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Moving Towards Electrification of Workers' Transportation: Identifying Key Motives for the Adoption of Electric Vans

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Abstract: The large-scale diffusion of low-emission vehicles is required to increase the sustainability of the transport system. Statistics show strong and continued growth in the sales of electric and other low-emission vehicles in the passenger car market. The commercial market, however, has thus far been a different story, despite the fact that vans and other utility vehicles constitute an increasing share of total road traffic and emissions. The present study investigates the potential for increasing the adoption of electric vans (e-vans) among small- and medium-sized enterprises (SMEs). Data gathered in a web survey of 264 SME managers show that 25% of the managers expressed intentions to adopt e-vans within the next two years and another 27% within the next five years. Results from logistic regressions show that a combination of attributes related to the vehicle, the firm and the firm-environment relationships drives adoption intentions. Costs and vehicle reliability are typically important drivers of commercial vehicle purchases. E-vans, however, bring symbolic features into the decision process since they are seen as a measure to improve the green legitimacy of the enterprise. Various measures relevant to manufacturers/dealers and policy makers to stimulate the adoption of e-vans are discussed.

Keywords: electric vans; technology adoption; SME; green transportation

1. Introduction

The large-scale diffusion of low-emission vehicles is required to increase the sustainability of the transport system. The battery electric vehicle (BEV) is to date the most developed low-emission technology for motorized transport. The number of available BEV models offered by different car manufacturers is increasing, and adoption rates are growing. In 2017, the global stock of BEVs reached about 1.9 million [1]. The great majority of these BEVs were passenger cars; electric vans (e-vans) and other utility vehicles constitute only a minor share of the total number of BEVs sold. The low number of e-vans is concerning, since the contribution of utility vehicles to air pollution and greenhouse gas emissions is far greater than their share of vehicle kilometers. In the United States, about 10% of the vehicle-miles travelled in urban areas are done by utility vehicles, but they account for 50% of the CO_x-emissions in these areas [2]. Moreover, figures show that commercial vehicles constitute an increasing share of total road traffic in several countries [3–5].

Much recent research has identified early users of alternative fueled vehicles and determinants for adoption in the consumer market [6–11], whereas studies dealing with the commercial sector are limited [12]. It is well established that commercial adoption and buying decisions differ from those of consumers [13–15]. In vehicle purchases it has been shown that commercial buyers are more need-oriented and instrumentally driven compared to consumers [16,17], indicating that motives driving the adoption of e-vans differ from those for passenger BEVs. The purpose of the present study is to identify factors that stimulate e-van adoption intentions among managers in small- and medium-sized enterprises (SMEs) and to suggest methods for encouraging adoption plans and reducing resistance to e-van adoption. In this way, the study responds to the request from Rezvani, Jansson and Bodins (2015) for additional research on the adoption of low-emission vehicles outside the consumer market [18].

Study Context

While some previous studies on BEV adoption in the commercial sector have taken a qualitative approach [12,13], this study is based on a quantitative survey of managers in small- and medium-sized enterprises (SMEs) within industrial and construction industries in Norway. This context is relevant for several reasons. First, SMEs are generally considered good candidates for the early adoption of technology since they are better able to implement rapid changes compared to larger firms [19–21]. Second, enterprises within industrial and construction industries (e.g., carpenters, plumbers) conduct work that requires carrying tools, materials and other equipment necessitating car transportation, and their share of total road traffic is increasing (cf. above). Finally, Norway is an interesting case since the government has established a comprehensive incentive scheme to encourage the adoption of BEVs. The incentives include both monetary (e.g., value added tax (VAT) exemption) and non-monetary (e.g., access to bus lanes) features and have proven successful in the consumer market, where Norway is seen as a European and global frontrunner in terms of BEV adoption [1,22,23]. Sales statistics show that more than 56,000 passenger BEVs were sold in Norway in 2018, constituting 31% of the total number of passenger cars sold, the highest percentage in Europe [24]. BEVs now constitute 7.2% of the passenger car stock compared to 3.7% at the end of 2016. In the van market, the picture is totally different, despite the fact they are given equal privileges as passenger BEVs. E-vans constitute only about 1% of the total stock of vans in Norway (Figures downloaded from Statbank produced by Statistics Norway: https://www.ssb.no/en/statbank/table/11823/. Webpage last visited April 2019). Hence, whereas passenger BEVs in Norway have crossed the 'diffusion chasm', e-vans sales are lagging.

2. Identifying Predictors of E-Van Adoption

The great majority of studies on BEV adoption deal with consumer decisions. Different theoretical perspectives and methods have been used to understand these processes. Some studies consider BEV adoption a rational process [25], while others use norm- and attitude-based theories such as the theory of planned behavior [26,27] and social comparison theory [28] as departure points. The methodological approaches taken include demonstration projects [29], public surveys [11,27] and various forms of stated choice experiments [30,31]. Since the number studies of commercial BEV adoption are limited, we considered an open, 'explorative' approach appropriate for the current study. This implied the inclusion of a breadth of predictors and theoretical perspectives. Moreover, e-van adoption is an organizational innovation and its process differs from consumer adoption processes. While individual attitudes and motives might be relevant to SMEs' adoption of e-vans, organizational innovation theory proposes other adoption criteria and mechanisms in a business context [15,32,33]. Hence, to identify relevant predictors of e-van adoption, the present study considered various theoretical perspectives and studies on the adoption of technology by SMEs, including scattered empirical evidence on the business adoption of low emission vehicles (LEVs) [13]. This generated a preliminary list of potential e-van adoption predictors. To validate the list, in-depth interviews with five SME managers who were considering adopting e-vans were conducted, and a final list of predictors was prepared for a survey questionnaire. These are addressed in the following sections and can be grouped into three main categories: (i) vehicle attributes, (ii) firm-environment relationships and (iii) firm attributes.

