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The dynamics of electric vehicle acceptance in corporate fleets: Evidence from Germany

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ABSTRACT

Electric vehicles as part of corporate fleets play a key role in reducing CO_2 emissions. However, business practice has shown that employees often refrain from using these newly procured fleet vehicles. The aim of this paper is therefore to explain the drivers and barriers of acceptance of electric vehicles on the employee's level. Based on a Grounded Theory approach, the authors extracted five main determinants from interviews with 16 experts. They were cross-checked with the literature including technology acceptance literature and electric vehicle research. To understand the dynamics of acceptance, panel data was collected in a longitudinal study with three waves in Germany. The panel data was analyzed using partial least squares (PLS) path modelling. Results show that employees' environmental concern as an attitudinal factor is the only short-term determinant triggering the first electric vehicle usage. Later, the influence of environmental concern disappears, while the impact of product-related determinants, such as enjoyment, ease of use, perceived risks, and relative advantage increases. Furthermore, a mediating effect of enjoyment emerges between ease of use on the intention to use an electric vehicle. Several important implications for decision-makers in management and policy are deduced to support short- and long-term usage of electric vehicles in corporate fleets.

1. Introduction

One key to preserve the environment is the reduction of CO_2 emissions in the road transportation sector [1]. This is fostered by stricter CO_2 regulations as phased in, for example, in the EU, China and California from 2020 onwards [2]. To achieve CO_2 emission goals, the shift from oil-fueled vehicles towards electric vehicles (EVs)[1] is essential [4–6]. However, the effects of reductions of CO_2 emissions can only unfold if a large number of oil-fueled vehicles are substituted by EVs [7, 8]. One central building block is the fleet market, which is usually larger than the private car market. As a matter of fact, the share of the number of new car registrations in this market accounts to 65% in Germany [9] and 54% in the UK [10].

For the transition towards low carbon economies, different stakeholders need to be engaged in order to foster the adoption and diffusion of green innovations [5,11]. This holds particularly for the network of stakeholders involved in the diffusion of EVs [12,13]. For the EV fleet market, adoption is particularly complex, since stakeholder groups on two levels need to be engaged within a company. For example, senior managers, fleet managers and/or innovation managers on the organizational level need to purchase EVs before employees are able to use and accept them on the individual level [14,15].

Even if companies are now integrating more EVs into their fleets due to regulatory pressure, business practice has shown that once management has purchased EVs and adopted EVs on the organizational level, employees often discard or even refuse using these vehicles on the individual level [16,17]. Therefore, there seems to be a challenge on the employee's acceptance level. The understanding of the individual user acceptance in organizations is vital because "if there is no acceptance among the target group, the desired consequences cannot be realized and the organization may eventually discontinue the intended adoption" ([14]; p. 167).

Reasons may be manifold, but empirical research explaining employees' sluggish acceptance of EVs is scarce. So far, research rather

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[1] Electric vehicles (EVs) are alternative and innovative vehicles powered by electricity [3]. In this paper, we focus on Battery Electric Vehicles that are powered by electricity only.

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focused on private consumers' perception (e.g., [18]), and adoption decision of EVs (e.g., [19]). Little research has been dedicated to the adoption of EVs in fleet markets (notable exceptions are [20–23]). Most of this research, however, focusses on the organizational adoption level, i.e., the management level, rather than on the individual acceptance level.

Even worse is the lack of a deep understanding regarding the dynamics of acceptance, the acceptance process and long-term usage of EVs on the level of the individual employee. Therefore, longitudinal research designs seem to be appropriate to investigate acceptance as a longer-term process [24]. The insights from such studies are of particular importance for decision-makers in management and policy to take effective measures to improve EV usage among employees, to transform road transportation and to ultimately reduce CO_2 emissions.

Therefore, our aim is to fill this research gap and explain the dynamics of acceptance of EVs on the level of the employee. In particular, we identify and assess the short- and long-term determinants in the acceptance process. We base our research on a Grounded Theory approach, in which we identified five main factors having an impact on employees' intention to use EVs in corporate fleets. They were cross-checked with the results from an intensive literature research. To analyze the dynamics of acceptance, we assessed short- and long-term determinants of employees' EV acceptance in a longitudinal study. Instead of measuring acceptance only at one point in time, we explored the acceptance process and its determinants at three points in time, i.e., before the first use of the vehicles, three months after the first usage and six months after the first usage. In this way, we are able to evaluate the drivers and barriers of EV acceptance across a time dimension. This is the first study providing fundamentally new insights into the dynamics of EV acceptance.

The remainder of this paper is structured as follows. In the next section, we develop a theoretical framework of EV acceptance in corporate fleets based on a Grounded Theory approach using expert interviews and an extensive literature review. In the third section, we introduce our quantitative longitudinal study to test this framework and to assess the short- and long-term drivers and barriers in the EV acceptance process. Section 4 discusses the key findings from the data analysis. Finally, Section 5 deduces implications for decision-makers in management and policy. Section 6 concludes with a brief summary, limitations and avenues for future research.

2. Grounded Theory development

2.1. Expert interviews

To develop a theoretical framework of the drivers and barriers having an impact on the employees' acceptance process of EVs in corporate fleets, we used a Grounded Theory approach [25]. In this paper, we refer to the notion of "acceptance" since we are focusing on the individual employee's intention to use EVs as a new technology in a corporate context (see e.g., [14]). Due to the focus of our study on the EV acceptance on the individual employee's level, we refrained from investigating determinants of EV adoption on the management level in our expert interviews. In a first step, we conducted expert interviews before comparing the results with the findings from the literature in a second step.

We selected the experts regarding their activities and experience in the field of EVs, based on which we could expect superior knowledge regarding the employees' acceptance of EVs in corporate fleets [26]. In addition, experts were supposed to have all the relevant information on EV acceptance and to be capable of communicating this information (see Gläser and Laudel [27] based on Gorden [28]). Our intention was to receive a comprehensive picture of the determinants of fleet users' EV acceptance. We refrained from interviewing users as experts, since we expected difficulties in observing and communicating all the relevant determinants of EV acceptance. Our aim was to maximize the diversity of the perspectives in the sample to receive a multi-faceted view of the research topic.

We stopped the sampling procedure when information redundancy occurred. The final sample consisted of 16 experts: Three managers from different car manufacturers, three managers from two major electric utilities, five researchers from two large universities and one research institution, three managers from two service providers and two members of different automotive associations. Table 1 shows important sample characteristics of the final sample. Expert names were replaced by pseudonyms. The number of experts in the sample is consistent with guidelines for exploratory research [29].

The size of participating institutions or companies ranged from medium-sized research institutions ("Research" and "Association") to large-scale multinational corporations (especially "Car manufacturers"). We invited key informants to our interviews on manager or senior manager levels to participate in our interviews.

We conducted the expert interview by telephone. They were based on an interview guideline consisting of two parts. The first part was narrative in nature. The respondents were asked to outline the determinants of users' EV acceptance in corporate fleets as well as the stakeholders influencing the acceptance. They were encouraged to report small anecdotes from the past and to describe their experiences in detail. Some respondents gave comprehensive insights into users' EV acceptance resulting into a high variation in interview duration from 24 min to 46 min. In the second part, we asked participants to provide insights into positive and negative determinants of users' EV acceptance in corporate fleets. We dug deeper into the specific determinants that respondents mentioned. All questions were open-ended.

Three researchers conducted the interviews, with one leading interviewer and two assisting interviewers. The interviews lasted on

Table 1
Qualitative study sample.

No.	Name	Background	Level	Size of Company/ Institution	Interview duration
1	Ann	Car manufacturer	Senior Manager	about 100,000 employees	41:46:00
2	Brian	Car manufacturer	Senior Manager	about 120,000 employees	44:22:00
3	Charles	Car manufacturer	Senior Manager	about 130,000 employees	33:33:00
4	Denis	Electric utilities	Senior Manager	about 40,000 employees	27:34:00
5	Evelin	Electric utilities	Manager	about 40,000 employees	34:33:00
6	Frank	Electric utilities	Senior Manager	about 17,000 employees	27:53:00
7	Greta	Research	Senior Researcher	about 10,000 employees	28:35:00
8	Harold	Research	Researcher	about 6,000 employees	30:07:00
9	Ian	Research	Senior Researcher	>200 employees	45:55:00
10	Jennifer	Research	Researcher	about 10,000 employees	24:30:00
11	Keith	Research	Researcher	about 10,000 employees	29:41:00
12	Louis	Service provider	Manager	>8,000 employees	27:49:00
13	Mike	Service provider	Manager	about 12,000 employees	24:32:00
14	Naomi	Service provider	Senior Manager	about 12,000 employees	29:46:00
15	Oliver	Association	Senior Manager	>1,800 members	36:10:00
16	Penelope	Association	Senior Manager	>600 members	26:10:00

average 32 min. The interviews were recorded and transcribed. Since two researchers conducted the transcription, rules for transcription were formulated [30]. They ensure consistency and anonymity of the transcripts. To identify determinants of EV acceptance in corporate fleets, we used the Grounded Theory coding procedure, i.e., open, axial and selective coding [25]. We used [91] to code the interviews.

