Understanding the adoption of Alternative Fuel Vehicle fleets using an integrated framework: A review and research outline

Layla Mohammed
University of Manchester
Innovation
layla.mohammed@postgrad.manchester.ac.uk

Abstract

Background: The transportation sector has been identified as the primary cause of air pollution in European cities. Thus, to reduce carbon emissions and our reliance on fossil fuels, alternative fuel vehicles (AFVs) have been suggested as an innovative technology to help decarbonise the transportation sector. Despite governmental efforts through financial incentives, we still witness a slow growth of the adoption of AFVs worldwide. AFV fleets are suggested as ideal early adopters. However, the most significant barrier to acceptance of AFVs within fleets is how they are perceived by firms (Globisch et al. 2018b). Subsequently, to tackle this problem and promote AFV adoption within fleets, it is vital to understand the adoption factors that hinder or enable adoption of AFV within fleets. The literature on the adoption factors of AFV by firms is scattered (Nesbitt and Sperling, 2001). Hence, it is difficult for future researchers to identify the ‘gaps’ within the literature to make significant contributions. Therefore, a review paper is required to provide a comprehensive evaluation of the adoption factors of AFVs by firms and shed light on the potential current ‘gaps’ to discuss future research opportunities.

Purpose: To build and utilise a comprehensive theoretical model that is able analyse sustainable technology adoption at a firm level. We combine the unified theory of acceptance and use of technology (UTAUT) (Venkatesh, 2003), technology, organisation and environment (TOE) model (Tornatzky and Fleischer 1990) (TOE), Dwivedi et al. (2017) model, and Choi et al. (2011) and Kupers and Weibler (2008) theories of organisational emotions. We integrate these models to form our firm adoption of sustainable technologies (FAST) model. We utilise our model to provide a theoretical overview of the AFV fleet adoption literature and to be able to provide suggestions for future research.

Design/methodology/approach: To assess the literature of adoption of AFV fleets, this paper utilised the ‘snowballing’ method. This method aims to synthesize the research within a particular field to provide a focused understanding of the literature.

Preliminary findings: After reviewing the existing literature, we find the following:

1. There exist further research avenues on policy. Policy has been acknowledged within the adoption literature as an important factor that can enable or hinder the adoption of innovative technologies particularly, within the environmental arena (Kerr & Newell, 2001; Woerter et al., 2017). Within the AFV literature, there is currently limited focus on the impact of policy. Therefore, it argued that, further understanding of policy may consolidate findings and advance our understanding within this field.

2. Emotions are overlooked within the AFVs fleet adoption literature. Kaplan et al. (2016;18) notes that
ECV researchers have not yet linked policy with emotions. Yet, within the psychology literature there is evidence to suggest that there exists a bi-directional relationship between policy and emotions (Nabi, 2003 and Rodriguez-Sanchez et al. 2018). Thus, it is believed that further understanding of emotions as an influential factor of ECV adoption is required. This paper views these constructs holistically and attempts to build upon technology adoption theories.

Keywords: Commercial Electric Vehicles, Technology Adoption, Policy, Emotions.
Understanding the adoption of Alternative Fuel Vehicle fleets using an integrated framework: A review and research outline
Abstract

Transportation scholars have suggested the adoption of alternative fuel vehicles (AFVs) by firms to be the ‘ideal’ target market’ due to their market share and their ‘early adopter’ characteristics. This paper provides an overview of enablers and barriers to AFV fleet adoption from the extant literature. We propose an interpretative model of Firm Adoption of Sustainable Technologies (FAST) to provide a conceptual framework to analyse the AFV fleet adoption literature. This task reveals gaps and limitations in previous research. From our analysis we classify the primary enablers and barriers that influence firms to adopt AFVs. Moreover, we suggest further research avenues on policy and emotions and understanding the important interlink between them.
1. Introduction

Alternative fuel vehicles (AFVs) are currently being presented as a solution to decrease carbon emissions and our reliance on fossil fuels. AFVs are vehicles that run on fuel other than traditional petroleum-based fuels (petrol or diesel) or any technology of powering an engine that does not involve petroleum solely. Such cars include hydrogen, electric, hybrid, solar-powered, ethanol and biodiesel (Yeh, 2007). The transportation sector is the primary cause of air pollution in European cities. For instance, in the UK, in 2018, transport accounted for a third of all carbon dioxide emissions. This is the only sector that has not seen the same steady decrease in emissions. Transportation emissions only declined in 2007 yet remain higher than they were in 1990 (European Commission, 2019). Over half of these vehicles contributing to air pollution are owned by commercial fleets (businesses) (Brand et al. 2017). Governments have introduced policies to encourage the adoption of AFVs. Nonetheless, we still witness a slow growth of AFVs. In 2017, the global share of AFVs in circulation was only 4.4% (Middleton, 2017), perhaps due to the high price of petrol (Anable et al. 2014) and technological lock-in (Steinhilber et al. 2013).

In light of this, this paper focuses on commercial AFV market. Nesbitt & Sperling (1998), Gnann et al. (2015), Wikstrom et al., (2014) and Kaplan et al. (2016) agree that commercial fleets make ideal ‘early adopters’ since businesses tend to have a higher mileage compared to private users and tend to buy vehicles in bulk (Sierzchula, 2014). Thus, in essence, we argue that the first step to widespread adoption of AFVs is the adoption and diffusion of AFV fleets. Commercial vehicles are defined as a diverse group of vehicles owned by business, ranging from the ubiquitous white van to taxis, buses and heavy goods vehicles (HGVs). Multiple cars owned by business are also known as fleets.