2.1. Vehicle Attributes

Classic diffusion theory [34] claims that much of the variance in adoption rates can be explained by the attributes of the innovation. One of the strongest predictors of an innovation's rate of adoption is its perceived relative advantage vis-à-vis conventional technologies and its ability to provide gains to the user [34,35]. Empirically, relative advantage is often associated with efficiency/productivity indicators and is thus closely related to the 'Technology Acceptance Model' (TAM), in which perceived usefulness is one of two key predictors of technology adoption [36]. Concerning BEVs, utility/gain factors may include cost savings, more environmentally friendly transport and faster transit. Despite the higher upfront costs compared to internal combustion engine vehicles (ICEVs), lower fuel and maintenance expenditures make BEVs a likely cost saver in the long run. Studies have shown that some—but not all—consumer segments respond to information on total ownership costs in their preference rankings for various vehicle technologies [25]. This effect may be even stronger in the business market, since commercial vehicle purchasers are primarily instrumentally driven [16,17] and vehicle attributes that support cost savings and reliable and efficient transport are highly valued. Accordingly, SME managers' perceptions of the capability of e-vans in providing these gains is likely to affect adoption intentions.

Green innovations, however, often come with functional disadvantages compared to conventional technologies and may thus be associated with greater risk. Perceived risk is the subjective expectation of loss that the decision maker experiences when considering the adoption of an innovating technology [37]. Loss includes monetary loss (financial risk), reduced esteem (social risk), safety concerns (physical risk), feelings of tension/anxiety (psychological risk) and operational deficiencies (performance risk) [38]. Perceived risk theory suggests that buyers aim to minimize their perceived risk rather than to maximize the expected utility [39] and that reducing the perceived risk of adopting a green technology increases green purchase intentions [40]. Concerning BEVs, range limitations are seen as a particularly strong risk parameter and a barrier to widespread adoption [41]. For e-vans, reduced payload capacity has also been emphasized as an adoption hindrance for last mile operators [12]. Range and payload limitations are related to performance risks. Reduced load space limits the amount of goods to be transported, whereas insufficient battery capacity can strand the driver and lead to several hours of unproductive time and loss of income to the SME. The term 'range anxiety' describes this specific risk perception, which is likely to create a general uncertainty about pursuing e-vans over ICE vans in the business market.

2.2. Firm–Environment Relationships

Institutional theory emphasizes that organizational practices and structures are strongly influenced by social and cultural pressures from stakeholders. DiMaggio and Powell (1983) use the term 'organizational fields' to describe organizations that constitute a recognized area of institutional life (e.g., suppliers, customers and competitors) and maintain that within these fields, a form of institutional isomorphism may emerge wherein managerial behavior becomes more homogeneous [42]. Isomorphic change can be driven by different mechanisms: for instance, through collaboration and knowledge sharing [43,44] or when enterprises imitate and model themselves after organizations that they perceive to be successful (mimetic isomorphism). In this way, successful business competitors form norms and become 'role models', and their use of new technologies, e.g., e-vans, may stimulate their adoption in other enterprises in the industry and gradually lead to the establishment of an industry practice. The influence of normative factors is recognized in the consumer adoption of low-emission vehicles. Cherchi (2017) reported a strong effect of social conformity on the overall utility attached to BEVs and concluded that the effect can be strong enough to compensate for limited driving range and differences in the purchase price between BEVs and ICEVs [45].

Coercive isomorphism describes the pressure exerted on organizations by their stakeholders [42]. Several studies previously reported that the adoption of green technologies and practices are motivated by customer concerns. For example, Yen and Yen (2012) found that customer pressure positively influenced the extent of firms' green technology purchasing in the electronics industry [46]. Indeed, Perry and Towers (2009) claimed that SMEs that fail to adopt appropriate corporate social responsibility and environmental management practices run the risk of being excluded from larger firms' supply chains [47]. This type of pressure might well enforce the implementation of green technologies in SMEs.

The enforcement of environmental practices among businesses may also be driven by governmental bodies through legislation. In the case of electric mobility, however, authorities in many countries use rewards rather than punishment to induce change by introducing privileges for BEVs over ICEVs. Incentives are often used to speed up the rate of adoption of innovations [34] and may be particularly important for green innovations since they often come with economic and functional disadvantages compared to conventional technology, e.g., limited range in the case of BEVs. Results from various studies indicate that incentives, in particular tax incentives, are a powerful tool to stimulate the adoption of alternative-fueled vehicles [48–50]. Eggers and Eggers (2010) maintained that the consumer adoption of low-emission vehicles might be limited if incentives were not provided [51], and Figenbaum and Kolbenstvedt (2016) claimed that governmental incentives had been critical to the success of BEVs in Norway [52]. On the other hand, the low number of e-vans indicates that incentives are of less importance to commercial buyers than to private consumers, although government grants have been reported to influence fleet managers' decisions to adopt LEVs [13].

Corporate image refers to the way a firm's management and employees believe that stakeholders and others view the enterprise [53]. There is a growing awareness regarding the environmental effects of business operations. Research has documented that stakeholders prefer to deal with environmentally oriented firms [54,55], suggesting that the 'greening' of the corporate image builds a competitive advantage. Due to their high level of observability, SME managers may consider e-vans a good way to communicate and strengthen a green corporate image. Symbolic meanings have generally not been emphasized in commercial vehicle buying decisions [16], as opposed to private buyers who may place a high value on the image of the car, for instance as a means of expression of self-identity [56,57] or social signaling [42]. For e-vans, this might be viewed differently: the image-building capability of e-vans may be a significant driver of adoption intentions.