For open coding, two researchers independently coded the interviews regarding the positive and negative determinants of EV acceptance. Afterwards, results were compared and a preliminary coding plan was established listing the positive and negative determinants of EV acceptance. In a second step, we discussed the coding plans, regrouped and redefined our coding plan. Moreover, we identified relationships between the codes (axial coding) from open coding. Two independent researchers judged the coding plan as well as the rules for transcription. The results of the coding procedure revealed insights into the positive determinants (e.g., enjoyment) and negative determinants (e.g., perceived risks) of EV acceptance in corporate fleets. The qualitative data from the expert interviews were then compared to the literature relating to our topic. Based on the constant comparisons of the data from our qualitative study with the literature, we formulate the hypotheses in the following section.

2.2. Literature review

We compared data from the expert interviews with insights on from the literature. First, we investigated the determinants adoption and acceptance in the literature relating to EVs (which we termed EV literature). Since EVs have become an interesting technology to compete with traditional vehicles with combustion engines, an increasing amount of research has been dedicated to this field (e.g., [31–39]. Second, we linked our qualitative data with the literature relating to the adoption of innovations [24] and the acceptance of technology such as the Theory of Planned Behavior (TPB) [40], the Theory of Reasoned Action (e.g., [41]), and to the Technology Acceptance Model (TAM) including its further developments such as the Unified Theories of Acceptance and Use of Technology (UTAUT 1) by Venkatesh, Morris, Davis, and Davis [42] and UTAUT 2 by Venkatesh, Thong, and Xu [43].

We compared the determinants mentioned in the literature with our data from the expert interviews to derive hypotheses explaining user acceptance of EVs in corporate fleets. The underlying contention is that behavioral intention is *the main* variable explaining and predicting usage behavior, i.e., the ultimate acceptance and usage of EVs.

Since our objective was to investigate the dynamics of employees' acceptance in the course of time, we had to derive hypotheses regarding the change or stability of the determinants over time. We used insights from prior empirical studies with longitudinal research designs. Table 2 provides an overview of the effects of different determinants of acceptance in longitudinal studies. Hypotheses relating to a determinant's temporal change or stability are subsequently denoted with "a".

2.3. Hypotheses

Based on the expert interviews and on the literature review, we formulated the following hypotheses. First of all, nine out of 16 experts filed environmental aspects as important drivers of EV acceptance. In particular, they highlighted employees' environmental concern as on important factor for EV acceptance. For example, Ian (Pos. 22) stressed that "the ecological, the environmental concern is one aspect." He continues (Pos. 52): "There is often the desire to take more social responsibility in environmental questions." In the same manner, Ann (Pos. 45) pointed out: "The second aspect [besides enjoyment, see below] is simply the concern to do something for the environment." Also, Brian (Pos. 60) stated that people use an EV "since it is a new technology that is less harmful for the environment".

In a similar vein, research on end-consumers' EV adoption has found that environmental concern [44], environmental attitude [36,49], pro-environmental identity [3,39] or green self-identity and environmental consequences [50] are strong drivers of EV adoption. Regarding the variable's temporal dimension, Jensen et al. [44] found in their longitudinal study that environmental concern positively influenced EV preference before and after a test period.

Based on the findings from our expert interviews and the literature review, we expect that an employee's concern about the environment positively influences his/her intention to use EVs (H1) in a corporate fleet. We expect that this effect will be stable and constant over time (H1a).

H1. Environmental concern has a positive effect on the behavioral intention to use EVs.

H1a. The effect of environmental concern is constant over time.

The experts also stressed perceived risks as a barrier towards EV acceptance. Ten out of 16 experts mentioned the perceived risk of EVs' limited range. Oliver (Pos. 34) stated: "Of course, users are skeptical in the first instance, since the vehicles have a limited range. … The range must fit! If users say, we cannot deal with the [limited] range and then rehearse the rebellion, then the fleet manager has to be very patient and has to have a lot of good facts to convince them that it is still working." This is despite the fact that range does not seem to be a factual risk in the commercial sector, since driving profiles can be well defined in several cases, and charging can take place over night on the company's premises. Therefore, Greta (Pos. 47) attenuated the range issue for corporate fleets: "But you can get the range issue under control since you have well-known movement profiles in the commercial sector in contrast to the private sector". Finally, highlighting the perception of risk, Denis (Pos. 31) mentioned: "Range anxiety, lack of charging infrastructure and lengthy charging times and so on is only in people's minds, since studies have shown that you do not have to be afraid of limited range since the kilometers that you drive on average are within the range of an electric vehicle".

Regarding the public charging infrastructure, the experts were undecided, whether it is actually perceived as a risk from the users' perspective. Brian illustrated (Pos. 34): "The question is, whether the charging infrastructure will play a role. I am not so sure yet, because small enterprises normally have short routes and we will see whether they use the public charging infrastructure in between." When there is no fast-charging option, "customers will hardly have the possibility to use the public charging infrastructure … This means that we will see whether the public charging infrastructure will play a special role, also for small enterprises in order to charge the vehicles on the way." Denis points at other use cases (Pos. 51): „It could be a problem for smaller companies, if I have to drive – say 100 km per day – when I am thinking of sales people, then I need a public charging infrastructure, which is not available, yet. This could be a negative point which is in the back of people's minds. Understandably." Mike highlights the interrelationship between range, public infrastructure and charging time (Pos. 26): "The charging time is, of course, a barrier that I have to take into account. Accordingly, I have to plan the range and the charging times. … This is something that does not contribute to employees' acceptance."

Similar to our experts, the EV literature has stressed the perceived risks of limited range [32,49,51,52], insufficient charging infrastructure [23,32] as well as lengthy charging times [32,49,51,52] as barriers towards adoption. Therefore, we hypothesize:[2]

H2. Perceived risks have a negative effect on the behavioral intention to use EVs.

Six experts filed enjoyment as an important positive determinant of EV acceptance. For example, EVs can accelerate much faster than

[2] Since there is a lack of research regarding the temporal dynamics of this variable, we refrain from formulating hypothesis H2a.

Table 2
Effects of determinants of acceptance in longitudinal studies (path significance: *p < 0.05, **p < 0.01, ***p < 0.001).

Sources	Foundation	Data	Data Collection Schedule	Endogenous variable (acceptance)	Determinants of acceptance			
					Environmental Concern	Enjoyment (Intrinsic Motivation)	Ease of Use (Effort Expectancy)	Relative Advantage (Usefulness, Performance Expectancy)
Jensen et al. [44]	EV Literature	Panel data, n = 369	After initial information/after 3 months	Preferences for EVs	At least **/**			
Davis et al. [45]	TAM	Panel data, n = 107	After introduction/ 14 weeks later	Behavioral intention			**/n.s.	***/***
Venkatesh and Davis [46] (both settings)	TAM	Panel data, n = 36–43 in four studies	After initial training/after 1 month/after 3 months	Behavioral intention			*/*/*	***/***/***
Venkatesh and Morris [47] (entire sample)	TAM	Panel data, n = 342	After initial training/after 1 month/after 3 months	Behavioral intention			**/*/**	***/***/***
Venkatesh et al. [42] (voluntary setting)	TAM	Panel data, n = 119	After initial training/after 1 month/after 3 months	Behavioral intention		**/**/***	**/n.s./n.s.	***/***/***
Venkatesh et al. [42] (mandatory setting)	TAM	Panel data, n = 96	After initial training/after 1 month/after 3 months	Behavioral intention		**/**/**	*/n.s./n.s.	***/***/***
Bhattacherjee and Premkumar [48] (Study 1)	TAM	Panel data, n = 54	After initial training/after 2–3 weeks/after 9–10 weeks	Behavioral intention				../***/***
Bhattacherjee and Premkumar [48] (Study 2)	TAM	Panel data, n = 77	After initial training/after 1 month	Behavioral intention				../***
Present study	Expert interviews + EV Literature + TAM Literature	Panel data, n = 76	After initial information/after 3 months/after 6 months	Behavioral intention to use EVs	H1a: constant effect	H3a: constant effect	H5a fading effect	H6a: constant effect

vehicles with combustion engines thus providing an added value to the users. Evelin (Pos. 34) stated that “I think that acceptance emerges quite quickly. In nine out of ten cases, those who once sat in an EV, are immediately excited about it. Then, there is no problem about it.” Oliver pointed out in more detail (Pos. 30) that “the advantage of an EV is not immediately obvious for the user in the first instance. And, you need a lot of arguments to convince him/her to choose an EV. It could be the driving pleasure … that they think it's great and that everything feels good with the car.” Frank termed it more technically (Pos. 55): “A lot of customers … are enthusiastic about the excellent engine torque, high traction, fast acceleration, very quiet and very comfortable and therefore very much enjoy driving.”

The role of enjoyment has been equally stressed in the EV adoption literature, as well (e.g., [39,53]). TAM literature also added enjoyment to the later versions of the models. Davis, Bagozzi, and Warshaw [54] were the first to integrate enjoyment (intrinsic motivation) into their motivational model. They defined enjoyment using the construct of intrinsic motivation which “refers to the performance of an activity for no apparent reinforcement other than the process. … enjoyment is an example of intrinsic motivation” ([54]; p. 1112). They found that enjoyment had both a direct and an indirect effect on behavioral intention. Venkatesh et al. [43] finally included enjoyment (as hedonic motivation) into their Unified Theory of Acceptance and Use of Technology (UTAUT2). In their study, enjoyment had a positive, highly significant impact on behavioral intention. Regarding the temporal stability of the variable, Venkatesh et al. [42] found support for positive, constant effects of enjoyment on behavioral intention on a time dimension.