To promote AFV adoption within fleets, it is vital to understand the factors hindering or enabling adoption of AFVs within fleets. Researchers have employed several theories, methodologies, time horizons and markets (bus, taxi, trucks) providing a scattered overview (Nesbitt and Sperling, 2001) yet, there is no unified view of the factors that influence firm’s decision to adopt AFVs. Therefore, a review paper is required to provide an inclusive summary of the adoption factors that influence AFV fleets. From this emerges a need for identifying the ‘gaps’ in the extant literature to provide future research directions.

Existing reviews have mainly focused on individual consumers’ experiences and perceived factors that affect the decision-making process in adopting electric vehicles (EVs). For example, Rezvani et al. (2015) review the adoption factors affecting such decisions. On the other hand, Daramy-Williams et al. (2019) review consumers’ actual experiences of EVs. A more closely related review is Biresselioglu et al. (2018). Namely, the authors provide an inclusive review of the main factors that influence individual, collective and formal social units to adopt electric vehicles (EVs). However, to the best of our knowledge, a comprehensive review of the factors that influence company’s adoption decisions of AFV fleets using an integrated framework does not exist. This is perhaps due to researchers focusing more on the private market than the adoption of AFV fleets (Kaplan et al. 2016).

The main objective is to identify prevalent technology adoption models that could be used to understand the adoption of sustainable technologies. The second objective is to provide a critical review of the factors affecting the adoption of AFV fleets and use them to explain Firm Adoption of Sustainable Technologies (FAST). Our aim is to provide a framework to analyse this literature; by doing so, we are able to reveal gaps and limitations in extant research upon which we build our research agenda. We review fifty-eight academic articles on the adoption of commercial AFVs in relation to the FAST model. The remainder of this paper is presented below in a graphical presentation.

**Figure 2: Outline of the paper**

![Outline of the paper](graphic)
2. Overview of Technology Adoptions Models

Rogers (1962) defines adoption as the individual decision to make full use of an innovation. This paper integrates the following theories to provide an overview of the main factors that influence Firm Adoption of Sustainable Technologies (FAST); the unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al. 2003), Dwivedi et al. (2019) extended model of UTAUT, Technology organisational and environment (TOE) model (Tornatzky and Fleischer 1990) and Choi et al. (2011) theory of organisational emotions towards innovation adoption. We integrate these models to aim for a complete overview of technology adoption factors. This, accordingly, enables us to offer a solid interpretation of the AFV literature and thus conclude on what we do not yet know in AFV literature. Figure 3 visualises our FAST model and illustrates how the different models are integrated as well as our added contribution of ‘perceived risk.’ Table 1 defines the constructs of our FAST model. The remainder of this section will discuss these different models and how they are integrated to form FAST.

Figure 3: Firm Adoption of Sustainable Technologies (FAST)

**UTAUT**

Venkatesh et al. (2003) combine eight of the most dominant theories of technology adoption to understand individual employee acceptance and use of technology in a firm context. Figure 4 illustrates the theories that form UTAUT.

**Figure 4:** Theories that form UTAUT

![UTAUT Diagram]

Alone, each of these theories are used to explain individual intention or adoption of technologies. To empirically test the UTAUT model, Venkatesh et al. (2003) use data from four firms over a six-month period. Uniquely, the UTAUT model can explain almost 70% of the variance in technology intention to adopt (Venkatesh et al. 2003) and 50% in adoption (Venkatesh et al. 2012), which is a significant increase over any of the initial eight models alone. Thus, UTAUT provides a strong foundation to evaluate technology adoption. Since its inauguration, the UTAUT model has been used to explain a variety of sustainable technologies such as sustainable household technology (Ahn et al. 2015), and the use of solar water heaters (Saleh et al. 2014). Researchers have paid much attention to the UTAUT model when identifying factors influencing the adoption of sustainable technologies. UTAUT has four
constructs to explain user intention and adoption: 1) performance expectancy, 2) effort expectancy, 3) social influence and 4) facilitating conditions.

Dwivedi et al. (2019) extended UTAUT model
To complement the UTAUT model, we utilise Dwivedi et al. (2019) extended model of UTAUT to add the attribute ‘attitudes’ and the added path between external environment and behaviour intention. We do this because firm attitudes play a vital role in organisational technology adoption (Unsworth et al. 2012).

Table 1: Definitions of constructs FAST

<table>
<thead>
<tr>
<th>Construct</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management involvement (MI)</td>
<td>Is how managers convince and explore effective ways to engage employees in using the innovation. Training for the innovation (Choi et al. 2011).</td>
</tr>
<tr>
<td>Training for the innovation (TI)</td>
<td>Is providing information, knowledge, and skills relevant to the innovation, and thereby enhances employees’ understanding and technical readiness (Choi et al. 2011).</td>
</tr>
<tr>
<td>Performance expectancy (PE)</td>
<td>As the degree to which an individual believes that using the system will help him or her to attain gains in job performance (Venkatesh et al. 2003; 447).</td>
</tr>
<tr>
<td>Efforts expectancy (EE)</td>
<td>The degree of ease associated with the use of the system (Venkatesh et al. 2003;450).</td>
</tr>
<tr>
<td>Social influence (SI)</td>
<td>The degree to which an individual perceives that important others believe he or she should use the new system (Venkatesh et al. 2003; 451).</td>
</tr>
<tr>
<td>External environmental factors (EEF)</td>
<td>Is the environment in which an organisation operates its business (Tornatzky and Fleischer 1990).</td>
</tr>
</tbody>
</table>

3 Referred to as an external attribute. E.g. learning tools. Hereon referred to as external environment.
Organisational factors (OF)  Relates to the characteristics and resources of the firm (Tornatzky and Fleischer 1990).

Attitude  An individual’s positive or negative feelings about performing the target behaviour (Dwivedi et al. 2019; 724).