2.3. Firm Attributes

Various characteristics of the firm affect innovation efforts and output. Organization innovativeness refers to a firm's cultural readiness and appreciation for innovation [58]. Innovativeness has become a key element in most business areas and has emerged as a desirable quality of organizations since it enhances their likelihood of survival and long-term success [58,59]. Organizations with higher levels of innovativeness are more inclined to implement or adopt innovations [60], which might also transfer into an increased willingness to experiment with alternative mobility technologies, such as e-vans.

Enterprises' engagement in green innovations is related to their available resources and capabilities. Recently, the concept of eco-capability has been introduced to describe a firm's capacity to deploy human, business and technology resources to enhance the firm's performance and conserve the natural environment [61]. Closely related to this is how concerned and aware managers and employees are about environmental issues. The environmental orientation of an enterprise rests on the extent to which managers recognize the importance of its environmental problems [62]. Often this is embodied in corporate mission statements which describe the firm's internal values, norms of moral behavior, efforts committed to environmental conservation and attitudes towards environmental conservation that may influence its relationships with external stakeholders. Findings suggest that environmental orientation is positively related to the implementation and use of green innovations, as well as eco-innovation practices [63,64]. As a 'green' technology innovation, e-vans are likely to appeal to firms with a high level of environmental orientation. Although claims have been made that SMEs are less involved in environmental practices compared to larger firms and that they undertake reactive rather than proactive measures to environmental management [65–67], heterogeneity in SMEs' engagement of environmental practices has previously been reported [68]. For instance, many enterprises subscribe to environmental certification schemes, such as the ISO14001, to help manage the environmental effect of their operations. Enterprises that engage in a high level of transportation could significantly reduce emissions from their operations by substituting ICE vans with e-vans. Furthermore, e-vans may be a measure to meet the requirements of third-party certification schemes.

A distinct characteristic of SMEs is that they are often managed by their owners and that the owners' norms and attitudes can greatly affect company practices. According to the Value-beliefs-norm theory [69], pro-environmental norms and attitudes will influence an individual's behavior in different domains, including actions taken in organizational life. Marshall et al. (2005) found a significant relationship among managers' attitudes, subjective norms and cooperate environmentalism in the US wine industry [70], and Papagiannakis and Lioukas (2012) claimed that managers with high environmental consciousness viewed their company as an arena in which to materialize their personal environmental concerns [71].

Other influential individuals with regard to technology adoption include innovation champions. Champions are innovative-minded persons within a firm who promote the adoption of a specific technology [34]. Champions work to obtain support from management as well as resources in order to implement the technology and overcome the resistance it may provoke within the organization. Championing behavior is positively related to technology adoption [34,72–74], including 'green' innovations [75]. The presence of e-van champions in industrial and construction enterprises is likely for two reasons. First, e-vans may motivate 'eco-champions' within the firm to exert their influence, and second, given the high penetration of e-vans in the private market, carry-over effects may be present in the sense that employees with positive BEV experiences in the private domain may become advocates for the adoption of e-mobility in the enterprise.

2.4. Researh Model

Figure 1 summarizes the above discussion in a research model that is empirically tested. Four control variables are included in the model in addition to the factors discussed above. Since e-vans have a limited driving range and available models in the market are restricted to smaller vans, the suitability of e-vans, and hence adoption intentions, is likely to be influenced by the daily mileage of the firm's car fleet and fleet characteristics. Firm size is included since previous studies have shown that this is a likely predictor of adoption capabilities [19–21]. Finally, location might be a relevant predictor, as BEV innovators in Norway tend to be located in the capital region of Oslo [76]. Corresponding to the majority of BEV adoption studies, the main focus of the present research is on intentions for adoption rather than actual adoption. This is due to the low market share of e-vans and difficulties in reaching current users. Only 14 enterprises in our sample were currently using e-vans (see below).