According to the experts and the results of prior research, we expect that enjoyment will have a positive and constant influence on the behavioral intention to use EVs in corporate fleets.

H3. Enjoyment has a positive effect on behavioral intention to use EVs.

H3a. The effect of enjoyment is constant over time.

Although, the next determinant “ease of use” has not explicitly been mentioned by our experts, we included the variable based on its impact found in related studies. In TAM research, perceived ease of use (EOU) is a powerful predictor of behavioral intention [45]. We adapted the definition of ease of use from Davis ([57]; p. 320) to the EV context as the degree to which a person believes that using an EV would be free of effort. Based on Innovation and Diffusion Theory [24], Moore and Benbasat [55] included ease of use into their instrument to measure technology acceptance.

EV research on end-consumers' adoption has included ease of use into adoption models (see similar [56]). In a business-to-business context, fleet managers also expect that employees' perceived ease of use positively influences EV acquisitions [15,21].

In addition to the direct effect of ease of use on behavioral intention, we expect enjoyment to mediate the effects of perceived ease of use on behavioral intention to use EVs (e.g., [54]). We therefore expect, that in combination with enjoyment, ease of use will indirectly influence the intention to use EVs.

The majority of longitudinal studies show that ease of use has no significant effect on behavioral intention at later stages (see Table 2). Nevertheless, the impact of ease of use seems to fade in the process of acceptance. Based on the aforementioned research results, we formulate the following hypotheses:

H4. Enjoyment mediates the relationship between ease of use and the behavioral intention to use EVs.

H5. Ease of use has a positive effect on the behavioral intention to use EVs.

H5a. The effect of ease of use fades over time.

The experts pointed towards the fact that users will weigh the pros and cons in their decisions of using EVs. Louis, for example, contrasted the positive impact of enjoyment with the downside effects of perceived risks of range and charging time (Pos. 48): "The average customer drives 22 km and then the fear of running out of batteries disappears. … Then, the enjoyment of driving outbalances [the perceived risk of range and charging time], since the enjoyment of driving EVs is enormous. And this is, what you have to achieve. You have to let people sit in the EV and let them drive, since 99% of the people get out of the car with a smile on their face and they had so much fun driving the cars. And this is essential. To really make your own experiences instead of just theoretically reading about it in the newspaper, where the facts speak against the car, i.e., range and charging time and so on."

The comparison of advantages and disadvantages is also a core concept in the TAM literature. For example, Davis [57] incorporated such a comparison in his construct of "perceived usefulness" and Rogers [24] in "relative advantage". Later, relative advantage items were integrated into the concept of "performance expectancy" in UTAUT [42] and UTAUT2 [43]. Therefore, we rely on the concept of relative advantage in our study assuming that users will weigh the advantages and disadvantages of using an EV (see also [58]).

The relative advantage concept is consistent with research on EV adoption that suggests that consumers will weigh the characteristics of EVs, i.e., its advantages with its disadvantages [32,49,51].

In longitudinal studies, support was found for a constant effect of relative advantage (or, alternatively, perceived usefulness or performance expectancy) in TAM research in the course of time [42,46–48].

Therefore, we suggest the following hypotheses.

H6. The relative advantage of EVs has a positive effect on the behavioral intention to use EVs.

H6a. The effect of relative advantage is constant over time.

3. Quantitative longitudinal study of EV acceptance in corporate fleets

3.1. Questionnaire development and measures

To analyze the dynamics of acceptance over time, we conducted a longitudinal study. Respondents were asked to fill in the questionnaires before the first test-drive (t_0), after three months (t_1) and after six months (t_2) of extensive EV usage. We used the expert interviews and the literature review as a foundation to develop standardized questionnaires for the three points in time. Three researchers selected, translated and adjusted the relevant items. For the measurement of the constructs at the different points in time, we adapted the items regarding the use of future tense (t_0) and present tense (t_1 and t_2) (see Table 3). We used seven-point Likert-type scales ranging from "strongly agree" (1) to "strongly disagree" (7).

To measure environmental concern, we adapted four items from Lee [59]. Items regarding perceived risks were collected from our expert interviews and from different studies on EVs [60,61]. Using principal component analysis revealed one component reflecting the perceived risks of EVs (including range and charging). To measure enjoyment, we used the three-item scale developed by Davis et al. [54]. However, the original items were intended to measure intrinsic motivation towards the use of software programs. Inspired by the expert interviews, one further item was included to fully grasp the construct of enjoyment of using an EV instead of using a software program (item No. 3 of enjoyment in Table 3). Ease of use was operationalized by adapting the items developed by Davis [57]. He developed the original items to measure the ease of use of software programs. Therefore, a number of items were not directly transferrable to our EV study and had to be dropped. Instead, differences in the perceived ease of use of driving and/or handling EVs (as e.g., charging and starting the vehicle) were indicated by the experts and included as separate items in the questionnaire. The item we used to assess relative advantage was inspired by Moore and Benbasat [55]. We chose one item to express the weighing of advantages and disadvantages against each other.

Table 3
Measurement model evaluation.

Code	Time	t_0			t_1			t_2		
	Source/Item(s) for times t_0 and t_1/t_2	CR	AVE	Loading	CR	AVE	Loading	CR	AVE	Loading
BI	**Behavioral Intention (adapted from Ajzen and Fishbein [41])**	1.000	1.000		1.000	1.000		1.000	1.000	
1	I intend to drive the electric vehicle during the next half year.			1.000***			1.000***			1.000***
EC	**Environmental Concern (inspired by Lee [59])**	0.885	0.719		0.940	0.840		0.894	0.738	
1	I take part in environmental protection activities.			0.831***			0.914***			0.898***
2	I often think about how the situation of the environment can be improved.			0.913***			0.934***			0.896***
3	In my daily life, I use environmentally-friendly products.			0.796***			0.902***			0.778***
PR	**Perceived Risks (based on expert interviews)**	0.860	0.672		0.893	0.737		0.888	0.725	
1	I fear/find that the range of the EV will be/is insufficient.			0.760***			0.750**			0.822***
2	I fear/find that it will be/is difficult to find a charging station, when I need it.			0.785***			0.907***			0.875***
3	I fear/find that charging the battery takes too much time.			0.907***			0.908***			0.857***
ENJ	**Enjoyment (adapted from Davis, Bagozzi and Warshaw [54])**	0.940	0.796		0.957	0.847		0.951	0.830	
1	I (will) have fun driving an Electric Vehicle			0.892***			0.931***			0.921***
2	I (will) find driving an Electric Vehicle pleasant.			0.878***			0.897***			0.915***
3	Driving an Electric vehicle (will) thrill(s) me.			0.899***			0.935***			0.908***
4	I (will) enjoy driving an Electric vehicle.			0.900***			0.917***			0.900***
EOU	**Perceived Ease of Use (adapted from Davis [57])**	0.904	0.702		0.948	0.820		0.930	0.769	
1	I (will) find that driving an Electric Vehicle is easy.			0.851***			0.947***			0.898***
2	Learning to drive an Electric vehicle will be/is easy.			0.797***			0.832***			0.853***
3	I find that handling an Electric Vehicle will be/is easy.			0.853***			0.919***			0.913***
4	Learning to handle an Electric vehicle will be/is easy.			0.847***			0.920***			0.841***
RA	**Relative Advantage (inspired by Moore and Benbasat [55])**	1.000	1.000		1.000	1.000		1.000	1.000	
1	The advantages of using an electric vehicle (will) outweigh the disadvantages.			1.000***			1.000***			1.000***

3.2. Data collection

We used paper-based coded questionnaires to collect data from employees of four companies across nine regions in Germany. EV users had to complete the questionnaire in three waves: after a theoretical training and before the first test-drive (t_0), after three months (t_1) and after six months (t_2) of extensive EV usage. Each respondent was assigned an identification number at time t_0, so that his/her answer could be matched with responses at times t_1 and t_2 to create a panel data set. Data were processed anonymously. Only the researchers had access to personal information and the identification numbers.

As a result, a panel of 84 respondents, who fully completed the questionnaires at all three points in time t_0, t_1 and t_2 was created. We had to delete 6 cases due to too many missing values. As a result, the panel dataset contained data from 78 respondents at times t_0, t_1 and t_2. With 78 respondents and 60 items, the data set comprised 4,680 data points. The data set included 71 missing values (1.5%.). Group mean replacement was used when more than 5% of the values were missing in one item. The remainder of the missing values were replaced by mean replacement [62]. Two outliers were detected by using single-linkage hierarchical clustering and removed. The final dataset consisted of 76 cases.

The sample size of 76 respondents appears to be relatively small. However, panel data with three waves are rare in a business-to-business context and similar studies operate with equally small sample sizes (e.g., [46,48]).

Due to the small sample size, we intended to use partial least squares (PLS) path modelling for structural equation modeling [62]. To determine the minimum sample size for PLS [62], recommend using power analyses as developed by Cohen [63]. For a statistical power of 80%, a significance level of 5%, a maximum of six arrows pointing at a construct and a minimum R^2 of 0.25 in the endogenous construct, at least 48 observations are needed. In addition, G*Power was additionally used to estimate the minimum sample size [64]. With two-tailed estimations, $\rho^2 = 0.3$, R^2 of 0.25, a probability error of 5% and six predictors, G*Power revealed the same minimum sample size of 48 observations to achieve a statistical power of 80%. Our sample size of 76 cases lies well above this threshold so that PLS can be used.