Perceived risk (PR)  is ‘…uncertainty regarding possible negative consequences of using a product or service’ (Featherman and Pavlou, 2003; 453).

Emotions  Relates to employees’ emotional reactions towards the adoption of the innovation (Choi et al. 2011).

Firm intentions  When a firm plans to adopt a sustainable technology (e.g. if a firm chooses to adopt AFVs over ICE).

Firm adoption of sustainable technologies  Continuous use of environmentally friendly technologies by all employees.

UTAUT was originally developed to understand firm adoption (Venkatesh et al., 2012), but does not explicitly include organisational nor external factors. The TOE model, on the other hand, considers these factors. To overcome these limitations, we integrate the organisational and external factors from the TOE model with UTAUT to provide an organisational overview of the adoption process of sustainable technologies by firms.

**TOE**

As the UTAUT model already evaluates technology characterises, we complement it by integrating the external environment and organisation characteristics constructs from the TOE model. The external environment construct evaluates the competitive pressure, industry characteristics and government regulations that a firm faces when adopting a new innovation. On the other hand, organisation characteristics assess the influence of a firm size, slack and market structure. Prior literature has employed the TOE framework to explain firm adoption of sustainable technologies such as green IT adoption (Lei and Ngai, 2013) and smart grid technologies (Dedrick et al. 2015). Thus, the TOE model, serves as complementary to the
UTAUT model, which is able to analyse sustainable technology adoption from a firm perspective.

**Emotions**
Zehetner et al. (2011) found firm adoption decisions are not always rational nor are they based on a cost-benefit criteria; highlighting the important and influential role emotions play in firm technology adoption decisions. Choi et al. (2011;112) states firms’ collective emotions toward the innovation are a direct predictor of adoption, they ultimately influence the success of innovation in the work unit. Thus, we believe Choi et al. (2011) theoretical framework is appropriate to explain firms’ collective emotions towards adopting an innovation.

**Choi et al. (20119) framework of collective emotions**
Collective emotions are the synchronous convergence in affective responding across individuals towards a specific event or object (Von Scheve and Ismer, 2013;406). Choi et al. (2011) model integrates several theories: institutional theory of implementation (Scott, 1995), cognitive appraisal theory of emotion (Roseman et al. 1990), technology acceptance model (TAM) (Davis, 1989) and affective events theory (Weiss & Cropanzano, 1996). There exists a linear relationship among the following attributes; going from the first to the fourth stage. The first stage is management involvement, and training for an innovation. The second stage is collective appraisal, made up from perceived usefulness (PU) and perceived ease of use (PEU). The third stage is emotions e.g. positive and negative and the fourth stage is firm adoption. In our model, we link management involvement and training for the innovation to the PE and EE constructs since these constructs are closely related to PU and PEU (Venkatesh, 2003).

**Perceived risk**
Perceived risk refers to subjective dimensions of risk that relate to financial, social, safety, psychological, and operational risks (Stone and Grønhaug, 1993). The related sustainable adoption literature identifies perceived risk as a psychological factor that influences attitudes (Huijts et al. 2012). Moreover, perceived risk is documented to have a significant influence on technology intentions in the general technology adoption literature at an individual (Featherman and Pavlou, 2003) and organisational level (Heart, 2010). Despite this, perceived risk has not yet been considered in prevalent technology adoption models, despite numerous technology adoption scholars noting its importance (Dickson 1976 and Gao et al. 2012). Gao et al. (2012), for example, specifically evaluate risk perceptions of industrial firms when adopting discontinuous innovations. The authors find that perceived risk significantly affects intentions to adopt an innovation. It then follows that perceived risk is evidently a factor that
should be considered when evaluating the technology adoption of firms. Thus, we add perceived risk to our FAST model.

3. Method
This paper adopts a snowballing literature review methodology (Figure 4). A ‘snowballing literature review’ methodology is a ‘search approach for systematic literature studies’ (Wohlin, 2014;1). This strategy 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 this paper. The process requires the use of backward and forward citations. The former entails searching the reference list (backwards snowballing), and the latter entails looking at the citations of each paper (forward snowballing) (Badampudi et al., 2015). Greenhalgh & Peacock (2005) suggest that the advantage of this method lies in its reliability to pinpoint prominent research papers.

![Figure 4: Snowballing procedure](image)


We use the databases Science Direct, Wiley, Sage and Springer, Web of Science, and Scopus to establish a tentative start set of papers and to reduce author bias (Wohin, 2014), and do not specify years thereby ensuring the researcher has included all relevant publications.
Moreover, we use a combination of two-set of keywords pertaining to AFV fleets and firm adoption to help facilitate our search including: 'Alternative Fuel Vehicle fleets,' 'Corporate fleet' or 'Electric Commercial Vehicles,' 'Electric Commercial Fleets,' 'Company Firm Adoption,' ‘Electric Vehicles,' Organisation Adoption,' Organisation Acceptance,' 'Government Adoption,' SME adoption,' 'Behaviour,' and 'Intention.'

The next step in the inclusion process is examining if the papers meet the following criteria: 1) they relate to the adoption of AFVs within fleets, 2) they are in a developed country, 3) they are written in English, and 4) they are from peer-reviewed journals. We, therefore, exclude books, book chapters and non-academic studies, as peer reviewed journals are an indicator of high quality (Wicherts, 2016). For diversity in the initial set of papers, we followed Wohlin (2014) established guidelines.

3.3 Iteration process

An iterative backwards and forward snowballing approach was used four times until no new studies arose. It also ensured the traceability of results (Badampudi et al., 2015), as all new studies were then placed into a separate file until the next iteration cycle.