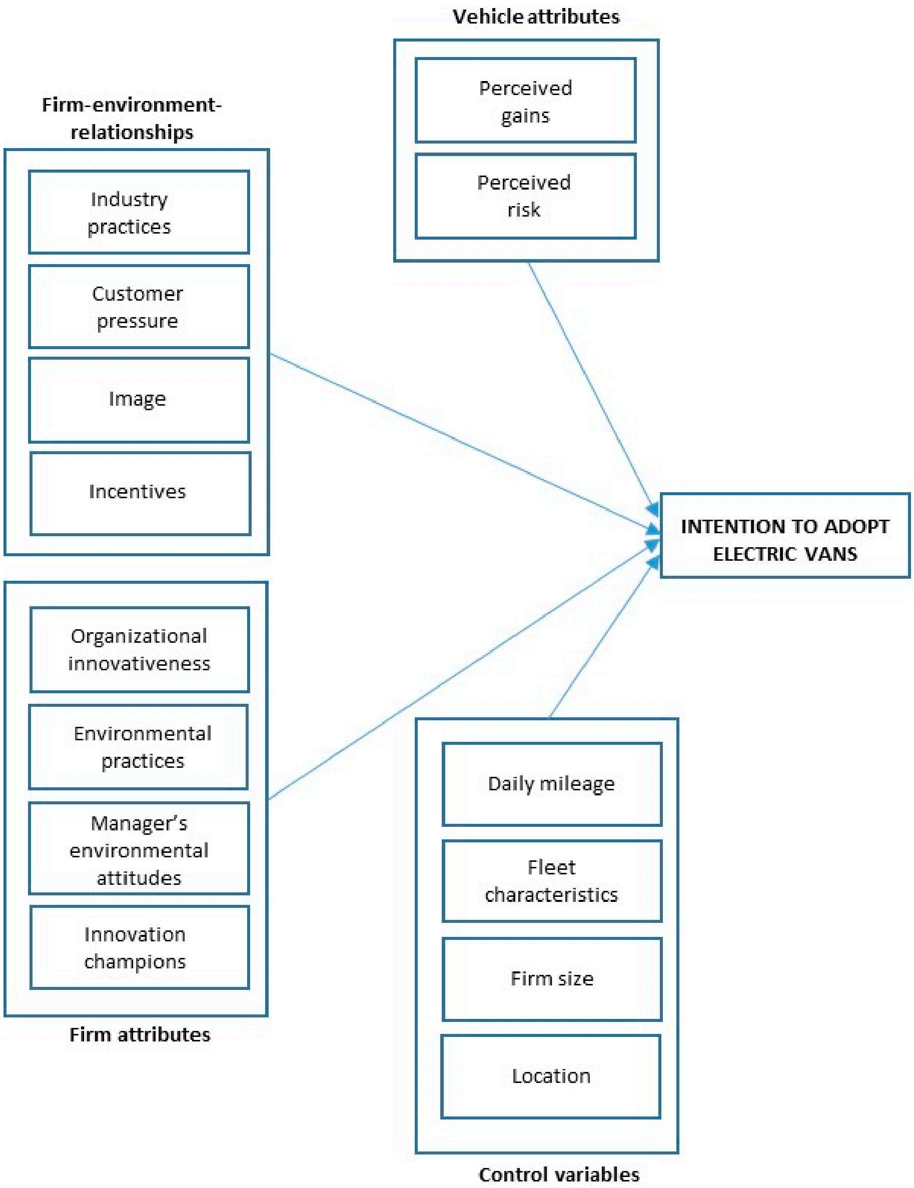

Figure 1. Research model.

3. Materials and Method

3.1. Data Collection

Data was gathered through a web-based survey among managers in SMEs in seven industrial and construction trades: carpenters, electricians, bricklayers, house painters, plumbers, installation contractors and tinsmiths. These trades were selected since their work requires carrying tools, materials and other equipment necessitating car transportation. Respondents were recruited among members of tradesperson organizations in the four largest cities in Norway (Oslo, Bergen, Trondheim and Stavanger). Sampling enterprises in urban areas, rather than nationwide, was motivated by the fact that BEV infrastructure (charging stations, parking lots, etc.) is more developed in the major cities, and BEVs for passengers have been adopted first and most extensively in urban areas in Norway [76]. Managers were recruited due to their general knowledge about the enterprise and their involvement in strategic decisions concerning technology adoption and environmental management. This is particularly relevant in the SME context [77]. From the tradesperson member organizations the research team received e-mail addresses of contact persons in relevant enterprises. For the great majority of enterprises, the contact person/respondent was the owner/general manager, but in some cases, they held another managerial position in the firm (see Table 1).

Table 1. Reliability tests and descriptive statistics for reflective measures.

	# of Items in Scale	Cronbach's Alpha	Mean	Std. Dev.	Skewness	Kurtosis
Perceived gains	2	0.590	2.87	0.881	0.106	0.035
Perceived risk	3	0.826	3.48	0.821	−0.226	−0.062
Manager environmental attitudes	3	0.696	3.66	0.839	−0.908	1.463
Champion influence	3	0.839	2.29	0.885	0.070	−0.817
Organizational innovativeness	4	0.764	3.74	0.614	−0.153	−0.146
Incentives	3	0.869	3.68	1.005	−0.765	0.256
Image	2	0.913	3.58	0.945	−0.718	0.453
Customer pressure	3	0.767	2.75	0.917	−0.120	−0.591

E-mails providing information on the survey's purpose and content were sent to 2360 enterprises. Prospective respondents were asked to participate by clicking on an attached link to the survey website. As an incentive to take part, they could enter a raffle with the opportunity to win NOK 5000 (approx. US$600 at the time). After sending out a reminder, 317 replies were received, although 53 questionnaires were rejected because they were incompletely filled in and/or the firm was operating in a different industry. This provides a response rate of 12%, which is common in research engaging SME owners/managers [54].

The survey was completed by managers in SMEs of different sizes: the distribution was largely even across enterprises with fewer than 10 employees (27%), 10–19 employees (20%), 20–49 employees (27%) and 50–99 employees (27%) (In Norway SMEs are identified by employment size as enterprises with fewer than 100 persons employed). Thirty-five percent of the enterprises were located in Oslo. The sampling frames provided by tradesperson member organizations did not provide background information on the enterprises, meaning that there was no opportunity to validate the representativeness of the sample. A surrogate test for non-response bias was conducted by comparing early versus late respondents [78]. Late respondents were defined as responses received after the reminder ($n = 43$). Two-tailed t-tests showed no significant differences between early and late respondents for any of the variables included in the model.

3.2. Measurement

Intentions to adopt e-vans: Respondents were asked whether the enterprise currently used e-vans. Non-users were further asked if the enterprise planned to adopt e-vans over the next two years (yes/no/uncertain), and if not, over the next five years (yes/no/uncertain).

Vehicle attributes: Two statements concerning the relative advantage of e-vans over ICE vans with respect to economy and shorter run times were used to capture perceived gains. The perceived risk scale included three items relating to the uncertainty of using e-vans compared to ICE vans.

