework we illustrate that firms adopting AFVs are influenced by a combination of technical, contextual, social, cognitive, and emotional factors. the FAST theoretical framework enables us to provide a comprehensive perspective of the extant literature. Analysing the performance expectancy construct allows us to identify the primary enablers that influence firms to adopt AFVs. We find that firms adopt for efficiency, environmental, economic, and strategic gains. Analysing the effort expectancy construct, we identify the main barriers that hinder firms to adopt AFVs. These can be categorised as operational and economic barriers, limited knowledge, and organisational policies.

Second, we find that the majority of studies show that large firms are more likely to become early adopters. This is due to their access to financial resources, fleet size, the willingness to accept financial risks in exchange for first-mover advantages, image, managerial structure, centralised refuelling stations, organisational policies, the implementation of CSR, the tendency to have positive environmental attitudes, and the ability to rotate drivers and vehicle assignments to address limited range issues.

Third, we find that barriers to adoption are the most researched and discussed topic in the literature, while emotions are the least researched factor and thus require more research.

5.2. Discussion and Future Research

Based on our FAST theoretical framework and the comprehensive overview of AFV adoption barriers and enablers, we were able to identify a number of important gaps in the AFV literature, which we suggest as areas of future research. We identify six key areas that warrant future research: first, the impact of policy on the adoption of AFV fleets. Second, the role and impact of emotions on the adoption of AFV fleets. Third, the link between policy and emotions. Fourth, the degree of influence of different stakeholders on adoption decisions of AFV fleets. Fifth, the influence of symbolic meanings on firm adoption of AFVs. Lastly, we suggest that future research should focus on different samples of firms (other than 'early adopters'), as well as on actual adoption rather than intentions to adopt. We also suggest that our FAST theoretical framework is tested empirically with primary data. Each of these suggestions for future research are discussed below.

The studies analysed suggest that government incentives are secondary factors of adoption (Sierzchula, 2014, Klauenberg et al., 2016, Lebeau et al., 2016, Barisa et al., 2016, Figenbaum, 2018, Skippon and Chappell, 2019). However, considering the influence of policy on the adoption of green technologies in general (Woerter et al., 2017), we argue that there exist further research avenues related to the impact of policy on the diffusion of AFVs. As highlighted by Wesseling (2016), further research effort should be directed at analysing national, regional and local innovation policy in relation to environmental policies - in multiple geographical locations - to evaluate EV diffusion. This means that evaluating the policy mix of AFVs in a given country can potentially shed light on the impact of current policies on the diffusion of AFVs. In fact, Rogge and Reichardt (2016) state that to understand the impact of policy, the whole mix of policies needs to be considered.

We also find that firms tend to be influenced by social and psychological attributes such as attitudes, perceived risk, and emotions (Kaplan et al., 2016, Klauenberg et al., 2016, Saukkonen et al., 2017). This review acknowledges that emotions play a role in firms' adoption decisions (Saukkonen et al., 2017). Two recent studies by Globisch et al. (2018a) and Wolff and Madlener (2019) have touched upon emotions by examining the constructs of 'perceived enjoyment' and technophilia. Nonetheless, our analysis reveals that emotions are largely under researched. More research is needed to understand different emotions, how they change over time, and how collective versus individual emotions, in a firm context, interact and influence the decision-making process of AFV fleet adoption. This is important because, as Kemp et al. (2008) confirm, organisational emotions interplay in all stages of the decision-making process. Rezvani et al. (2015) find that emotions of individuals influence adoption behaviour. They argue that investigating the role of emotions in the adoption of EVs could provide suggestions for designing educational campaigns and policy-related information to overcome the barriers to adopt EVs. We believe this is likely to extend to the adoption of AFVs by firms. Therefore, we urge future research focusing on emotions and their effects on the adoption of AFVs.

One avenue that particularly warrants research is the link between emotions and policy, as highlighted by Kaplan et al. (2016). Within the psychology literature, there is evidence to suggest the existence of a bi-directional relationship between emotions and policy (Rodriguez-Sanchez et al., 2018). Thus far, research within the AFV area has not yet investigated this important relationship. Linking research streams focusing on decision-making, emotions, and policy would provide novel insights to the AFV adoption literature.