3.4 Data analysis

Our proposed FAST model (Figure 4) acts as a lens through which we evaluate the final set of papers. 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 this it ‘uses a set of procedures to make valid inferences from the text' (Weber 1990; 9). We employ category selection and material evaluation (Mayring 2008). During the category selection phase, we utilise our integrated model to structure the review, while three independent authors evaluated the material to ensure the reliability and validity of the data analysis coding. To substantiate our analysis, we build our model using existing empirical models and literature.

4. Results

Management involvement

In the AFV fleet adoption literature, most studies highlight the importance and the role of top and middle management such as fleet managers in the procurement process of adopting AFV fleets (Boutueil, 2016, Skippon and Chappell, 2019, Hagman and Langbroek, 2019). Boutueil (2016) found that managers often track the progress of AFVs using monitoring tracking
technologies. Klaunberg et al. (2016) believes that analysing patterns of EV usage may uncover the potential for corporate fleets to fully convert their fleets. It seems research on management involvement is rather limited. Further research into this area could explore ways in which managers could ensure successful implementation of AFVs within fleets.

Training for the innovation

Several transportation scholars have investigated the influence of formal communication methods, such as training to use AFVs within firms (Haller et al. 2007, Mattson, 2012, Bennett, 2015, Seitz et al., 2015 and Saukkonen et al. 2017). In general, most studies found that training for AFVs supports the firm’s decision to adopt. However, John et al. (2009) find that formal training does not influence adoption in the case of public fleets, due to the limited training employees receive. However, the authors believe that more training would influence AFV use. Both Jacob et al. (2009) and John et al. (2009) find that employees learn about AFVs through informal communications with each other, due to the limited training firms offer. Margaritis et al. (2016) suggest that national authorities should provide training schemes for organisations, since the correlation between education and adoption is significant (Bennett 2015 and Wikstrom et al. 2015).

Performance expectancy

Existing research highlights that employees using AFVs within organisations tend to help them attain gains in their job performance, which ultimately influences firm intentions and adoption. From an employee perspective, the literature suggests that perceived ‘productivity/efficiency gains’ influences user intentions (Seitz et al., 2015, Wolff and Madlener 2019 and Denstadli and Julsrud, 2019). However, the literature does not specifically state how AFVs increase perceived productivity. The literature within this body of research has touched upon performance expectancy variables. Yet, research within this area is limited and generally disregards the end user of the vehicle (Globisch et al. 2018a, Globisch et al. 2018b). As such, the literature has focused primarily on the relative advantages of AFVs over the internal combustion engine (ICE), from a firm perspective. We identify that these relative advantages can be classified as operational or economical.

When AFVs are in operation, they provide environmental benefits including lower emissions, lower environmental impact, and reduced noise (Golob et al. 2007, Nesbitt and Davis 2013, 4 Defined as getting more work done in less time with AFV than with the ICE or the overall satisfaction with AFVs (Wolff and Madlener 2019 and Denstadli and Julsrud, 2019).

5 Relative advantage is the degree to which the innovation is perceived as better than the one it supersedes (Rogers 1995).
Van Rijnsoever et al. 2013, Sierzchula 2014, Wikstrom et al. 2014, Rolim et al. 2014; Kirk et al. 2014, Boutueil 2016, Mohamed et al., 2018, Zhang et al., 2018, Globisch et al. 2018a, Wolff and Madlener, 2019, Anderhofstadt and Spinler, 2019, Reis, 2019 and Anderson, 2019). On the other hand, cost savings (Denstadli and Julsrud, 2019), such as lower energy costs per kilometre (Mattson, 2012; Galvan et al., 2016 and Zhang et al., 2018) and lower operating costs (e.g. maintenance and fuel) (Nesbitt and Davies 2013 and Barisa et al. 2016, Boutueil 2016 and Hagman and Langbroek, 2018 and Skippon and Chappel, 2019) are related to economic gains.

Although firms tend to adopt AFVs for their operational and economic attributes, they also adopt AFVs to gain competitive advantage over other firms. Moreover, Lebeau et al. (2016) and Saukkonen et al. (2017) find that firms use the environmental friendliness of AFVs as a marketing tool. However, this was found to be firm dependent e.g. industry. Therefore, more research is required on the perceived gains from a user perspective to be able to draw more solid conclusions on the degree to which an individual believes that using the system will help him or her to attain gains in job performance (Venkatesh et al. 2003; 447).

**Effort expectancy**

AFVs are still in their infancy stage and therefore are still experiencing a number of complexities that hinder firms perceive ease of use. We identify four barriers that hinder firm adoption: operational, economic, limited knowledge and organisational policies.

**Operational**

Driving range is one of the biggest barriers to adoption (Koestse and Hoen, 2014; Wikstrom et al., 2015; Barfod et al. 2016; Boutueil, 2016; Margaritis et al. 2016; Zou et al. 2016; Christensen et al., 2017; Lebeau et al. 2016; Kuppusamy et al., 2017; Figenbaum et al., 2018; Morganti and Browne, 2018; Globisch et al. 2018a; Zhang et al., 2018 and Denstadli and Julsrud 2019). This has caused users to be more aware of their energy use. Notably, there have been two attributes contributing to a fleet user changing their driving behaviour due to limited range; weather conditions (Wickström et al. 2014, Zou et al. 2016, and Wolff and Madlener 2019) and driving style, e.g. aggressiveness, (Rolim et al. 2014 and Hagman and Langbroek, 2018).