4. Results

Based on the data set, we created three models for each point in time, i.e., t_0, t_1 and t_2 [65] using the software package SmartPLS 3 [66]. We modelled the behavioral concepts as reflective measurement models [67]. We refrained from using consistent PLS, since Heywood cases occurred when estimating the models [68]. We used the path weighting scheme for the structural model with a maximum of 1,000 iterations and a stop criterion of 10^{-7} to estimate the PLS path models [62].

The measurement models were assessed by testing composite reliability (CR), convergent validity using average variance extracted (AVE) as well as indicator reliability using the constructs' factor loadings and their significances [62,69] (see Table 3). To ensure that the constructs are significantly different from each other (discriminant validity), we used the Heterotrait-Monotrait (HTMT) criterion [70].

In all three models t_0, t_1 and t_2, the measurement models fulfil the quality criteria recommended for PLS modelling (see e.g., [71]). HTMT ranges from a minimum of 0.055 to a maximum of 0.550 between the theoretical concepts in each of the three models and is thus well below the conservative threshold of 0.85 [70]. In addition, HTMT's one-sided confidence interval does not include the value 1, i.e., HTMT is significantly different from 1 [71,72].

Due to the exploratory nature of our research, we used R^2, size and the significance of the path coefficients as well as effect sizes to assess the structural model [73]. R^2 in the endogenous variable ranges from weak levels 0.279 at time t_0, 0.242 at time t_1 to moderate levels 0.312 at time t_2 [74]. The effect sizes f^2 at all three points in time range from small (0.002) effects to medium sized effects (0.113) in the relevant paths [75]. Since long-term effects on the intention to use EVs in corporate fleets are poorly understood so far, we consider these levels as acceptable.

To test the significance of the path coefficients, we ran the bootstrapping procedure with 5,000 subsamples [76]. Table 4 shows the hypotheses, paths, path coefficients for each point in time as well as their confidence intervals. Significant path coefficients are highlighted in bold, with $p < 0.1$ marked with one asterisk (*) and $p < 0.05$ with two asterisks (**) (see similar [44]).

Due to the complexity of the results and our interest in the impact of the determinants in the acceptance process over time, we summarize the significance levels in the course of time in Fig. 1. Significant paths with $p < 0.1$ are shaded in light grey and path with a significance of $p < 0.05$ are shaded in dark grey. Non-significant paths are left blank.

5. Discussion

Looking at our results, valuable insights on the employees' acceptance process of EVs over time emerge. First of all, environmental concern has a positive, highly significant impact on the intention to use EVs before the first usage at time t_0. However, this is the only point in time, in which environmental concern has an impact on employees' intention to use EVs. Therefore, we find support for H1 only before the first usage of EVs in corporate fleets. This effect fades in the course of time, so that it is no longer significant at times t_1 and t_2. Consequently, we reject H1a suggesting a constant effect over time. The effect of environmental concern on behavioral intention at time t_0 is well documented in the EV adoption literature in the business-to-consumer context. Its declining impact in the long-run, however, is surprising and has not been documented in the literature before.

With regard to the entire model, environmental concern is the only significant variable triggering the intention to use EVs before the first usage. It is the only attitudinal factor in the model. Obviously, product-related characteristics, such as perceived risks, enjoyment, ease of use

Table 4
Path coefficients and confidence intervals at times t_0, t_1 and t_2.

H	Relationship	Path coefficients, significance levels and [5%, 95%] confidence intervals		
		before first usage	after three months	after six months
		t_0	t_1	t_2
1	Environmental Concern → Behavioral Intention	**0.322** [0.121, 0.528]**	0.039 [-0.166, 0.265]	0.122 [-0.048, 0.342]
1a	Environmental Concern → Behavioral Intention	effect disappears during active usage at times t_1 and t_2		
2	Perceived Risk → Behavioral Intention	−0.113 [-0.302, 0.016]	−0.116 [-0.288, −0.024]	**−0.173** [-0.313, -0.048]**
3	Enjoyment → Behavioral Intention	0.124 [-0.098, 0.341]	**0.230* [0.003, 0.441]**	**0.279** [0.087, 0.488]**
3a	Enjoyment → Behavioral Intention	effect emerges with active usage at times t_1 and t_2,		
4	Ease of Use → Enjoyment → Behavioral Intention	0.064 [-0.050, 0.197]	**0.092* [0.004, 0.174]**	**0.112* [0.034, 0.230]**
5	Ease of Use → Behavioral Intention	0.091 [-0.129, 0.308]	0.147 [-0.057, 0.317]	−0.142 [-0.348, 0.064]
5a	Ease of Use → Behavioral Intention	effects is insignificant at all times		
6	Relative Advantage → Behavioral Intention	0.130 [-0.141, 0.393]	**0.180* [0.006, 0.356]**	0.238 [-0.055, 0.483]
6a	Relative Advantage → Behavioral Intention	effect emerges with active usage at time t_1 and disappears until time t_2		

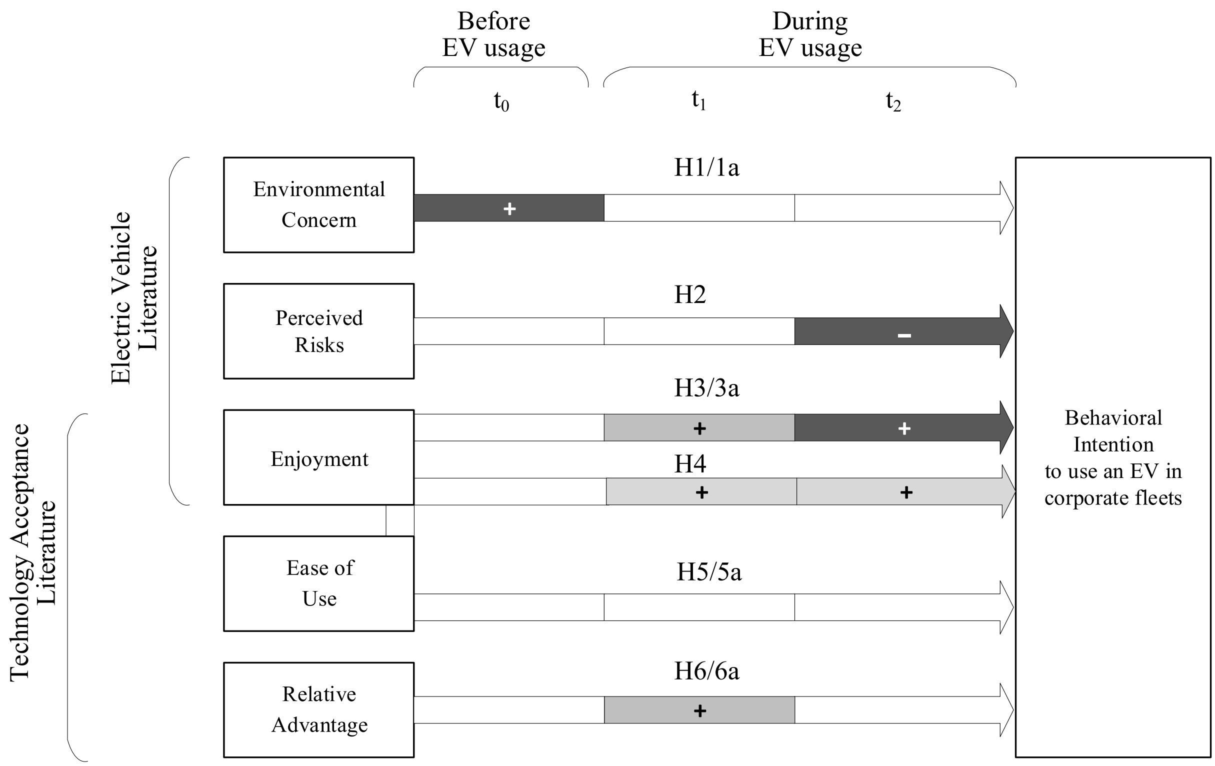

Fig. 1. Determinants in the EV acceptance process.

and relative advantage are irrelevant for employees to initiate first time EV usage. Consequently, it will be difficult for companies to foster the first EV usage without appealing to employees' environmental concern and with only focusing on product-related aspects.

This changes, however, during employees' EV usage at times t_1 and t_2. Then, product-related effects become stronger dominating the impact of environmental concern. For example, the users' perceived risks regarding range, charging infrastructure and charging times have been well researched in the EV adoption literature and have also been well covered in the public media. The negative impact of employees' perceived risks is significant only after six months of usage, at time t_2. H2 thus only holds for longer usage times.

The late significance of perceived risks at time t_2 is surprising. One explanation why the effect of perceived risks is not significant at earlier stages may be that perceived risks have been attenuated since the companies provided initial trainings, information packages and leaflets on the use of EVs as well as telephone hotlines for assistance in case of problems during the vehicle usage. Mobility patterns were usually well defined for the companies taking part in our study, so that they could be well anticipated and range anxiety did not emerge. Also, the charging infrastructure was installed on the company premises so that employees apparently did not perceive any risks with charging the vehicles. A reason why perceived risks become significant after six months (t_2) may be that problems occurred during a longer usage time. Furthermore, employees may equally still appreciate the benefits of EV usage such as enjoyment and ease of use. However, in the course of time, negative aspects such as range and infrastructure became more important despite the acknowledged EV benefits. This is consistent with Prospect Theory, in which individuals value losses higher than gains [77].