Several articles in the review revealed that management tends to have positive attitudes and a strong interest towards AFVs, regardless of firm size (Saukkonen et al., 2017, Globisch et al., 2018a).Yet, the AFV fleet adoption literature is limited with regards to the role of different stakeholders of a firm and how these affect the decision-making process. To elaborate, this review highlighted that it is not only top management that influences adoption decisions of AFVs (Globisch et al., 2018a). Instead, employees and governments (through legislation and policy) are important stakeholders that have an influence on a firm's decision-making process. Additionally, 'policy entrepreneurs' are also documented to influence firm's decisions to adopt (Wikström et al., 2016b). Yet, they remain overlooked within the AFV research area. We believe that understanding the role of all the stakeholders involved in the decision-making process as well as the degree of influence of each stakeholder (in terms of attitudes, emotions, subjective norms) would provide novel insights to this research area.

One of the reasons why most firms adopt AFVs is to project a 'green image', suggesting that firms have the financial resources to take the risks associated with being an early adopter. Therefore, it is surprising that there is limited research on the symbolic meanings of AFVs in different industries, and situations where a green image may provide an inherent advantage, since symbolic meanings are environmentally dependent. We urge that future research should explore the meanings of symbolic adoption of AFVs in different countries and industries. This is especially important in light of the findings of Kaplan et al. (2016) showing that firms in different countries perceive subjective norms and intentions to adopt differently.

Furthermore, we contend that the AFV literature has two primary methodological restrictions. First, the majority of studies have used government fleets or early adopter firms participating in demonstration projects as their sample. However, using such samples could cause concerns of 'early adopter' bias (Rogers, 1962). Early adopter firms tend to be more favourable towards new technologies (Kaplan et al., 2016), and public fleets are in essence brought together in order to comply with regulations, as government agencies are expected to be seen as leaders in fostering governments' environmental policies and spearhead the creation of the AFV market. Early adopters (innovators) tend to have more interest in innovative technologies, and generally have the necessary financial resources, making them more resilient to the risks that come with being an early adopter. On the other hand, a technology may be considered established when it has been picked up by the 'early majority', 'late majority', or 'laggards' positioned further down on the adoption curve. These groups are perhaps more sensitive to the risks associated with adoption (Rogers, 1962). We, therefore, urge future researchers to employ samples focusing not only on early adopters in order to provide new insights into the adoption factors affecting 'early majority', 'late majority', and/or 'laggards'. Moreover, the majority of the studies reviewed take the form of a choice modelling method to understand AFV adoption. These studies should be combined with studies that collect primary data on firms that are in the process of making the decision to adopt to understand how such a process is structured, and what variables may affect wider diffusion of AFVs by firms.

Lastly, previous research has argued that taxonomies are particularly useful for organising knowledge within a research area, exploring the relationships within a classification and contributing to theory building (Glass and Vessey, 1995, Doty and Glick, 1994). We used extant literature to classify adoption barriers and enablers of sustainable technologies and to organise knowledge within the AFV field. It is, however, important to mention that the different adoption factors are interlinked. Indeed, the adoption of AFVs requires a combination of factors, because no single factor alone can explain adoption rates or influence adoption. Fleet adoption behaviour is explained by a combination of organisational, emotional, attitudinal, and social factors (Seitz et al., 2015, Globisch et al., 2018a, Wolf and Madlener, 2019). We therefore propose that future research should study the relationships within the FAST theoretical framework. In addition, to contribute to theory building, future research should test the FAST theoretical framework using primary data to increase our knowledge of the significance of each factor affecting adoption. Our FAST framework requires validation and potentially further refinements. Further empirical research within this area would allow for a meta-analysis to assess the significance of the different factors in the FAST theoretical framework.

5.3 Strengths and Limitations

To our knowledge, our review is the most comprehensive review on the adoption of AFV fleets. To do this, we built a comprehensive theoretical framework that explains Firm Adoption of Sustainable Technologies (FAST). We also highlight areas for future research. However, our study is not without limitations. First, although our theoretical framework provides a useful lens through which we are able to provide a comprehensive evaluation of the factors affecting technology adoption at a firm level, it is possible that other factors may have been overlooked. Second, this review incorporates academic studies from numerous countries, such as Norway (Figenbaum et al. 2018), USA (Haller et al., 2007), Germany (Seitz et al. 2015), UK (Bennett, 2015) and Sweden (Wikström et al. (2016a). Different countries have different economic environments, policy support, and therefore different perceptions of risk, and may hold different attitudes and emotions towards AFVs. The differences in countries are likely to have an impact on adoption decisions, and may explain the differences in our findings. Nonetheless, by relying on FAST, we are able to provide a comprehensive overview of the primary factors that hinder or enable firms to adopt AFV fleets.