Moreover, the charging infrastructure is a significant barrier to adoption (Nesbit and Sperling 1998, Haller et al. 2007; Johns et al., 2008; Kirk et al. 2014 Koetse and Hoen 2014; Barisa et

---

6 Complexity refers to the level of difficulty in understanding and using the innovation (Rogers, 1995)
al., 2016; Yang, et al., 2016, Palm and Backman, 2017; Xylia and Silveia 2017; Hagman and Langbroek, 2018, Anderhofstadt and Spinler, 2019, Denstadli and Julsrud, 2019 and Skippon and Chappell, 2019). This is particularly true if the AFV is an exact replacement for the internal combustion engine (ICE) (Veldez et al., 2019). However, some scholars argue that the infrastructure only needs to be adequate, since firms benefit from centralized refuelling stations within their workplace (Golob et al. 2007; Sierzchula, 2014; Wikstrom et al. 2014 and Blusch et al., 2018). However, Kirk et al., (2014) believe that refuelling within the workplace is only suitable for large organisations who can afford refuelling stations in the workplace. Thus, further research within this area is necessary to shed light on these contradictions.

Furthermore, charging time (Van Rijinsoever et al. 2013; Koetse and Hoen 2014; Zou et al. 2016; Yang et al., 2016, Reis 2019; Figenbaum et al., 2018 and Skippon and Chappell, 2019), the lack of standardized charging stations and equipment (Boutueil, 2016, Mohamed et al., 2018), as well as maintenance issues e.g. battery replacement costs (Kuppusamy et al. 2017; Zhang et al., 2018 and Skippon and Chappell, 2019) are also important barriers to adoption.

Lastly, the lack of available AFV models (Barisa et al., 2016, Yang et al., (2018) Skippon and Chappell, 2019 and Denstadli and Julsrud, 2019) and task-appropriate vehicles (Jacob et al. 2009; Nesbitt and Davies 2013; kirk et al. 2014 and Valdez et al., 2019) leads to doubt surrounding the usability of AFVs within fleets, thus hindering their adoption (Denstadli and Julsrud, 2019). Accordingly, Koetse and Hoen (2014) and Zhang et al., (2018) state that if there were more AFV makers, firm willingness to adopt would increase.

Economic

The majority of scholars found that initial capital costs hinder the adoption (Golob et al 1997; Nesbitt and Davis 2013, Wikstrom et al., 2015; Barfod et al. 2016; Barisa et al., 2016; Galvan et al., 2016; Palm and Backman, 2017; Kuppusamy et al., 2017; Globisch et al 2018a, and Reis, 2019). Bus companies perhaps feel the strain of cost the most, as recharging time is longer and more buses are necessary to fulfil the timetable for busses to run on time (Miles and Potter, 2014). Consequently, the total cost of ownership (TCO) is higher for e-buses (Mohamed et al., 2018).

Limited knowledge

Another noteworthy barrier is firms’ limited understanding of environmental issues, the impact that fuel vehicles have on our environment, the vehicles attributes, ownership costs and re-sale value of the vehicle (Nesbitt and Davis 2013, Siechula 2014, Wikstrom et al., 2015, Boutueil, 2016, , Barisa et al., 2016, Xylia and Silveia 2017 and Hagman and Langbroek,
Moreover, not only is there a need for more information, but also for this information to be more accessible (Wikstrom et al., 2016a, Boutueil, 2016, Palm and Backman, 2017, Li et al., 2018 and Anderson 2019). Given the size and importance of this market, it is surprising that firms have limited knowledge of these areas. Implementation of education programmes tailored to address uncertainty around AFVs could be a viable starting point. Future research could identify firms’ areas of limited knowledge of AFVs, so policy makers and marketers are able to directly address them.

**Organisational policies**

Organisational policies can hinder the adoption of green vehicles in two ways. Either firms have a lack of green policies that guide the implementation (Mohamed et al., 2018) or the firms policies are too strict. Consequently, these limitations deter managers to adopt AFVs (Nesbitt and Sperling, 1998, Nesbitt and Davis 2013 and Skippon and Chappell, 2019). Therefore, the decision-making criteria requires restructuring (Nesbitt and Davies, 2013) especially for those firms that allow employees to choose their own vehicles (Skippon and Chappell, 2019). Evaluating this construct highlights that AFVs are still perceived by firms as extremely difficult to use. Koetse and Hoen (2014) argue that the adoption of AFV fleets will only increase when the adoption barriers are reduced.

**Social influence**

Numerous studies have confirmed that subjective norms play a central role in a firm’s decision-making process to adopt AFVs into their fleets (Bennett, 2015, Kaplan et al. 2016 and Wolff and Madlener 2019). For instance, most studies find that firms adopt to communicate a “green” image of their brand (Nesbitt and Sperling 1998; Nesbitt and Davis, 2013; Rolim et al. 2014; Sierzechula’s, 2014; Boutueil 2016; Barisa et al., 2016; Denstadli and Julsrud 2019 and Skippon and Chappell, 2019). However, Boutueil (2016) found that firms did not adopt just to improve their image of the company, but rather for their customers and employees. Similarly, social signalling is also found to influence firms’ intentions to adopt sustainable vehicles (Wikstrom et al., 2015 and Skippon and Chappell, 2019). However, within the commercial sector, symbolic meanings are under researched (Gnnan et al. 2015) unlike the private sector, where cars are seen as an expression of self-identity (Graham-Rowe et al. 2012).

---

7 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, p. 302).
Many transportation scholars have highlighted subjective norms as an important influential factor on adoption intentions, as they relate to firm customers and/or employees (John et al. 2009, Kaplan et al. 2016, Klaunberg, 2016 and Wolff and Madlener 2019). However, studies thus far have only considered the subjective norms of top management with the exception of John et al. (2009:406) who consider ‘supervisors and co-workers’ subjective norms. Furthermore, these studies assume that top management has positive subjective norms. Therefore, more research is required on the user’s subjective norms in relation to actual adoption. Research could also investigate how to manage negative subjective norms of end users and thus how to translate this into positive adoption intentions and adoption. Hence, at the moment, it is difficult to explain the degree to which social influence of AFVs influences adoption behaviour of individuals.