The effect of enjoyment on the behavioral intention to use EVs is not significant at time t_0 (H3). The positive effect of enjoyment increases, however, and becomes significant at times t_1 ($p < 0.01$) and t_2 ($p < 0.05$). H3 is supported at times t_1 and t_2. Correspondingly, we have to reject hypothesis H3a since the effect becomes stronger at times t_1 and t_2 instead of being constant.

The significant impact of enjoyment is consistent with the current EV adoption literature and also with TAM Literature. Inconsistent with TAM is the effect evolving and becoming stronger in the course of time instead of being constant, i.e., it is very weak at first and increases after three and six months (t_1 and t_2). The cause may lie in the corporate context of using an EV: It is likely that using a vehicle for business purposes is usually not necessarily associated with enjoyment. Obviously, fleet car users of do not associate enjoyment with driving an EV in the first instance. However, in the course of time, users learn that driving an EV is enjoyable so that enjoyment has an impact on EV acceptance in corporate fleets. Corporate car users will need to make EV driving experiences and to learn so that the positive effect of enjoyment can unfold.

The question arises now, how far enjoyment mediates the relationship of perceived ease of use on behavioral intention (H4). To analyze the mediating effect of enjoyment, we checked the indirect and direct effects' significances [78]. Before the first usage (t_0), neither the indirect effect of enjoyment on the relationship between ease of use on the intention to use an EV nor the direct effect of ease of use on the intention to use an EV are significant. Therefore, enjoyment is not a mediator for the relationship between ease of use and intention to use an EV at this stage. However, this changes during EV usage at times t_1 and t_2. Then, the indirect effect becomes significant, while the direct effect of ease of use on the intention to use EVs remains insignificant (Table 4). This is a case in which enjoyment fully mediates the relationship between ease of use and the intention to use an EV. In sum, H4 is supported at times t_1 and t_2.

This mediating effect of enjoyment has been investigated in TAM research before (e.g., [54]). However, there has been a lack of evidence regarding the evolution of this effect in other contexts than computer usage. Our results show that ease of use only indirectly influences the intention to use EVs only when enjoyment is present and when EVs are actually used.

Ease of use, however, does not show any significant direct effect (H5 and H5a) at any point in time. This result is very astonishing since EV and TAM literature suggest that ease of use being is an important determinant. In addition, TAM research suggests that the effect of ease of use on behavioral intention fades in the course of time. Therefore, we are unable to find support for both H5 and H5a in our study. The irrelevance of this effect may be explained when we take a closer look on the object of acceptance. Obviously, employees expect and experience no serious usage problems with EVs since only the drive technology differs from a traditionally fueled vehicle. As part of a corporate fleet, the charging infrastructure is present, vehicles are serviced and additional help in case of problems using the vehicles (e.g., personal help, trainings, hotlines) is available. This may also be the reason why our experts have not mentioned ease of use as a driver of EV acceptance in the interviews.

Finally, the effect of relative advantage is not significant at the first point in time t_0. However, this changes at time t_1, in which relative advantage has a significant positive impact on behavioral intention at a level of $p < 0.01$. After six months of usage, this effect disappears again (t_2). H6 is therefore only supported at time t_1, whereas H6a has to be rejected since the effect is not constant over time.

These results can be explained by the fact that assessing the relative advantage of an EV is a complex process, in which the individual employee has to weigh the advantages and disadvantages of using a complex product (the EV) in his/her daily business life. In addition, (s) he has to compare EVs' relative advantage with the relative advantage of traditionally fueled vehicles [33]. EVs' relative advantage becomes clearer in the course of time and the impact on behavioral intention is significant after three months of usage (t_1).

This effect is similar to situations, in which consumers intend to purchase a complex new product. Then, the purchasing process can become very extensive [79]. Transferred to the case of EV usage in corporate fleets, users need to collect information, make experiences with the EV and evaluate the advantages and disadvantages. Therefore, it takes time for users to evaluate the relative advantage so that the positive effect of relative advantage on behavioral intention only becomes significant at time t_1.

Nevertheless, this effect disappears again after six months of extensive usage. Instead, the direct advantages (such as enjoyment) and disadvantages (such as perceived risks) have a significant impact on the intention to use a corporate EV. Obviously, for users the directly product-related characteristics such as perceived risks, enjoyment and also ease of use through enjoyment are more important drivers of the intention to use at later points in time. More complex constructs, in which the user has to weigh advantages and disadvantages through a cognitive process, lose importance for the intention to use in the long run. This effect is also supported by research on consumer behavior. If consumers have, for example, experiences with a new product, buying becomes a routine decision. Consumers do not consider other alternatives anymore. Therefore, a situation of limited decision making prevails [79]. In this situation, involvement is low and the obvious direct advantages (enjoyment) and disadvantages (risks) gain importance for triggering EV usage.

In sum, only environmental concern as an attitudinal factor drives first time EV usage in corporate fleets. During the usage phase, other product-related factors becomes more important. We were unable to find support for any of the hypotheses regarding the longitudinal effects (H1a, H3a, H5a and H6a) as derived from the EV and TAM literature. This result indicates that the process of EV acceptance is very different from end-consumers' EV adoption and from employees' acceptance regarding computer systems or software used in companies as explained in the TAM literature.

6. Implications

6.1. Implications for management

Our results are highly relevant for companies purchasing and integrating EVs into their fleets. In particular, top level managers, fleet managers, professional buyers, innovation managers and marketers as well as consultants need to know why employees are accepting the new vehicles so that CO_2 emissions can actually be reduced in the long-run and environmental goals can be achieved. Based on this knowledge, effective measures can be designed to promote the short- and long-term usage of electric vehicles among employees.

When integrating EVs into a corporate fleet (time t_0), managers should identify and address especially those employees who show environmental concern also regarding other areas of life (e.g., office management, housing, transportation), since environmental concern is the only significant effect on the intention to use EVs. This is in line with Schuitema et al. [39] who found that, among early adopters, "pro--environmentalists" have more positive perceptions of EV attributes and thus are more likely to adopt EVs. Research has also shown that especially younger employees might show higher environmental concern than older employees [80]. These employees should then quickly be convinced and/or incentivized to test-drive the newly purchased EVs. This is consistent with expert Mike's illustration: "The first step is … to get employees to use the car for the first time and to convince them that it is reliable, preferably on short distances. And when the first barrier, mostly a psychological one, has been taken, then there is a good acceptance. But you have to overcome it in the first step. In the second step, the acceptance increases when you have made it over the first barrier."

These pioneers can then function as multipliers within the company. Their opinion can influence peers within the company (similar [81]). They may cause so called "peer effects", in which in which they either actively promote EVs [24] or passively have an influence on the adoption [82] of EVs within the company. In the former case, peer effects emerge through interpersonal communication, in which early adoptions convince their peers of trying and driving the new vehicles. In the latter case, peer effects are created when employees observe their peers using the EVs as part of the corporate fleet (see similar [83]).

In addition, corporate communication should support the use of EVs by launching an internal campaign addressing employees' environmental. As our results suggest, prospective advantages of driving EVs such as enjoyment and ease of use should be stressed that employees can expect when using EVs. In line with corporate communication, trainings and large-scale test drives should be offered and incentivized when the vehicles are available for employees. This is important, since employees do not seem to associate enjoyment with the EV usage in the first instance. Therefore, they need to be informed about EV benefits that can be expected. In this way, enjoyment can actually become effective in fostering EV acceptance in corporate fleets. Therefore, managers should promote enjoyment early which may be unusual in a lot of companies since enjoyment may not directly be related to workplaces. Nevertheless, times are changing, and employees' work-life-balance becomes more important. Companies are struggling to recruit highly qualified employees, so that EVs may become part of a recruitment program and an instrument of the remuneration policy [23] trying to attract younger people to the company. In this way, companies may become more attractive by incentivizing new staff and demonstrating the company's environmental concern at the same time.

In addition to the communication of expected enjoyment, it should also be stressed that the vehicles are very easy to drive and charge. In combination with enjoyment, ease of use has a positive impact on people's intention to use EVs. The benefits of enjoyment and ease of use should also be fostered by top management's use of EVs to function as role models. In this way, signaling effects can be indirectly and subliminally communicated to company's employees (similar, e.g., [84]).

After the technical integration of the vehicles into the fleets, companies should promote EVs' environmentally friendly aspects (especially for those employees, who have not yet used them) as well as enjoyment and their ease of use (especially for those employees, who have already used them). This should also counteract perceived risks in the long run, since they still strongly influence the employees' decision whether to use the vehicles or not.

Typically, the negative aspects of EVs such as range deficiencies are discussed in the media, so that users perceive high "risks" of driving EVs. To reduce these risks, employees should be educated about the facts regarding the "risks" of using an EV. The charging infrastructure should be well maintained and sufficient chargers should be available. A reliable charging infrastructure should be installed with transparent charging status and range forecasts to reduce perceived risks. Since the perception of the risks is important, the measures for risk reduction have to be communicated regularly to the employees. For example, "success stories" (e.g., maximum ranges achieved) should to be communicated within the company.