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Declaration of interest

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Glossary

Alternative Fuel Vehicles (AFV)

Corporate Social Responsibility (CSR)

Electric Vehicles (EVs)

Effort Expectancy (EE)

Environmental Factors (EF)

Firm Adoption of Sustainable Technologies (FAST)

Greenhouse Gas (GHG)

Heavy goods vehicles (HGVs).

Internal Combustion Engine (ICE)

Management Involvement (MI)

Organisational Factors (OF)

Perceived Risk (PR)

Performance Expectancy (PE)

Plug in Vehicles (PIV).

Small, Medium Enterprises (SMEs)

Social Influence (SI)

Training for Innovation (TI)

Technology Acceptance Model (TAM)

The Unified Theory of Acceptance and Use of Technology (UTAUT)

Technology Organisational and Environment (TOE)

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Appendix 1: Original definitions of the constructs that form FAST

Construct	**Definition**
Perceived Risk	"A combination of uncertainty plus seriousness of outcome involved" (Bauer, 1967; 15).
Management Involvement (MI)	The ability of managers to convince and explore effective ways to engage employees in using a specific innovation (Choi et al., 2011).
Training for innovation (TI)	The information, knowledge, and skills enhancing employees' understanding and technical readiness for the adoption of a specific innovation (Choi and Chang, 2009).
Performance expectancy (PE)	"The degree to which an individual believes that using the system will help them to attain gains in job performance" (Venkatesh et al., 2003; 447).
Effort expectancy (EE)	"The degree of ease associated with the ease of use of the system" (Venkatesh et al., 2003; 450).
Social influence (SI)	"The degree to which an individual perceives that important others believe he or she should use the new system" (Venkatesh et al., 2003; 451).

Environmental factors (EF)	Refers to the external factors that influences a firm to adopt an innovation, e.g. government regulations and the industry in which the firm conducts its business (Tornatzky and Fleischer, 1990).
Organisational factors (OF)	Refers to the resources available to a firm to support the acceptance of an innovation, e.g. firm size, managerial structure and organisational slack (Tornatzky and Fleischer, 1990).
Attitude	"An individual's positive or negative feelings about performing a target behaviour" (Dwivedi et al., 2019; 724).
Emotions	Employees' collective emotional reactions towards the adoption of technologies (Choi et al., 2011).
Behavioural intentions[1]	"The strength of one's intention to perform a specified behaviour" (Fishbein and Ajzen's (1975; 288).
Firm adoption of sustainable technologies[2]	Continued use of an innovation (Venkatesh et al., 2003).

[1] Venkatesh et al. (2003) and Dwivedi et al. (2019) both use Fishbein and Ajzen (1975)'s definition to define behavioural intentions.
[2] Referred to as "Use behaviour" in UTAUT (Venkatesh et al., 2003).

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Appendix 2: Adoption of Alternative Fuel Vehicle Fleets - A Theoretical Framework of Barriers and Enablers

References included in the study

The following pages present a table of the 53 references included in this study. The table includes the following criteria: author(s) name and year, country, sample size and type, vehicle type, method, theory and main findings. We attempted to gather as much information as possible on each study. However, in some studies this information was not explicitly stated, and in such instances we have used either N/A or a (-) dash.