**External influence**

**Industry**

Arguably, governments are the most likely to adopt AFVs into their fleets first, because they are required to set an example as a force against climate change and air pollution (Nesbitt and Sterling 1998, Van Rijnsoever et al. 2013, Klaunberg et al. 2016 and, Palm and Backman, 2017), and contribute to national and regional climate goals and policy (Barisa et al., 2016).

However, Kaplan et al. (2016) found energy and technology companies to be more familiar with EVs and are thus more likely be early adopters, compared to agricultural and public-sector firms who are less familiar. Moreover, vehicle miles travelled (VMT) also has an influence on firms’ intentions to adopt (Seitz et al. 2015). Analysing a firms VMT is used as an indicator of a firm’s suitability to adopt AFVs. The literature suggests that firms that tend to have small annual/daily VMT tend to me more feasible to become early adopters of AFVs (Golob et al. 1997 and Koestse and Hoen,2014). It is believed that construction (Klaunberg et al. 2016, Christensen et al. 2017 and Denstadli and Julsrud 2019) and healthcare companies are the most suitable to adopt EVs, due to their mileage being relatively low, and the number of registered vehicles within this sector being high. In an earlier study, Golob et al. (1997;224) states that transportation and communication firms have the highest VMT, followed by the automotive, business service sector, retail, wholesale trade sector, while schools recorded the lowest VMT.
**Government regulation**

Despite the widely documented, positive significant correlation between government regulation\(^8\) and adoption. The use of government incentives tends to be used by firms to support adoption behaviour (Skippon and Chappell, 2019). The literature suggests that government incentives do not always play a central role in the adoption of AFVs within fleets (Sierzchula 2014 and Figenbaum 2018). The role which government plays, tends to depend on each firm's: country, size, industry and profitability. Overall, it can be said that most organisations do 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; Koestse and Hoen 2014; Barisa et al., 2016; Li et al., 2018; Yang et al., 2018; Zhang et al., 2018). Some government incentives include low registration fees and subsidies (Barfod et al. 2016) and low emission zones and highway toll exemptions (Anderhofstadt and Spinler, 2019).

Furthermore, legislation always plays a role in the uptake of EVs within government agency fleets (Sierzchula’s, 2014 and Wikstrom et al., 2016b) as well as firms (Parker et al. 1997, Nesbitt and Sterling, 2001). Surprisingly, in Parker et al. (1997), study, half of the respondents surveyed believed that the government does not act strongly enough to enforce regulations delineated in acts such as: The Clean Air Act (1990) and Energy Policy Act (1992). More research is necessary to gauge if firms still hold these opinions.

**Trialability\(^9\)**

Field trials and demonstration/pilot projects are being introduced to firms to explore mobility options and test new technology. Numerous scholars document its influence on a firm's intentions to adopt (Sierzchula 2014 and Palm and Backman 2017). Through trials and demonstration projects employees build knowledge through experiencing the innovation and therefore tackle any unease, uncertainties or pre-existing notions that they may have had about the vehicle (Wikstrom et al. 2016b and Klauenberg et al., 2016, Mohamed et al., 2018). The initial experience shapes the user's perception and influences users to accept or become reluctant to use the technology (Wikstrom et al. 2016a;63). Thus, trails and demonstration projects significantly assist firms to form positive subjective norms, attitudes and experiences towards AFVs to influence adoption. However, although governments around the world have provided demonstrations and trail projects to learn about AFVs, little has been done to provide comprehensive information to firms on how adopting AFVs would benefit their firm. It is

---

\(^8\) Including, but not limited to; policy, legislation and monetary and non-monetary incentives.

\(^9\) Trialability is the degree to which adopters are able to experiment with an innovation on a limited basis (Rogers, 1995).
surprising that as of yet, there is no study on how to educate firms on the important issues of AFVs and how adopting AFV would benefit their firm.

Organisational factors

Size

Firm size relates to the number of employees within a firm. This factor is a significantly influences firm’s intentions to adopt AFVs (Gnann et al 2015; Seitz et al. 2015, Kaplan et al. 2016). Naturally, the literature suggests that large firms are more likely to adopt AFVs even with industry regulation and onsite refuelling (Golob et al. 1997). Large firms are better suited than small firms for several reasons. First, they are more willing to accept the financial risks associated with nascent technologies (Golob et al. 1997; Nesbitt and Sperling 1998; Sierzchula’s 2014). This is partly to gain rewards such as first mover advantages, operational capabilities, and/or compelling business models (Sierzchula’s 2014). Second, larger firms have a better access to information through their fleet manager than do smaller firms (Bennett, 2015). Third, they are easily able to rotate drivers and vehicle assignments to accommodate limited range issues (Golob et al. 1997). Finally, large firms are more inclined to transform corporate social responsibility (CSR) into applied business practice (Golob et al. 1997; Nesbitt and Sperling, 1998 and Zhang et al., 2018). This is because they are more likely to include an environmental attitude and CSR into their general business philosophy’ (Seitz et al. 2015;259). Additionally, a firm’s fleet size is also regarded as an influential factor for firms to adopt (Golob et al. 1997, Sierzchula 2014, Kaplans et al. 2016). This review found that firms with larger fleets and more employees are more likely to purchase AFVs (Golob et al. 1997 and Seitz et al. 2015).