A further measure to reduce perceived risks is to install professional technical support at an early stage of the project and communicated to the employees. If employees experience problems while using the cars on a long-term basis, they should be able to call a telephone hotline. This support has become very effective during the project. Another option would be that the car even connects to a remote help desk that can access the vehicles and offer remote assistance. It may be helpful to cooperate with professional car rescue institutions for urgent cases. In this way, perceived risks and negative experiences in the long run can be avoided.

The knowledge about these implications are also important for car manufacturers, leasing companies and retailers who are selling or leasing EVs. They have to support and advise management in the decision whether and how to integrate EVs into their fleets. They also have to provide guidance how to increase EV acceptance among employees. For all of them (usually technical staff), it is important to understand that technical and directly product-related characteristics are irrelevant for the employees before the first usage (t_0) and that environmental concern triggers the decision to drive an EV. Product-related characteristics only become effective after the first trials and during longer usage.

6.2. Implications for policy

In addition to implications for management, we include suggestions for policy makers to foster acceptance of EVs on the employee's level. They are deduced from our research results. First of all, due to our findings regarding environmental concern especially at time t_0, governments should address and support its own employees' environmental concern in order to trigger first usage of EVs. To further support the impact of employee's environmental attitude, Politicians could use their personality to function as role models and opinion leaders in their countries [36]. Instead of using traditionally oil-fueled cars, they should choose EVs as their state coaches. This must then be covered in the media (also in social media) and communicated to the public [15,33]. Currently, only 761 out of 29,065 vehicles of the German state fleet are electric (2.6%) [85]. Also, incentives could help to implement a green fleet strategy. Commitment to EVs and testimonials regarding environmental concern could help to foster first trials instead of purely praying for environmental activities (similar [86]). A growing number of role models should then stress the advantages such as enjoyment and ease of use of the cars to ascertain acceptance in later stages of the process. This will have a positive effect on EV acceptance also in state fleets, as well as on EV adoption in the consumer market.

Policy makers should also focus on reducing perceived risks as perceived risks may have a negative effect at later stages in the acceptance process. For example, investments into the public fast charging infrastructure and into the harmonization of payment options have to be made to reduce the perceived risks of charging, charging times and range. The measures need to be properly communicated to the public since most of the risks are only "perceived" risks (see similar [31,36]).

In addition, policy must develop more concise green strategies and substantiate these strategies by investing into green technologies such as EV incentives and infrastructure (as e.g., Norway). These strategies should be followed in taking operational and executive measures regarding our findings (addressing and increasing environmental concern, highlighting enjoyment and reducing risks). This would fit as well with a federal and the European green strategy, i.e., the European Green Deal. Governments should rather lend green and consumer-oriented lobbies an ear, instead of promoting and sticking to the old-traditional large manufacturers' lobbyists trying to maintain or even extent the state-of-the-art. This should increase and support managers' and citizens' environmental concern and, finally, acceptance and adoption of EVs.

7. Conclusion

In our study, we have analyzed the dynamics of EV acceptance in corporate fleets on the employee's level. We have developed a theoretical framework based on a Grounded Theory approach using expert interviews and a thorough literature review. In a quantitative longitudinal study, we have assessed the impact of attitudinal and product-related determinants at three points in time, i.e., before the first use, after three months and after six months of EV usage.

The direction of the hypotheses derived from 16 expert interviews and from prior research, could be confirmed so that our research is in line with the existing TAM and EV literature. Nevertheless, our paper reveals fundamentally new insights into the dynamics of these determinants in the acceptance process in the course of time. In particular, environmental concern is the only trigger of first-time EV usage. However, its role slumps in the long run. In contrast, directly product-related characteristics become more important for EVs' acceptance in the long-run. Enjoyment and perceived risks have a direct impact on the intention to use EVs only at later stages in the acceptance process. Moreover, ease of use only becomes a long-term determinant in combination with enjoyment, since the latter acts as a mediator on the relationship between ease of use and the employees' intention to use EVs. This understanding helps general managers, corporate fleet car managers, innovation managers, marketers, consultants as well as policymakers in reducing CO_2 emissions.

Our paper is restricted by some limitations that open up avenues for future research. First, additional determinants of acceptance should be introduced into the model to identify additional short-term determinants triggering the first usage of EVs (t_0). For example, it seems worthwhile including subjective norm as deduced from Theory of Planned Behavior or additional personal characteristics such as personal innovativeness [60,87] or habit [88] into the model. In this context, the role of learning and trainings as mediators could be a further fruitful avenue of research since we did not differentiate these levels in our study. However, other studies have demonstrated the effect of trainings on the acceptance of new technologies in a corporate context [89].

Second, the evolution of perceived risks at later stages should be investigated in more depth since they play an important role in the long-term acceptance of EVs in corporate fleets. At the moment, it is unclear, whether the long-term negative effect is the result of actual problems with the vehicles or "just" a matter of employees' perception, who overrate negative aspects as suggested in Prospect Theory or whether it is a process of learning. For the long-term acceptance process, future research is also needed to deepen the knowledge of "peer effects" on employees' acceptance, as suggested in the implications section, and their impact to attenuate perceived risks. If peer effects have a significant impact, critical masses [90] within a company may likewise play a role in the acceptance process.

Third, our results are based on a sample consisting of German companies. Future research should be conducted in other countries in order to find more support, to extend the model and/or to detect intercultural differences. Finally, the sample size was relatively small so that larger samples should be collected in order to support the results. Also, longer-term effects, e.g., after 12 months, would be interesting to investigate, as well.

Author contribution

Ellen Roemer: Conceptualization; Data curation; Formal analysis; Funding acquisition; Investigation; Methodology; Project administration; Resources; Software; Visualization; Writing – original draft. **Jörg Henseler:** Supervision; Methodological consulting; Validation; Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