Study details							Results			
Author and year	**Country**	**Sample size and firm size**	**Type of firm/sample**	**Vehicle type**	**Method**	**Theory**	**Technical Factors**	**Contextual factors**	**Organisational factors**	**Individual and social factors**
Golob et al. (1997)	USA	2000 fleet sites in California.	A mix of large and small firms.	AFVs	Quantitative: Survey.	N/A	Reduced emission. Firms in the private sectors influenced by operational needs.	Charging infrastructure.	Sensitive to capital cost.	-
Parker et al. (1997)	USA	537 trucking firms.	-	AF trucks	Quantitative: Survey.	N/A	Increased performance	Legislation. Although sceptical about legislation.	Perceived cost saving per mile.	-
Nesbitt and Sperling (1998)	USA	2700 fleets in California.	A mix of large and small firms.	AFVs	Mixed method: focus groups, interviews and questionnaire.	N/A	-	Limited policy incentives for firms. Policy requires more flexibility.	-	-
Nesbitt and Sterling (2001)	USA	59 individuals in the focus groups. 39 participated in one-to-one interview. 2117 fleet sites used for the questionnaire.	-	AFVs	Mixed method: focus groups, interviews and mail and telephone questionnaire.	N/A	-	-	Identifies four decision making structures for large and private firms adopting AFVs: autocratic, bureaucratic, hierarchic and democratic.	-

Zhao and Melaina, (2006)	China and USA	In China, 12 cities participated in the ‘‘National Clean Vehicle Action’’ program.	Demonstrations and experts Based on USA and China training programs. The Clean Cities Program in the USA	AFVs	Qualitative	N/A	A relatively low oil price.	Limited charging infrastructure. More polices are required for the long and short term to raise awareness and support adoption of AFVs.	High purchase price.	-
Haller et al. (2007)	USA	Based on 180 vehicles of a public fleet at a mid-point of an implementation program.	Government fleets	AFVs	Quantitative There are three parts of the assessment: cost effectiveness analysis, implementation evaluation, and environmental outcome analysis. Uses: Cost analysis volatile organic compound (VOC) reduction estimates.	N/A	Difficult to attain emission reduction.	Delays in anticipated grants for installing charging stations.	Difficult to attain cost savings.	-
Johns et al. (2009)	USA	98 drivers	Public fleet based on a midpoint of a 10-year	AFVs	Mixed method: Quantitative	Theory of reasoned action	Vehicle performance	Charging refuelling convenience.	Informal communication influenced AFV	Subjective norms.

			conversion plan.		98 drivers took part in a Survey. Qualitative 2 drivers took part in an interview.				use within firms.	Environmental attitudes do not have a significant effect on perceived or actual adoption.
Jacob et al. (2009)	USA	7 Interviews	Public firms (small) based on a midpoint of a 10-year conversion plan.	AFVs	Qualitative Case study	N/A	-	Political risk: A political environment must be stable to succeed. External risk: uncertainty of technology and public funding sources.	Knowledge is communicated informally- due to limited resources and technical uncertainty. Converting to AFV is complex -requires complete change of entire organisational framework. Internal risk: limited knowledge.	Trust between fleet manager and political powers. If knowledge on technical problems are well understood fleets are more likely to adopt.

Mattson (2012)	USA	Based on 115 small urban and rural transit agencies.	Public transit agency	AF buses	Quantitative Survey	N/A	Fears over fuel supply hinder adoption.	External risks (e.g. financial, technology availability) hinder small public firms.	Cost savings. Costs associated with infrastructure hinder adoption. Size of the transit agency influences decisions to adopt. Larger agencies are more suitable to adopt.	Beliefs regarding the benefits of emission reduction. Improved public perception.
Nesbitt and Davies (2013)	USA	53 vehicles demonstration drivers. In addition, vehicle use and performance data was collected from the 28 PHEV pickups.	Public Demonstration/ trial.	AFV	Mixed method Interviews Online questionnaire.	N/A	-	Lack of task appropriate vehicles. Limited charging infrastructure.	Fuel savings. Meeting sustainability goals. Improving brand image. For successful adoption to occur, action and input is required from all employees even those who are not involved in the decision-making process.	Attitudes and behaviour gap' evident among managers.

									Vehicles must meet the needs of employee's job functions. Firms fleet purchase policies are barriers to adoption.	
Van Rijnsoever et al. (2013)	The Netherlands	45 respondents	Based on Dutch government fleet.	AFVs	Quantitative Questionnaire.	N/A	Local emissions are regarded as a very important factor.	-	Initial purchase price is regarded as a very important factor.	-
Axsen et al. (2013)	UK	57 staff members took part in the experience project. A couple months later 21 staff members were recruited to take part in a semi-structured interview.	Large[1] technology firm (with 500 staff members).	EVs	Mixed method. .	N/A	-	-	-	Employees are significantly influenced by social interactions. Perception of EVs change through social interactions.
Sierzchula (2014)	USA and The Netherlands	14 USA and Dutch organisations Six public and eight private	Mix of public and private firms.	EVs	Qualitative Case study method	N/A	Environmental impact.	Government grants. Economic uncertainty deters small	Testing new technology is the primary driver for adoption.	Positive attitudes from fleet managers tend to help in converting a firm's fleet.