Firm–environment relationships: The incentives scale consisted of three statements concerning the appeal of different governmental inducements to stimulate BEV uptake. Corporate image consisted of two statements describing how e-vans could potentially affect customer perceptions of the company. Customer pressure was captured by three items related to managers' perceived importance of environmental issues in customer buying decisions. These were partly based on the work of Gadenne et al. [54]. Finally, respondents were asked whether they were aware of any industry competitors adopting e-vans. The question was used as an indicator of industry practice.

Firm attributes: Environmental management practice was measured by asking whether the enterprise was currently subscribing, or planning on subscribing, to a formal environmental certification program (e.g., ISO14001). Three statements previously used by Dibrell et al. (2011) were used to capture the manager's environmental attitudes [79]. A high score for this construct indicates that the manager had a strong attitude towards the natural environment. Influence of champion was measured by three statements taken from the 'champion behavior scale' [80]. The items chosen relate to the champion's enthusiasm for and confidence about the success of the innovation. The four items comprising organizational innovativeness were adopted from Hurley and Hult [58]. The wording of some of the items was modified slightly to fit the specific purpose of the current study.

Regarding control variables, respondents were asked whether the car fleet's daily mileage was normally below or above 80 km and was coded respectively as either suitable or not suitable for e-van replacement; those responding that daily mileage varied were coded as not suitable. The threshold was based on Renault Norway's coding scheme, which was developed to make it easier for dealers and enterprises to determine the suitability of e-vans. The scheme defines three categories based on daily driving distance; (i) vehicles with a maximum driving distance of 80 km per day (can be replaced by e-vans); (ii) vehicles with a driving distance of 81–120 km per day (can potentially be replaced, depending on road type, driving style, speed, cargo, topography, temperature and charging); (iii) vehicles with a driving distance over 120 km (should not be replaced unless it is possible to charge during the day). This basis for the scheme is that the summer and winter range can be 30–50% less than the official range of e-vans [81]. According to the scheme, daily mileage of 80 km or less is a 'safe' range for e-vans. Fleet characteristics describes whether the enterprise currently operated small vans (max load 1000 kg). Finally, firm size describes the number of employees.

For all multi-item measures, responses were given on a Likert-type scale ranging from 1 (totally disagree) to 5 (totally agree). A complete description of the measures is provided in Appendix A. Prior to e-mailing respondents, two academic experts and two SME managers completed the questionnaire in a pre-test.

3.3. Reliability and Validity Tests

Reliability analysis was performed to test for internal consistency in the multi-item measures (see Table 1). Cronbach's alpha exceeded the 0.70 guideline to qualify as a reliable measure [82] for six of the eight scales: incentives, perceived risk, image, champion influence, organizational innovativeness and customer pressure. Results showed a low overall inter-item correlation for one of the items describing manager environmental attitudes. Excluding this item increased the alpha value for the scale to 0.696. The scale used in the analysis therefore consists of items 1 and 3 (see Appendix A). Performance expectancy displayed low internal consistency (Cronbach's alpha = 0.59). Two other measures for assessing internal consistency are item-to-total correlations and inter-item correlations. Hair et al. (1998) suggested that correlations exceeding 0.50 and 0.30 for item-to-total correlations and inter-item correlations, respectively, are deemed acceptable [83]. The performance expectancy items showed both high item-to-total correlations (0.82 and 0.87) and inter-item correlations (0.42). Taken together, the reliability of the scale was considered acceptable. The twenty-two items comprising the eight scales were included in a factor analysis MLE (Maximum Likelihood Estimation) to assess discriminant validity. Items loaded according to the theoretical concepts with no second-order loading exceeding 0.30. In the logistic regressions below, the latent variables are used to explain adoption intentions.

4. Results

4.1. Descriptive Statistics

Tables 1 and 2 provide descriptive statistics for the multi-item and category measures, respectively. The figures describe a fairly high degree of innovativeness among the enterprises (as seen by the managers), indicating a generally positive motivation to implement technical innovations rather than to stick to conventional solutions (mean score innovation scale = 3.74). Considering the limited number of e-van users in the sample, however, this general tendency to adopt new technologies has not triggered e-van adoption. Moreover, statistics display overall low championing behavior, suggesting that there are few spokespersons for e-vans within the sampled firms. The mean score for the environmental attitude scale is well above the midpoint. Thus, the SME managers surveyed here are generally in favor of spending more resources on environmental conservation. Still, fewer than 40% of the enterprises are engaged in (or plan to engage in) formal environmental management practices (Table 2).

Table 2. Frequencies for category variables used in the models.

	N	%
Adoption		
- Adopter	14	5
- Adoption intentions 2 years	65	25
- Adoption intentions 5 years	72	27
- No intentions	113	43
Environmental management practices		
- Certified/plan to certify	104	39
- Not certified/no plan to certify	160	61
Industry practice		
- Industry competitors have adopted	56	21
- Industry competitors have not adopted	208	79
Daily mileage		
- Below 80 km per day	145	55
- Above 80 km per day	119	45
Fleet characteristics		
- Small vans in fleet	208	79

The fact that a minority of the enterprises subscribe or plan to subscribe to formal certification programs may be due to perceptions of low external pressure to engage in such practices. As seen in Table 1, the mean score for 'customer pressure' is below the mid-point. Governmental incentives provided to stimulate uptake of BEVs are generally judged to be fairly attractive (mean score incentive scale = 3.68). The high standard deviation, however, indicates that there is great variability concerning how SME managers judge incentives. Low adoption rates of e-vans have been explained mostly by range limitations. As noted above, Renault considers daily mileage below 80 km to be compatible with e-van use. The figures in Table 2 show that more than half of the sample reports daily mileage for their car fleet below this critical limit. Close to 80% of the enterprises in the sample have one or more small vans in their fleet. On average, they operate 5.5 small vans. At the time of data collection, four e-vans were available in the Norwegian market, all with a range of approximately 170 km: Renault Kangoo Z.E., Peugeot Partner Electric, Citröen E-Berlingo and Nissan E-NV200.