[1] S. Anowar, N. Eluru, M. Hatzopoulou, Quantifying the value of a clean ride: how far would you bicycle to avoid exposure to traffic-related air pollution? Transport. Res. Pol. Pract. 105 (Supplement C) (2017) 66–78, https://doi.org/10.1016/j.tra.2017.08.017.
[2] McKinsey, Company, The Road Ahead for E-Mobility. 27/01/2020: McKinsey Center for Future Mobility, 2020. Retrieved from, https://mckinsey.com/industries/automotive-and-assembly/our-insights/the-road-ahead-for-e-mobility#.
[3] L. Whitmarsh, S. O'Neill, Green identity, green living? The role of pro-environmental self-identity in determining consistency across diverse pro-environmental behaviours, J. Environ. Psychol. 30 (3) (2010) 305–314, https://doi.org/10.1016/j.jenvp.2010.01.003.
[4] M.B. Bossle, M.D. de Barcellos, L.M. Vieira, L. Sauvée, The drivers for adoption of eco-innovation, J. Clean. Prod. 113 (2016) 861–872, https://doi.org/10.1016/j.jclepro.2015.11.033.
[5] J. Hojnik, M. Ruzzier, What drives eco-innovation? A review of an emerging literature, Environ. Inoovat. Soc. Trans. 19 (2016) 31–41, https://doi.org/10.1016/j.eist.2015.09.006.
[6] M.-L. Tseng, T.-D. Bui, Identifying eco-innovation in industrial symbiosis under linguistic preferences: a novel hierarchical approach, J. Clean. Prod. 140 (2017) 1376–1389, https://doi.org/10.1016/j.jclepro.2016.10.014.
[7] G.J. Offer, D. Howey, M. Contestabile, R. Clague, N.P. Brandon, Comparative analysis of battery electric, hydrogen fuel cell and hybrid vehicles in a future sustainable road transport system, Energy Pol. 38 (1) (2010) 24–29, https://doi.org/10.1016/j.enpol.2009.08.040.
[8] L. Sussams, J. Leaton, Expect the Unexpected the Disruptive Power of Technology, 2017. http://www.carbontracker.org/report/expect-the-unexpected-disruptive-power-low-carbon-technology-solar-electric-vehicles-grantham-imperial/.
[9] Kraftfahrt-Bundesamt, Jahresbilanz - Neuzulassungen 2019, 2020. Retrieved 16/03/2021, Flensburg, Retrieved from, https://www.kba.de/DE/Statistik/Fahrzeuge/Neuzulassungen/jahresbilanz/2019/2019_jahresbilanz_inhalt.html?nn=2594996.
[10] Society of Motor Manufacturers and Traders, Car Registrations by Sales Type 2019, 2020. Retrieved 16/03/2021, London, Retrieved from, https://www.smmt.co.uk/vehicle-data/car-registrations/.
[11] A. Tariq, Y.F. Badir, W. Tariq, U.S. Bhutta, Drivers and consequences of green product and process innovation: a systematic review, conceptual framework, and future outlook, Technol. Soc. 51 (2017) 8–23, https://doi.org/10.1016/j.techsoc.2017.06.002.
[12] J. Cao, X. Chen, R. Qiu, S. Hou, Electric vehicle industry sustainable development with a stakeholder engagement system, Technol. Soc. 67 (2021) 101771, https://doi.org/10.1016/j.techsoc.2021.101771.
[13] D. Weiss, F. Nemeczek, A text-based monitoring tool for the legitimacy and guidance of technological innovation systems, Technol. Soc. 66 (2021) 101686, https://doi.org/10.1016/j.techsoc.2021.101686.
[14] R.T. Frambach, N. Schillewaert, Organizational innovation adoption: a multi-level framework of determinants and opportunities for future research, J. Bus. Res. 55 (2) (2002) 163–176, https://doi.org/10.1016/S0148-2963(00)00152-1.
[15] J. Globisch, E. Dütschke, J. Schleich, Acceptance of electric passenger cars in commercial fleets, Transport. Res. Pol. Pract. 116 (October) (2018) 122–129, https://doi.org/10.1016/j.tra.2018.06.004.
[16] D. Dunphy, Electric Vehicles Continue Mainstreaming with Acceptance and Support, 2021, 02/03/2021, Retrieved 12/04/2021, Retrieved from, https://fleetmanagementweekly.com/electric-vehicles-continue-mainstreaming-with-acceptance-and-support/.
[17] F.W. Rother, Elektroautos im Fuhrpark: "Das Beste liegt noch vor uns". 24/02/2021, 2021. Retrieved 12/04/2021, Retrieved from, https://edison.media/unternehmen/elektroautos-im-fuhrpark-das-beste-liegt-vor-uns/25214460/.
[18] M. Dijk, Technological frames of car engines, Technol. Soc. 33 (1) (2011) 165–180, https://doi.org/10.1016/j.techsoc.2011.03.013.
[19] Z. Rezvani, J. Jansson, J. Bodin, Advances in consumer electric vehicle adoption research: a review and research agenda, Transport. Res. Transport Environ. 34 (2015) 122–136, https://doi.org/10.1016/j.trd.2014.10.010.
[20] J. Globisch, E. Dütschke, M. Wietschel, Adoption of electric vehicles in commercial fleets: why do car pool managers campaign for BEV procurement? Transport. Res. Transport Environ. 64 (2018) 122–133, https://doi.org/10.1016/j.trd.2017.10.010.
[21] S. Kaplan, J. Gruber, M. Reinthaler, J. Klauenberg, Intentions to introduce electric vehicles in the commercial sector: a model based on the theory of planned behaviour, Res. Transport. Econ. 55 (June) (2016) 12–19, https://doi.org/10.1016/j.retrec.2016.04.006.
[22] W. Sierzchula, Factors influencing fleet manager adoption of electric vehicles, Transport. Res. Transport Environ. 31 (2014) 126–134, https://doi.org/10.1016/j.trd.2014.05.022.
[23] S. Skippon, J. Chappell, Fleets' motivations for plug-in vehicle adoption and usage: U.K. case studies, Transport. Res. Transport Environ. 71 (2019) 67–84, https://doi.org/10.1016/j.trd.2018.12.009.
[24] E.M. Rogers, Diffusion of Innovations, Simon and Schuster, New York, 1995.
[25] J. Corbin, A. Strauss, Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory, fourth ed., Sage publications, Los Angeles, London, 2014.
[26] J. Gläser, G. Laudel, On interviewing "good" and "bad" experts, in: A. Bogner, B. Littig, W. Menz (Eds.), Interviewing Experts, Palgrave Macmillan, London, 2009, pp. 117–137.
[27] J. Gläser, G. Laudel, Experteninterviews und qualitative Inhaltsanalyse als Instrumente rekonstruierender Untersuchungen, VS Verlag für Sozialwissenschaften, Wiesbaden, 2010.
[28] R.L. Gorden, Interviewing: Strategy, Techniques, and Tactics, Dorsey Press, 1975.
[29] G. McCracken, The Long Interview, vol. 13, Sage Publications, Newbury Park, 1988.
[30] U. Flick, An Introduction to Qualitative Research, Sage Publications Limited, Los Angeles, London, 2018.
[31] M. Bockarjova, L. Steg, Can Protection Motivation Theory predict pro-environmental behavior? Explaining the adoption of electric vehicles in The Netherlands, Global Environ. Change 28 (September) (2014) 276–288, https://doi.org/10.1016/j.gloenvcha.2014.06.010.
[32] K. Degirmenci, M.H. Breitner, Consumer purchase intentions for electric vehicles: is green more important than price and range? Transport. Res. Transport Environ. 51 (March) (2017) 250–260, https://doi.org/10.1016/j.trd.2017.01.001.
[33] O. Egbue, S. Long, Barriers to widespread adoption of electric vehicles: an analysis of consumer attitudes and perceptions, Energy Pol. 48 (September) (2012) 717–729, https://doi.org/10.1016/j.enpol.2012.06.009.
[34] T. Franke, F. Bühler, P. Cocron, I. Neumann, J.F. Krems, Enhancing sustainability of electric vehicles: a field study approach to understanding user acceptance and behavior, in: M. Sullman, L. Dorn (Eds.), Advances in Traffic Psychology, CRC Press, Boca Raton, 2012, pp. 295–306.
[35] K.S. Gallagher, E. Muehlegger, Giving green to get green? Incentives and consumer adoption of hybrid vehicle technology, J. Environ. Econ. Manag. 61 (1) (2011) 1–15, https://doi.org/10.1016/j.jeem.2010.05.004.
[36] J. Jansson, A. Nordlund, K. Westin, Examining drivers of sustainable consumption: the influence of norms and opinion leadership on electric vehicle adoption in Sweden, J. Clean. Prod. 154 (June) (2017) 176–187, https://doi.org/10.1016/j.jclepro.2017.03.186.
[37] I. Moons, P. De Pelsmacker, Emotions as determinants of electric car usage intention, J. Market. Manag. 28 (3–4) (2012) 195–237, https://doi.org/10.1080/0267257x.2012.659007.
[38] P. Plötz, U. Schneider, J. Globisch, E. Dütschke, Who will buy electric vehicles? Identifying early adopters in Germany, Transport. Res. Pol. Pract. 67 (September) (2014) 96–109, https://doi.org/10.1016/j.tra.2014.06.006.
[39] G. Schuitema, J. Anable, S. Skippon, N. Kinnear, The role of instrumental, hedonic and symbolic attributes in the intention to adopt electric vehicles, Transport. Res. Pol. Pract. 48 (February) (2013) 39–49, https://doi.org/10.1016/j.tra.2012.10.004.
[40] I. Ajzen, From intentions to actions: a theory of planned behavior, in: J. Kuhl, J. Beckmann (Eds.), Action Control, Springer, Berlin, Heidelberg, 1985, pp. 11–39, https://doi.org/10.1007/978-3-642-69746-3_2.
[41] I. Ajzen, M. Fishbein, Understanding Attitudes and Predicting Social Behavior, Prentice-Hall, Englewood Cliffs, NJ, 1980.
[42] V. Venkatesh, M.G. Morris, G.B. Davis, F.D. Davis, User acceptance of information technology: toward a unified view, MIS Q. 27 (3) (2003) 425–478, https://doi.org/10.2307/30036540.
[43] V. Venkatesh, J.Y. Thong, X. Xu, Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology, MIS Q. 36 (1) (2012) 157–178, https://doi.org/10.2307/41410412.
[44] A.F. Jensen, E. Cherchi, S.L. Mabit, On the stability of preferences and attitudes before and after experiencing an electric vehicle, Transport. Res. Transport Environ. 25 (December) (2013) 24–32, https://doi.org/10.1016/j.trd.2013.07.006.