1 Large enterprises employ 250 or more people (House of Commons, Business statistic, 2019;5).

		firms from different industry, different sizes.			Interviews and three project reports (where interviews were not possible). Content analysis			firms from adopting.	Improving firms' public image. Economic loses prevent small firms from adopting. Firms adopt to gain first-mover advantages, specialised operating capabilities or a compelling business model.	
Wikström et al. (2014)	Sweden	174 electric vehicles operating on commercial fleets	Users in the Swedish Procurement of Electric Vehicles and Plug-in Hybrids scheme (Trail)	AFVs	Mixed method Questionnaires and Logbook data used. 30 interviews	Kolb's Experiential Learning Model	Winter conditions reduce usage. This is because the use of heating reduces the energy consumption and therefore the range of the vehicle.	Firms only require a modest infrastructure.	Firms tend to charge in the workplace.	Increased experience in driving an EV results in increased driving distance between charging. Increased experience boosts confidence, general attitudes and usage over time.
Kirk et al. (2014)	UK	14 participants.	Experts: vehicle manufacturer or dealership	AFV vans	Qualitative Interviews.	N/A	Low emissions	Limited charging Infrastructure.	High capital costs.	-

			representatives, drivers with experience, fleet operators and refuelling equipment manufacturers and suppliers.					Lack of awareness. Limited choice of models.		
Koetse and Hoen (2014)	The Netherlands	940 respondents, randomly selected from Dutch internet panel owned by TNS-NIPO.	-	AFVs	Quantitative Online questionnaire.	N/A	Limited driving range Long re-charge time.	Limited charging Infrastructure.	Preferences for company car depends of annual mileage. Early adopters tend to have low annual mileage.	Preferences for company cars differ from the individual market. Preferences for AFV will increase when charging infrastructure and technology improve.
Miles and Potter (2014)	UK	-	Milton Keynes demonstration project.	Electric bus.	Case study of Milton Keynes demonstration project.	N/A	Long refuelling time means more buses are required to fulfil the bus timetable.	-	Converting buses to electric is expensive due to the number of buses required to fulfil the requirements of a bus timetable.	-
Seitz et al. (2015)	Germany	177 Firms. 5 expert interviews.	Mix of large and small firms. Experts.	AFVs Trucks.	Mixed method Online survey. And 5 expert interviews.	Technology Organization Environment framework (TOE).	Performance and productivity of the vehicle are highly influential factors.	-	Cost saving. Image is influential factor.	environmental attitudes have a significant and positive affect on intentions to adopt.

									Corporate Social Responsibility (CSR). Firm size influence's adoption. Early adopters of AFVs, tend to be large firms. Large fleets more willing to adopt.	
Wikström et al. (2015)	Sweden	550 users.	Demonstration project. Private and public firms.	AFVs	Mixed methods Questionnaires focus groups. And technical data from logbooks.	N/A	Winter conditions decrease use and driving range.	-	Operational conditions hinder the use of EVs rather than technical capacity.	Lack of experience results in half of the battery being used as a 'security blanket.'
Bennett (2015)	UK	364 commercial and public sector fleet buyers.	Mix of small and large firms.	EVs	Quantitative Survey.	Extended theory of planned behaviour (ETPB).	-	Government policies are required to stimulate adoption.	Firms with environmental policies are likely to adopt. Firm size, geographical coverage, decision making	EV generally regarded as high risk. Hindering fleet managers to adopt. Moral obligation,

									structure and belief that EVs improve firm image found to be insignificant factors for adoption.	pre-existing beliefs, self-identity all significantly influenced employees' attitudes.
Boutueil (2016)	France	44 interviews with decision makers from 22 large organizations.	Large public and private firms.	EVs	Mixed method Interviews and surveys and data gathered on the firm's size, structure, vehicle use etc.	N/A	Immaturity of the electromobility system from battery technology and re-sale value.	Limited charging infrastructure. Lack of information on the availability of charging points. Lack of reliable information of range and vehicles maintenance.	Brand image with customers and employees. Economic efficiency. Operational efficiency. Testing new technology. Implementing car policies can overcome complexity of fleet decision process. The use of tracking and monitoring devices helped to overcome limited information, use and fleets costs.	-
Wang and Thoben (2016)	-	-	-	EVs for urban freight transport.	Review of 25 papers of electric commercial	-	Positive: Fast acceleration.	Limited infrastructure	High investment costs.	Accessibility costs e.g. lack of repair shops, and