Regarding vehicle attributes, the results display low scores for perceived gains, indicating generally low anticipations with respect to the potential advantages gained by adopting e-vans. Furthermore, many SME managers express risk concerns (mean value 3.48), indicating that vehicle attributes represent a significant barrier to e-van adoption.

With respect to adoption levels, Table 2 shows that only 14 enterprises (5%) were current users; 25% expressed intentions to adopt within the next two years, and another 27% within the next five years, whereas most respondents expressed no intention to adopt e-vans. The low number of adopters reflects the current market situation (see above): e-vans are still a technology in its infancy and have not reached a critical mass of adopters. The fourteen users in our sample can be seen as innovators, according to Rogers' (2003) adopter classification [34], and they displayed certain characteristics: the majority are located in the Oslo area, they have industry competitors that also have adopted e-vans and they judge the governmental incentives as highly beneficial to the firm. The importance of incentives for adoption corresponds to what has been observed in the private market [52] and indicates that early adopters of e-vans are, to some extent, instrumentally driven.

In the preceding analysis, the focus was on non-adopters, which represents the great majority of the market and investigates attributes that can explain why some enterprises express adoption intentions while others presently have no intentions to use e-vans.

4.2. Explaining Adoption Intentions

Table 3 shows the results from two logistic regressions that were run to understand which factors can statistically explain the intention to adopt e-vans. Model 1 predicts the binary outcome rejection/intention to adopt. The rejection group comprises respondents with no adoption intentions, and the intention group includes respondents who expressed adoption intentions within the next 2 or 5 years (see above). The preliminary tests for the homogenous subsets showed that group differences with respect to the independent variables relate mainly to rejection or intention, and to a lesser extent across the intention groups. Model 2, however, tests differences within the intention groups: a long adoption horizon (within 5 years) and a short adoption horizon (within 2 years).

Table 3. Predictors of e-van adoption intentions. Logistic regression.

	Model 1 No Intention vs. Intention		**Model 2 Long (5 Years) vs. Short (2 Years) Adoption Horizon**	
	B	**Standard Error**	***B***	**Standard Error**
Vehicle attributes				
Perceived gains	0.545	0.275 *	0.389	0.289
Perceived risk	0.079	0.252	−0.527	0.283 *
Firm–environment relationships				
Industry practice	0.928	0.501 *	0.992	0.458 **
Customer pressure	0.340	0.241	−0.207	0.266
Incentives	0.531	0.217 **	0.101	0.279
Image	1.231	0.299 ***	0.403	0.339
Firm attributes				
Environmental certification	0.602	0.245 **	0.307	0.246
Manager attitudes	−0.191	0.284	0.141	0.299
Innovation champion	0.939	0.263 ***	0.141	0.284
Organizational innovativeness	−0.034	0.310	0.403	0.339
Control variables				
Daily vehicle mileage (<80 km)	0.927	0.390 **	0.279	0.409
Use small vans	1.245	0.526 ***	0.276	0.682
Firm size				
10–19 employees	0.233	0.632	692	0.683
20–49 employees	−0.097	0.603	0.459	0.650
50–99 employees	0.879	0.541	774	0.518
Location (Oslo region)	0.460	0.431	−0.697	0.441
n	250		137	
Model Chi Squared	146.236 ***		25.600 *	
−2 Log Likelihood	196.823		162.465	
McFadden Pseudo R2	0.429		0.137	

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$.

4.2.1. Intention versus No Intention to Adopt (Model 1)

Eight variables display a statistically significant impact on adoption intentions. Three of these relate to firm-environment relationships, two characterize the firm, and one describes vehicle qualities. In addition, two of the control variables are significant. The perceived image-building capacity of e-vans stands out as particularly important for explaining adoption intentions. SME managers who perceive that the company can gain a positive image from adopting e-vans are more likely to express adoption intentions. The strong effect of image suggests that symbolic reasons are highly emphasized in e-van purchases, as opposed to commercial purchases of ICEVs. Previous studies in the private market have shown that BEVs send strong signals about the user to their surroundings [84,85], and business managers may view the car fleet as an opportunity to project a certain image of the enterprise to various stakeholders. The strong link between environmental management practices and adoption intentions suggests that potential adopters aim to strengthen the environmental image of the enterprise through e-van use. Hence, e-vans may provide green legitimacy to the enterprise in both a formal manner (by complying with green certification standards) and a symbolic manner (i.e., 'greening' its image).

The significant and positive coefficient for industry practice indicates that e-van adoption is influenced by actions taken by industry competitors: if one or more business competitors use e-vans, the likelihood for expressing adoption intentions increases. The tendency to homogenize innovation activities in business networks has been documented in various industries and contexts [40,71]. 'Institutional isomorphism' is also relevant in the present context in that SMEs within networks of tradesperson enterprises tend to imitate business competitors' adoption of e-vans. Over time, this can homogenize the sector's transportation innovation activities.