Organisational slack

This review highlights how testing new technology is a strong driver behind AFV fleets adoption (Sierzchula, 2014 and Zhang et al. 2018). To test such a high-end technology, a firm requires adequate cash flows, as liquidity of cash ultimately affects profitability. This review suggests that adopting AFVs is dependent on the company’s profits (Kuppusamy et al. 2017 and Anderson 2019). As expected, the high capital needed, and initial economic losses generally prevent small firms from adopting EVs because of lower relative cash flow (Globisch et al 2018a). This highlights the importance for firms to be cash rich in order to test and afford AFV fleets, at least until the benefits outweigh the costs.

Such information includes, but not limited to, trade associations.
Managerial structures

The managerial structure within an organisation plays a strong role in the decision-making process. Nesbitt and Sperling (2001) were the first to identify managerial structure as a factor that influences the adoption of AFVs. Their categorisation of fleets is broken into four different decision structures based on the levels of formalisation and centralisation. These include autocratic, hierarchic democratic, and bureaucratic. Autocratic firms can be small, private firms managed by the owner. They are less likely to take risks and thus are unlikely to be early adopters of AFVs. Saukkonen et al., (2017) found that entrepreneurs tend to be autocratic in their structure and are influenced by personal values and attitudes. Democratic firms often possess single decision makers yet lack an “appointed decision maker”. Their study found that autocratic and democratic decision-making structures were the least common structure types. Yet, a number of transportation scholars have focused on just small to medium (SMEs) businesses (e.g. Kaplan et al. 2016, Klaunberg et al. 2016). This is due to SMEs being viewed as ideal early adopters, since they have an autocratic managerial structure, are risky decisions makers, and tend to have an openness and ease to change (Nesbitt and Sperling, 2001).

On the other hand, for large firms, the decision to acquire AFVs or purchase an entirely new fleet of vehicles involves a highly complex decision-making process. Indeed, such firms tend to be hierarchic or bureaucratic with a dispersed decision-making process involving numerous functional departments and/or numerous geographical scopes of responsibility. Although senior managers generally spearhead these decisions (Nesbitt and Sperling, 2001 and Boutueil’s 2016), this decision-making can come from any level (Nesbitt and Sperling, 1998, 2001 and Boutueil, 2016 and Skippon and Chappell 2019).

Attitude

This review found that firm attitude is a significant factor influencing fleet adoption intentions. For instance, Sierzchula (2014) and Kaplan et al. (2016) found that fleet managers who maintain positive attitudes toward AFVs often succeed in adopting AFVs. This also holds true even for large firms (Saukkonen et al. 2017 and Globisch et al. 2018a). However, Bennett (2015) found this was not always the case. Yet, 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). Perhaps this is because top management tend to make the final decision. Moreover, research within this

11 E.g. Human resources, finance, fleet management, logistics, mobility management etc.
12 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).
area assumes that attitudes are positive (Kaplan et al. 2016, Lebeau et al. 2016, Globisch et al. 2018b, Morganti and Browne, 2018 and Wolff and Madlener 2019). Thus, further research within this area is still needed to understand how actual attitudes in different contexts influence adoption. This is especially important, as attitudes toward the vehicle may change once given a positive experience (Wikstrom et al. 2015). Hence, further research into the negative attitudes towards AFVs by a variety of stakeholders and how to manage them is invaluable.

**Perceived risk**

Risk perception within the decision-making process of fleets significantly influences adoption intention. Risk factors such as high levels of operational and financial risk are likely to have an impact on a firm’s intentions to adopt EVs (Bennett 2015). In the case of electric bus adoption, Mohamed et al., (2018) document this as the ‘guinea pig’ syndrome. In their study, respondents noted being the first firm to provide e-buses increased their perceived risk which therefore led them not to adopt. However, Denstadli and Julsrud (2019) found perceived risk to be only ‘marginally significant’. Nevertheless, the literature in this area only identifies perceived risk in terms of ‘technology anxiety’ e.g. range, and charge time (Mohamed et al., 2018) and the substantial start-up capital (Bennett 2015). Thus, research is required on the social and physical risks potentially influencing firms' willingness to adopt, as well as on user’s perception of usefulness and ease of AFVs. In fact, Bennett (2015) argues that information campaigns designed to lower the perception of risk are required.

**Emotion**

This review revealed that the role of emotions in the adoption decision-making process has not yet been thoroughly examined. To date, one paper by Saukkonen et al., (2017) studies the emotional triggers their conversion from ICE to natural and biogas vehicles for investment purposes. Their study was based on of numerous Finnish firms from different industries. However, the authors scope was rather narrow as it was limited to only the top and middle management of the firms. Nonetheless, Saukkonen et al. (2017;59) did find that firm decisions to adopt AFVs are not always rational. Namely, the authors state a firm’s decision to adopt is influenced by ‘subjective (e.g. feelings) and objective (e.g. facts) inputs’. Thus, this confirms that emotions do interplay in the adoption of AFVs by firms.

Studies within the consumer market, on the other hand, found that consumer's emotions profoundly influence attitudes and intentions to adopt EVs (Moons and De Pelsmacker 2012, Schuitema et al., 2013). There exist numerous areas for future research on the role of emotions in a firm’s adoption process. Some suggestions for further research could include how collective firm emotion influences the adoption of AFVs; and the link between attitudes
and emotions. This would then inform policy makers, marketers and manufactures when tackling the current barriers of AFV adoption.