					vehicles for urban freight transport**.**		Energy efficiency. Low operational costs. Low emissions and noise. Low maintenance costs. Negative: Battery capacity Weight and range. Payload capacity.		TCO (Total cost of ownership) Positive image. Poor knowledge of EVs.	vehicle options.
Galván et al. (2016)	Colombia	114 respondents.	Public firms.	AFV buses	Quantitative	N/A	Operating costs.	-	Purchase price is regarded as important factor for adoption.	-
Barisa et al. (2016)	Latvia	16 firms. 24 respondents	Public firms.	EVs	Quantitative Survey.	N/A	Environmental benefits. Lack of trust benefits. Battery range Limited availability of models.	Limited charging infrastructure. Long re-charge time. Charging facilities at home are regarded important.	Green image Reduced fuel costs. High purchase price.	-
Barfod et al. (2016)	Denmark	16 practitioners in	Experts	EVs	Quantitative	N/A	Environmental benefits.	Effective policy	Overall savings.	-

		policy-making organisations.					Limited vehicle range. Operational and technological challenges hinder adoption. Winter restricts usage.	initiatives are low registration fees, the purchase or use, emission-based taxes, and state subsidiaries.	High purchase price. Promotional opportunities.	
Lebeau et al. (2016)	Belgium	45 respondents from transport firms.	SMEs.	EVs	Quantitative Survey	N/A	Operational constraints hinder adoption: limited vehicle range. Environmentally friendly. Quick acceleration. Silence and ease of driving.	Limited charging Infrastructure. Require fast chargers. Require access to bus lanes. Long re-charge time. Require further financial incentives support adoption- to help with purchase costs. Lack of information on EVs.	Charging at the depot is regarded as a benefit-saves time. High purchase price. Uncertainty regarding residual value. Low operating costs.	Lack of knowledge in EVs and maintenance for EVs. Despite limited knowledge respondents still have positive attitudes.

								Limited availability of models.		
Wikström et al. (2016a)	Sweden	100 enterprises 40 users	Mix of public and private.	EVs	Qualitative Focus groups	Technology Acceptance Model (TAM)	-	The following issues need to be addressed for a successful implementation: simplifying information, handling failures, and to promote and progress the usage of EV	-	Users need to favour introduction to accept EVs.
Wikström et al. (2016b)	Sweden	Public firms 18 firms 9 identified as a policy entrepreneur	Demonstration projects. Public firms	AFVs	Qualitative Interviews	Combines theory of policy entrepreneurs with an outcome indicator perspective.	-	Policy entrepreneurs can significantly influence public firms to adopt.	-	-
Kaplan et al. (2016)	Austria, Denmark and Germany	1443 SMEs	SMEs	EVs	Quantitative Survey	Theory of Planned Behaviour (TPB).	-	-	-	Different countries perceive operational ease, subjective norms and intentions to adopt differently. Different sectors hold

										different levels of positive attitudes towards EVs. Positive attitudes, subjective norms and familiarity with EV lead to intentions to adopt.
Klauenberg et al. (2016)	Austria and Germany	206 in Austria and 546 in Germany -Fleet managers	Small to medium size firms	EVs	Quantitative Survey	-	Driving range of EVs comply with the daily mileage requirements for Germany nursing and pharmaceutical firms.	-	Wholesale, retail trade, service and Human health sectors are most likely to adopt. Fleet managers lack knowledge about EVs and their own driving patterns.	Fleet managers have positive attitudes towards EVs.
Saukkonen et al. (2017)	Finland	8 firms 12 interviews	Mix of small and large firms	AFVs.	Qualitative	N/A	Limited availability of models.	Lack of knowledge and awareness hinders adoption.	High purchase price. Firms make decision based on objective and subjective factors.	Limited charging infrastructure causes anxiety. Personal interest influences decisions regardless of firm size.
Palm and Backman (2017)	Sweden	2 Public firms	Public firms	EVs	Qualitative Interviews.	N/A	Environmental benefits.	-	Public firms felt it was their	-