The incentive scheme introduced by the Norwegian authorities is seen as a crucial success factor in the consumer market. The significant effect of incentives displayed in Table 3 indicates that governmental stimuli are also important within the commercial market. The survey inquiries about specified incentives such as free passage of tolls, free parking and access to bus lanes. Why non-adopters are less enthusiastic about these incentives is unclear. It may be related to the geographical location of the enterprise and its customers. If an enterprise mainly operates in areas of the city where parking and congestion are minor problems, it will not benefit from these privileges to the same extent as enterprises operating in congested areas. This theory remains speculative, however, since the data do not provide detailed geographical information on the enterprises and their customers.

As noted above, the adoption of technology is often driven by innovative-minded people within the firm, referred to as innovation champions. The presence of e-van champions within the sampled enterprises is limited (see Table 1). Nevertheless, the results in Table 3 indicate that employees who actively promote and gain support for e-vans within the firm are highly influential. Thus, the championing effect is present in vehicle adoption as well. Day (1994) argued that 'top-down' championing arises when innovations are costly, visible or involve new strategic decisions [86]. Half of the respondents who reported championing behavior stated that the champion(s) belonged to the top management. This figure should be interpreted with some caution, given that the respondents were recruited among managers, but it nevertheless suggests that e-van adoption in SMEs is frequently rooted in top management.

Of the two vehicle attributes, perceived gains displays a significant effect on adoption intentions, whereas perceived risk is non-significant. SME managers who perceive gains in the sense of expenditure cuts and shorter run-time to/from work sites express, unsurprisingly, stronger adoption intentions. E-vans come at a premium price compared to ICE vans, but with significantly lower running and maintenance costs, and total ownership costs can be equalized over 4–5 years [87]. The question remains whether such calculations are actually made or whether SME managers who turn down e-van performance simply express predisposed attitudes.

Still, the significant and positive effect of daily vehicle mileage suggests that the rejection of e-vans is not based solely on predisposed attitudes. SME managers in enterprises that operate car fleets with daily mileage suitable for e-van replacement (<80 km) are more likely to express adoption intentions. This finding expresses SME managers' range concerns and suggests that managers who reject e-vans have reasons for doing so, since e-vans are less capable of fulfilling the transportation needs of their enterprises. Correspondingly, the results indicate that firms using small vans are more likely to express adoption intentions.

4.2.2. Model 2: Long versus Short Adoption Horizons

The same model was implemented with a long (within 5 years)/short (within 2 years) adoption horizon as the dependent variable (Model 2). This model displayed an overall poor fit to the data (McFadden Pseudo R = 0.137), and only two variables were statistically significant. Results showed a strong effect of industry practice and a marginally significant effect of perceived risk. Industry practice is significant in both models and indicates that business competitors' use of e-vans not only stimulates intentions per se but also the strength of the intentions. Results further suggest that managers in the five-year intention group (long horizon) felt a greater risk associated with e-van adoption than did managers in the strong intention group. Thus, both users and the most likely adopters had, to a greater extent, overcome the general uncertainty barrier related to technology adoption.

5. Conclusions and Implications

Results show that SME managers in industrial and construction industries express fairly high intentions for adopting e-vans. Although e-van users are few, more than half of the enterprises expressed adoption intentions in the next few years. Industrial and construction industries account for approximately 15% of all vehicle traffic in Oslo and Bergen, two of the case cities [5]. This indicates that upscaling of the diffusion of e-vans in this sector could lead to a significant cut in transport-related emissions. Currently, a barrier to widespread adoption seems to be range limitations and a restricted number of e-van models, which leads to uncertainty about usability. This finding corresponds to previous discussions on adoption barriers of e-vans which primarily has been concerned with technical and operational attributes [12,88]. Vans with longer range and more load capacity, however, are to be introduced in the coming years and will unlock some of the potential. The results from the present study clearly indicate that policy makers and manufacturers/dealers also must address attributes related to the firm and the firm–environment relationships in order to realize the market potential.

A noteworthy finding was the importance of image to explain adoption intentions. E-vans bring symbolic features to commercial vehicle purchases. Car fleet policy is no longer solely a question of instrumental factors, but also about how the company vehicles can contribute to building an environmental image of the enterprise among stakeholders. Moreover, implementing environmental measures, such as e-vans, may influence the identity of the enterprise: i.e., the collective understanding of core features that distinguish the enterprise from other organizations [89]. According to self-image congruence theory [90], product choice is determined by a brand's ability to possess symbolic images complementary to its self-image. In the case of e-van adoption, an enterprise that pursues an eco-friendly identity will achieve a higher level of image congruence by adopting low emission vans rather than ICE vans. This finding is particularly relevant to dealers and manufacturers, who should target enterprises that have implemented or plan to implement environmental management practices (e.g., a subscription to environmental certification programs), since managers in these firms are likely to be more open to measures for improving the green legitimacy of the firm.

Dealers and manufacturers should also take note of the homogeneity of e-van adoption. The co-variation between adoption intentions and industry competitors' behavior suggests that there is a certain degree of 'institutional isomorphism' in these adoption processes. This further suggests that dealers should primarily target industries with current e-van users. From a marketing perspective, one should stimulate primary demand for e-vans as the market is mainly made up of enterprises with no experience with the technology [91]. Referring to best-practice cases within the same industry is likely to be an efficient way to communicate the benefits of e-vans, since enterprises often imitate successful competitors [42].