**Figure 5**: Overview of the AFV fleet adoption literature
5. Discussion and research outline

We use FAST as a lens to analyse the literature on the adoption of commercial AFVs. By doing so, we were able to highlight important factors that have an influence on firms’ decision making. It is important to note, however, that although this review has separated the literature into different categories according to our model, these categories are interlinked in many of the studies. The adoption of AFVs requires a combination of these factors; no single factor alone can influence a firm to adopt. Rather, it is a mixture of these factors within our FAST model that influences the adoption of AFVs by firms. Ultimately, for firms to adopt AFVs they must be compatible with the firm needs (Saukkonen et al., 2017)

**Contribution of our results**

Our review has enabled us to provide the following contributions to the AFV adoption literature. First, analysing the performance expectancy construct enables us to identify two main relative advantages over the ICE that influence firms to adopt; operational and economic. Second, we also identify the main complexities of AFVs that hinder firms to adopt AFVs under the effort expectancy construct. These can be categorised as; operational, economic, limited knowledge, and organisational polices. We use these classifications to shed light on the main enablers and barriers to AFV fleet adoption. These classifications can act as a starting point for future research and help inform marketers and policy makers. Third, we find that
government policies and incentives do not always play a central role within firms’ adoption decisions. Rather, government subsidies or policy initiatives are considered as secondary factors (Sierczula’s, 2014) that support their adoption behaviour (Skippon and Chappell, 2019). Fourth, our analysis reveals the most and least mentioned factors within the literature according to our model. We found that the effort expectancy construct to be the most mentioned factor in the AFV fleet adoption literature. On the other hand, emotions are the least discussed factor in the literature and thus requires more research.

Limitations of the literature
One limitation is the limited research on how top and middle managers are involved in the adoption of AFVs, and what strategies they use or could use to inform and transitions negative attitudes and subjective norms into positive ones. Another limitation of the AFV fleet adoption literature is the limited research on different stakeholders of a firm and how these individuals (within a firm) have an influence in the decision-making process. Moreover, the understanding of how, and to what extent, does an individual’s attitudes impact the adoption of AFVs by firms. Indeed, recent research documents that the attitudes of a single employee may also significantly influence a firm’s decision-making process (Globisch et al. 2018a). As such, this could also imply that an individual’s emotions will perhaps have a similar outcome. Furthermore, studies tend to assume that top and middle management always have positive attitudes and subjective norms. However, with the number of complexities of AFVs in general, we believe that such an assumption does not provide a realistic analysis of the adoption of AFVs by firms.

In addition, we contend that the AFV literature has some methodological restrictions. The majority of the studies included within this review take the form of choice modelling method to understand the firm adoption of AFVs from a preferences and intentions perspective. However, this, limits our understanding of this field, since intentions do not always translate into actual behaviour. One reason as to why most studies are conducted from this perspective is perhaps due to AFVs’ relatively high purchase price. This, therefore, limits some firms to easily adopt AFVs, which makes it difficult for researchers to conduct studies on adoption. However, as technology improves, AFVs are becoming more affordable. This hopefully, would encourage researchers to continue to research this area.

Moreover, in the few studies that do provide insight into actual adoption factors, studies have used early adopter organisations and/or government fleets as their sample. This sample can cause a bias in the findings, since early adopters tend to be more favourable towards new technologies (Kaplan et al. 2016), and public fleets are in essence forced to comply with
regulation and are expected to be seen as leaders in developing the AFV market. Moreover, there was little qualitative research within this field when compared to the amount of quantitative or mixed methods studies. Understanding adoption decisions requires an understanding of behavioural elements such as; feelings, motivations, attitudes, beliefs, and opinions. Qualitative research aims to answer questions such as ‘why’. Therefore, we believe that more qualitative research within this area is required to validate previous findings.

Future research suggestions

In light of our findings, we argue that there exist further research avenues on policy. With the AFV fleet adoption literature, as far as we are aware, no research has investigated a country’s AFV policies and its’ impact on the diffusion of AFV fleets. To this end, research on how the diffusion of sustainable technologies is affected by policy intervention is limited (Rogge and Reichardt, 2016).

Like Rezvani et al. (2015), we argue that emotions are an overlooked factor in the adoption of AVF fleet literature. This review acknowledges that emotions do interplay in a firms’ adoption decisions. However, the understanding of what emotions interplay, when, how they change over time and how collective v.s. individual emotions in a firm context influence a firm’s decision-making process seems to be non-existent. Thus, we believe future research within this field should focus on understanding the role of emotions and how they influence adoption behaviour. Rezvani et al. (2015) believes in examining emotions could enhance the understanding and provide suggestions for designing education, communication, and policy-related information for the diffusion EVs. We believe this is also most likely to apply to the adoption and diffusion of AFVs by firms.

One research avenue that particularly warrants research is the link between emotions and policy, as highlighted Kaplan et al. (2016). Within the psychology literature, there is evidence to suggest that there exists a bi-directional relationship between policy and emotions (Rodriguez-Sanchez et al. 2018). Thus, it is believed that further understanding of emotions as an influential factor of AFV adoption is required. Linking research streams of decision-making, emotions, and policy would provide novel insights to the adoption of AFV literature.

A significant barrier for the adoption of AFV fleets is due to the limited knowledge firms have on AFVs, along with their implications on TCO and environmental impact. Previous research within this area has demonstrated the positive significant link between education and adoption. Thus, to enhance our understanding, we suggest that further research should highlight ways in which to effectively educate firms on AFVs as well as the benefits and technicalities of AFVs.
Moreover, one reason why most firms adopt AFVs is to illustrate a ‘green image’. It is surprising that there is a limited research on the symbolic meaning of AFVs. We believe further research into the symbolic meanings of AFV for different industries and countries would provide interesting findings, since symbolic meanings are environment dependent. As such, manufacturers, policy makers, and marketers would then have a more informed understanding when trying to sell AFVs.


Nesbitt, K., & Davies, J. (2013). *From the top of the organization to the bottom line: Understanding the fleet market for plug-in electric vehicles. 2013 World Electric Vehicle Symposium and Exhibition (EVS27).*