		12 respondents							responsibility to set an example to develop the EV market. High purchase price.	
Xylia and Silveia (2017)	Sweden	21 public firms.	Public firms.	Electric bus.	Mixed method Secondary data Survey and interviews.	N/A	Environmental benefits.	Political environment hinders firms.	Economic barriers hinder firms.	-
Christensen et al. (2017)	Denmark and Germany	Germany 4 nursing companies. Denmark 2 firms from the construction industry, one in the professional services industry, two taxi firms and two firms from the wholesale and trade sector.	Mix of public and private firms.	Three categories of electric mobility Passenger Vans Trucks	Secondary data used from official statistics from each country.	N/A	EVs do not show their economic benefits unless travel distance is high. Limited driving range.	Different taxation structures in countries equates to Danish firms being less will to adopt.	Due to their low daily mileage, food distribution, taxis, construction, and other service sectors are the most suitable for early adoption.	Different behaviours e.g. attitudes in the two countries result in Danish firms being less willing to adopt.
Kuppusamy et al. (2017)	USA	-	Taxi company and an infrastructure service provider.	EV taxi	Quantitative	N/A	Reduced battery costs generate high profits and therefore adoption: more important than driving range.	-	Adoption decision can change according to mean miles driven. An increase in miles driven can	-

							Reduced charging time increase profits and reduced inconvenience parameters.		increase adoption.	
Mau and Woisetschläger (2018)	Germany	Qualitative: 39 experts from 35 different firms. Quantitative: 107 fleet managers.	Experts and firms.	EVs	Mixed method Semi structured interviews with fleet managers, manufacturers and dealers	-	Functionality of EVs influences firm adoption. Driving range Improvements in vehicle price or range positively affect adoption intentions.	Policy incentives do not increase intentions to adopt significantly.	Image TCO	-
Li et al. (2018)	America, Europe and Asia pacific (22 cities)	8 Practitioners	Practitioners	EV Buses	Qualitative Interviews Second data Literature and policy reports.	-	-	Private and public grants assist with EV bus adoption.	Involvement with utility firms and bus and infrastructure firms can provide knowledge, training and experience. They may also pay for charging infrastructure. Leasing of batteries can help bus firm overcome the high initial cost. This can also	-

									overcome technology risk.	
Globisch et al. (2018a)	Germany	229 carpool managers.	Field trial within the project “Get eReady” (2013–2016).	EVs	Quantitative Survey.	Organismic Integration Theory (OIT).	Environmental benefits. Limited range. Reliability.	-	Organisational innovativeness.	High interest in technology. Attitudes of single employees.
Globisch et al. (2018b)	Germany	575 actual users in commercial pool car fleets.	Field trial programme “Electromobility Model Regions” (2013-2015)	EVs	Quantitative Survey	TAM	Environmental benefits and perceived ease of use are important in supporting the EV adoption. Driving range is not much of a concern for commercial fleets compared to private individual adopters.		Perceived organisational usefulness is important in supporting the adoption of EVs. Organisational image significantly influences perceived organisational usefulness.	Subjective norms are pivotal in supporting the adoption of EVs. Perceived enjoyment significantly influences perceived ease of use.
Hagman and Langbroek (2018)	Sweden	24 selected vehicles (9 EVs and 15 ICEVs using fossil fuels and biogas. 11 respondents Analysed 50 shifts of taxi drivers driving patterns.	Taxi firms.	Electric vehicle taxis.	Mixed method.	N/A	-	Locations of charging points. Planning is required especially for those working a double shift e.g. charge in lunch breaks.	EVs have lower TCO. EV have higher profitability. Initial cost.	-