For policy makers, the results confirm the effect of incentives on the observed adoption intentions in the consumer market. Although important, the current incentive scheme is not deemed sufficient to stimulate the widespread adoption of e-vans. Adjustments of current policies need to be considered in order to create stronger momentum for diffusion and move the market beyond a critical mass. This momentum for transition of vehicle practices is likely to be dependent upon various regulatory conditions. First, the results above indicate that the continuation of today's incentive system is necessary—mobility benefits for e-vans, including access to bus lanes, free passage of tolls etc., is deemed important by many SME managers. Second, rapid technological advances and falling battery prices make many potential users concerned about resale prices. These doubts can be reduced by increasing depreciation rates. Third, with regard to tax policies, increasing the taxation of ICE vans (and fuels) warrants the value of shifting energy systems. Finally, the continued development of public charging infrastructure is necessary to support users' charging needs during the day. Easy access to charge points reduces the perceived performance risk associated with e-vans.

The wider adoption of e-vans would also benefit from various amplifying factors that could make the technology more relevant and useful. This could include the increased use of green certificate systems and stronger regulation on the use of ICE vans in urban areas. Several European cities have announced a desire to ban ICEVs from their streets. In addition to making e-vans more relevant, this measure would also stimulate manufacturers to develop new and improved LEVs. Lastly, green public procurement stimulates the adoption of environmentally friendly technologies. Hence, public procurement policies for trade services should include clear environmental criteria, including demands for green transportation.

The policy measures are summarized in Table 4.

Table 4. Relevant policy measures to stimulate a critical mass of e-van adopters. BEV: battery electric vehicle; ICE: internal combustion engine.

	Preconditions for Adoption	**Amplifiers for Adoption**
Pull factors	Mobility benefits Tax benefits Improved BEV infrastructure	Use of green certificate systems Green public procurement
Push factors	Taxation of ICE vans and fuel	Restrictions on use of ICE vans in urban regions

6. Further Research and Limitations

The explorative approach applied in the present work has allowed for the inclusion of a breadth of factors that may affect e-van adoption. Due to the nature of the innovation, we have in particular addressed concepts emerging from organizational innovation studies. Although co-variation between an independent variable and the dependent variable does not per se indicate a causal direction, the present study has produced findings that should be explored further in subsequent work.

From a research perspective, academics should pay further attention to the symbolic reasons for technology adoption in SMEs. For a broader understanding of the adoption decision process of e-vans, more in-depth studies of the meaning and dynamics of organizational image, identity and branding are needed. Moreover, investigations of isomorphism in SME business networks related to the adoption of green technologies are currently limited and should be further researched. The role of champions for sustainable innovations has been recognized in earlier works, but further work to understand their role as liaisons and conduits between external and internal networks would be of particular value.

Finally, the current study has some methodological limitations. SME managers are an elusive group, a fact reflected in the low response rate of 12%. Although this is in line with other studies engaging SME owners/managers, it nevertheless calls into question the representativeness of the sample. Moreover, foreseeing the difficulties in reaching SME managers, the questionnaire was kept as short as possible, which resulted in some measurement weaknesses related to the use of a limited number of items to measure rather complex concepts. There are also factors that may influence e-van adoption that have not been captured in our models, such as charging infrastructure and costs, parking facilities, fleet turnover considerations etc. (see Stephens et al. [92]).

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Appendix A Measures Used in the Study

Appendix A.1 Vehicle Attributes

Perceived gains

1. 'From an economical point of view, it is beneficial for us to use e-vans' (economic gain)
2. 'By using e-vans, the run-time to/from work sites is reduced' (productivity gain)

Perceived risks

1. 'It feels insecure to pursue e-vans over combustion engine vans'
2. 'The quality of e-vans is doubtful'
3. 'The risk of using e-vans compared to combustions engines vans is high'

For all items, responses were given on a five-point Likert-type scale (1 = 'totally disagree', 5 = 'totally agree').

Appendix A.2 Firm Attributes

Manager attitudes

1. 'Businesses should spend more resources on environmental conservation'
2. 'Environmental protection measures undermine business profitability' (reversed)
3. 'Managers should be advocating at the head of environmental protection measures'

Influence of champion

1. 'In our company there are employees who are eager proponents of e-vans'
2. 'In our company there are employees who are convinced that e-vans are a good option for us'
3. 'In our company there are employees who have great confidence in e-van technology'

Organizational innovativeness (based on Hurley and Hult (1998))

1. 'Technical innovations are readily implemented in our company'
2. 'Management actively seeks innovative ideas'
3. 'Innovations are readily accepted in program/project management'
4. 'In our company, innovations are perceived as risky and are resisted' (reversed)

For all items, responses were given on a five-point Likert-type scale (1 = 'totally disagree', 5 = 'totally agree').

Adoption of green practices

'Is the company subscribing to a formal environmental certification program; ISO14000 and/or Eco-Lighthouse?'

- Yes, ISO14000
- Yes, Eco-Lighthouse
- Yes, both
- No

Appendix A.3 Firm–Environment Relationships

Incentives

1. "Access to bus lanes makes it attractive for us to use e-vans"
2. "Free passage of tolls makes it attractive for us to use e-vans"
3. "Free parking makes it attractive for us to use e-vans"

Image

1. "Use of e-vans gives our company a positive image among customers"
2. "Use of e-vans make our company appear modern"

Customer pressure

1. 'Environmental aspects are highly emphasized in customer purchasing decisions'
2. 'Environmental issues are often a subject in conversations with customers'
3. 'In purchasing processes, customers strongly emphasize that suppliers are environmentally certified (e.g., ISO14001)'

For all items, responses were given on a five-point Likert-type scale (1 = 'totally disagree', 5 = 'totally agree').

Industry practices

'Do you know of other companies in your industry that have adopted electric vans?'

- Yes
- No

If yes:

'Does your company have close relations with any of these companies?'

- Yes
- No

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