Mohamed et al. (2018)	Canada	11 interviews from 11 transit firms. Respondents included: Directors, fleet/operation managers, maintenance managers, and planning managers.	Transit firms.	Electric bus	Qualitative Interviews.	N/A	Operational capabilities, and cost reductions significantly influence adoption.	Political support, local operational data, and demonstration projects are also important factors that influence adoption.	.	Perceived risk significantly influences adoption.
Figenbaum et al. (2018)	Norway	5 craftsmen, 7 service enterprises (small). Data logs of 115 vehicles used.	Small enterprise.	Electric vans.	Mixed methods.	N/A	Environmental impact. Limited range.	-	Limited range issues could be addressed by scheduling vehicles to charge throughout the day.	-
Morganti and Browne (2018)	France and UK	15 service operators' respondents and 8 policy makers.	Experts	Electric vans.	Qualitative Interviews.	N/A	Limited range. Queue, payload and grid anxieties.	-	-	-
Skippon and Chappell (2019)	UK	4 case studies (Large firms).	-	Electric passenger vehicles and vans.	Qualitative based on 4 in-depth case studies also using interviews	N/A	-	Government policy can create barriers.	CSR Goals. Commercial strategy. TCO. Operational suitability to user's job role. Organisational policies restrict employees to	-

									choose their own vehicle.	
Blynn and Attanucci (2019)	USA	14 transit fleet representatives	12 transit agencies across USA.	EV Buses	Mixed method	-	Operational complexity hinders adoption. Environmental benefits. Low noise. Maintenance costs savings. Battery performance uncertainty.	Infrastructure costs. Multiple polices are required to overcome the barriers to ensure the transition to electric fleets are seamless (without affecting the transit service). Oversubscribed grants. External political pressure can influence and hinder adoption.	TCO analysis finds EV buses are more cost effective than ICE buses. Electricity costs. Hight capital costs. Board or executive leadership influenced decisions. Life cycle costs can influence and hinder adoption.	Learning from peers and or direct experience influenced bus procurement decisions.
Denstadli and Julsrud (2019)	Norway	264 SME managers	SMEs.	Electric vans.	Quantitative Survey.	N/A	Attributes related to the vehicle. Vehicle reliability. Range limitation.	-	Costs of the vehicle. Green image. Symbolic features influence's decision makers.	-

							Limited models.			
Anderhofstadt and Spinler (2019)	Germany	23 experts.	Experts.	AFVs vans.	Quantitative Delphi study.	N/A	Reliability.	Limited infrastructure. Entering low emissions zones. Subsidies spur penetration.	Current and future fuel costs.	-
Reis (2019)	Portugal	11 respondents (drivers of vans).	Public firms.	Electric vans.	Qualitative Case study Interviews Direct observations.	-	EV vans in public services are more efficient and reliable. Environmentall y friendly. Reduction in noise pollution.	-	Economic.	-
Anderson (2019)	Denmark	61 municipalities.	Public firms.	EVs	Mixed method Interviews Survey.	TAM	Environmental benefits.	Political environment. Unsure of resale opportunities due to fast rate. of technological change.	Cost savings benefits. EVs mostly used for short trips. Large municipalities tend to be more pro-active and have a large number of EVs	-

									due to larger budget.	
Valdez et al. (2019)	UK	17 respondents.	Milton Keynes demonstration project.	EVs	Qualitative interviews with business and governmental actors Based on Milton Keynes during the Plugged-in Places programme	-	-	Limited infrastructure Direct financial incentives. The uptake of businesses adopting EVs influenced other firms to adopt.	-	-
Zhang et al. (2019)	China	30 firms. 192 respondents.	Mix of small and large firms.	AFV vans.	Quantitative Survey	N/A	Safety and driving range are highly important. Vehicle power.	Government support.	Maintenance and fuel costs. Cost savings have a negative influence due to the high costs to use AFVs. Corporate environmental goals.	-

Anderhofstadt and Spinler (2019)	Germany	23 experts.	Experts from large firms e.g. manufacturers, oil and gas companies and also individual academics.	AFV trucks.	Mixed method. Delphi study.	-	Greenhouse gas emissions. Tank-to-wheel emissions. Well-to-wheel emissions. Safety features Reliability Driving range. Noise emissions.	Policy: the possibility to enter low emission zones. Refuelling and charging infrastructure.	Current and future fuel costs. Purchase price. Depreciate and re-sale value. Service and maintenance costs. Taxes and insurance. TCO. TCO factors (secondary factors after costs).	-

Wolff and Madlener (2019)	Germany		Postal delivery service	Light duty vehicles (vans).		Adaptions from TAM & Diffusion of Innovation theory to form Unified Technology Acceptance Model (UTAM)				

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