[45] F.D. Davis, R.P. Bagozzi, P.R. Warshaw, User acceptance of computer technology: a comparison of two theoretical models, Manag. Sci. 35 (8) (1989) 982–1003, https://doi.org/10.1287/mnsc.35.8.982.
[46] V. Venkatesh, F.D. Davis, A theoretical extension of the technology acceptance model: four longitudinal field studies, Manag. Sci. 46 (2) (2000) 186–204, https://doi.org/10.1287/mnsc.46.2.186.11926.
[47] V. Venkatesh, M.G. Morris, Why don't men ever stop to ask for directions? Gender, social influence, and their role in technology acceptance and usage behavior, MIS Q. 24 (1) (2000) 115–139, https://doi.org/10.2307/3250981.
[48] A. Bhattacherjee, G. Premkumar, Understanding changes in belief and attitude toward information technology usage: a theoretical model and longitudinal test, MIS Q. 28 (2) (2004) 229–254, https://doi.org/10.2307/25148634.
[49] S. Carley, R.M. Krause, B.W. Lane, J.D. Graham, Intent to purchase a plug-in electric vehicle: a survey of early impressions in large US cites, Transport. Res. Transport Environ. 18 (January) (2013) 39–45, https://doi.org/10.1016/j.trd.2012.09.007.
[50] C. Barbarossa, S.C. Beckmann, P. De Pelsmacker, I. Moons, W. Gwozdz, A self-identity based model of electric car adoption intention: a cross-cultural comparative study, J. Environ. Psychol. 42 (June) (2015) 149–160, https://doi.org/10.1016/j.jenvp.2015.04.001.
[51] M. Barth, P. Jugert, I. Fritsche, Still underdetected – social norms and collective efficacy predict the acceptance of electric vehicles in Germany, Transport. Res. F Traffic Psychol. Behav. 37 (February) (2016) 64–77, https://doi.org/10.1016/j.trf.2015.11.011.
[52] B. Junquera, B. Moreno, R. Álvarez, Analyzing consumer attitudes towards electric vehicle purchasing intentions in Spain: technological limitations and vehicle confidence, Technol. Forecast. Soc. Change 109 (August) (2016) 6–14, https://doi.org/10.1016/j.techfore.2016.05.006.
[53] H. Khazaei, A. Khazaei, Electric vehicles and factors that influencing their adoption moderating effects of driving experience and voluntariness of use (conceptual framework), IOSR J. Bus. Manag. 18 (12) (2016) 60–65, https://doi.org/10.9790/487X-1812036065.
[54] F.D. Davis, R.P. Bagozzi, P.R. Warshaw, Extrinsic and intrinsic motivation to use computers in the workplace, J. Appl. Soc. Psychol. 22 (14) (1992) 1111–1132, https://doi.org/10.1111/j.1559-1816.1992.tb00945.x.
[55] G.C. Moore, I. Benbasat, Development of an instrument to measure the perceptions of adopting an information technology innovation, Inf. Syst. Res. 2 (3) (1991) 192–222, https://doi.org/10.1287/isre.2.3.192.
[56] B. Lane, S. Potter, The adoption of cleaner vehicles in the UK: exploring the consumer attitude–action gap, J. Clean. Prod. 15 (11–12) (2007) 1085–1092, https://doi.org/10.1016/j.jclepro.2006.05.026.
[57] F.D. Davis, Perceived usefulness, perceived ease of use, and user acceptance of information technology, MIS Q. 13 (3) (1989) 319–340, https://doi.org/10.2307/249008.
[58] S. Taylor, P.A. Todd, Understanding information technology usage: a test of competing models, Inf. Syst. Res. 6 (2) (1995) 144–176, https://doi.org/10.1287/isre.6.2.144.
[59] K. Lee, Opportunities for green marketing: young consumers, Market. Intell. Plann. 26 (6) (2008) 573–586, https://doi.org/10.1108/02634500810902839.
[60] J. Jansson, Consumer eco-innovation adoption: assessing attitudinal factors and perceived product characteristics, Bus. Strat. Environ. 20 (3) (2011) 192–210, https://doi.org/10.1002/bse.690.
[61] H. Jeeninga, W.G. Van Arkel, C.H. Volkers, Performance and Acceptance of Electric and Hybrid Vehicles, Municipality of Rotterdam, Rotterdam, The Netherlands, 2002.
[62] J.F. Hair, G.T.M. Hult, C. Ringle, M. Sarstedt, A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM), second ed. ed., SAGE Publications, Los Angeles, 2017.
[63] J. Cohen, A power primer, Psychol. Bull. 112 (1) (1992) 155–519, https://doi.org/10.1037/0033-2909.112.1.155.
[64] F. Faul, E. Erdfelder, A. Buchner, A.-G. Lang, Statistical power analyses using G* Power 3.1: tests for correlation and regression analyses, Behav. Res. Methods 41 (4) (2009) 1149–1160, https://doi.org/10.3758/BRM.41.4.1149.
[65] E. Roemer, A tutorial on the use of PLS path modeling in longitudinal studies, Ind. Manag. Data Syst. 116 (9) (2016) 1901–1921, https://doi.org/10.1108/IMDS-07-2015-0317.
[66] C.M. Ringle, S. Wende, J.-M. Becker, SmartPLS 3. Bönningstedt: SmartPLS, 2015. Retrieved from, http://www.smartpls.com.
[67] J. Henseler, Composite-based Structural Equation Modeling: Analyzing Latent and Emergent Variables, The Guilford Press, New York, 2021.
[68] J. Henseler, Partial least squares path modeling, in: P. Leeflang, T. Wieringa, T. Bijmolt, K. Pauwels (Eds.), Advanced Methods for Modeling Markets, Springer, Heidelberg, 2017, pp. 361–381, https://doi.org/10.1007/978-3-319-53469-5_12.
[69] J. Henseler, C.M. Ringle, R.R. Sinkovics, The use of partial least squares path modeling in international marketing, in: R.R. Sinkovics, P.N. Ghauri (Eds.), Advances in International Marketing, vol. 20, Emerald Group Publishing, Bingley, 2009, pp. 277–319, https://doi.org/10.1108/S1474-7979(2009)0000020014.
[70] J. Henseler, C.M. Ringle, M. Sarstedt, A new criterion for assessing discriminant validity in variance-based structural equation modeling, J. Acad. Market. Sci. 43 (1) (2015) 1–21, https://doi.org/10.1007/s11747-014-0403-8.
[71] J. Benitez, J. Henseler, A. Castillo, F. Schuberth, How to perform and report an impactful analysis using partial least squares: guidelines for confirmatory and explanatory IS research, Inf. Manag. 57 (2) (2020) 1–16, https://doi.org/10.1016/j.im.2019.05.003.
[72] G. Franke, M. Sarstedt, Heuristics versus statistics in discriminant validity testing: a comparison of four procedures, Internet Res. 29 (3) (2019) 430–447, https://doi.org/10.1108/IntR-12-2017-0515.
[73] J. Henseler, Partial least squares path modeling: Quo vadis? Qual. Quantity 52 (1) (2018) 1–8, https://doi.org/10.1007/s11135-018-0689-6.
[74] J. Henseler, G. Hubona, P.A. Ray, Using PLS path modeling in new technology research: updated guidelines, Ind. Manag. Data Syst. 116 (1) (2016) 2–20, https://doi.org/10.1108/IMDS-09-2015-0382.
[75] J. Cohen, Statistical Power Analysis for the Behavioral Sciences, Routledge, Abingdon, England, 1988.
[76] J.F. Hair, C.M. Ringle, M. Sarstedt, PLS-SEM: indeed a silver bullet, J. Market. Theor. Pract. 19 (2) (2011) 139–152, https://doi.org/10.2753/MTP1069-6679190202.
[77] D. Kahneman, A. Tversky, Prospect theory: an analysis of decision under risk, in: L. C. MacLean, W.T. Ziemba (Eds.), Handbook of the Fundamentals of Financial Decision Making: Part I, World Scientific, Singapore, 2013, pp. 99–127, https://doi.org/10.1142/9789814417358_0006.
[78] X. Zhao, J.G. Lynch Jr., Q. Chen, Reconsidering Baron and Kenny: myths and truths about mediation analysis, J. Consum. Res. 37 (2) (2010) 197–206, https://doi.org/10.1086/651257.
[79] C.W. Lamb, J.F. Hair, C. McDaniel, Essentials of Marketing, seventh ed., South-Western Cengage Learning, Mason, 2012.
[80] P.S. Morrison, B. Beer, Consumption and environmental awareness: demographics of the European experience, in: H. Shibusawa, K. Sakurai, T. Mizunoya, S. Uchida (Eds.), Socioeconomic Environmental Policies and Evaluations in Regional Science, Springer, Singapore, 2017, pp. 81–102, https://doi.org/10.1007/978-981-10-0099-7_5.
[81] Y. Zhang, Y. Yu, B. Zou, Analyzing public awareness and acceptance of alternative fuel vehicles in China: the case of EV, Energy Pol. 39 (11) (2011) 7015–7024, https://doi.org/10.1016/j.enpol.2011.07.055.
[82] B. Bollinger, K. Gillingham, Peer effects in the diffusion of solar photovoltaic panels, Market. Sci. 31 (6) (2012) 900–912, https://doi.org/10.1287/mksc.1120.0727.
[83] S.C. Mukherjee, L. Ryan, Factors influencing early battery electric vehicle adoption in Ireland, Renew. Sustain. Energy Rev. 118 (2020) 109504, https://doi.org/10.1016/j.rser.2019.109504.
[84] S. Skippon, M. Garwood, Responses to battery electric vehicles: UK consumer attitudes and attributions of symbolic meaning following direct experience to reduce psychological distance, Transport. Res. Transport Environ. 16 (7) (2011) 525–531, https://doi.org/10.1016/j.trd.2011.05.005.
[85] Manager Magazin, Regierung Fährt Eigenen Elektroauto-Zielen Hinterher, 05/06/2019, 2019. Retrieved from, https://www.manager-magazin.de/unternehmen/autoindustrie/elektroautos-bundesregierung-faehrt-eigenen-zielen-hinterher-a-1265905.html.
[86] J. Thøgersen, J.V. Ebsen, Perceptual and motivational reasons for the low adoption of electric cars in Denmark, Transport. Res. F Traffic Psychol. Behav. 65 (2019) 89–106, https://doi.org/10.1016/j.trf.2019.07.017.
[87] O.A. Gansser, C.S. Reich, A new acceptance model for artificial intelligence with extensions to UTAUT2: an empirical study in three segments of application, Technol. Soc. 65 (2021) 101535, https://doi.org/10.1016/j.techsoc.2021.101535.
[88] L. Cai, K.F. Yuen, D. Xie, M. Fang, X. Wang, Consumer's usage of logistics technologies: integration of habit into the unified theory of acceptance and use of technology, Technol. Soc. 67 (2021), https://doi.org/10.1016/j.techsoc.2021.101789, 101789.
[89] J.E. Amadi-Echendu, F.C.P. de Wit, Technology adoption: a study on post-implementation perceptions and acceptance of computerised maintenance management systems, Technol. Soc. 43 (2015) 209–218, https://doi.org/10.1016/j.techsoc.2015.09.001.
[90] S. Lew, G.W.-H. Tan, X.-M. Loh, J.-J. Hew, K.-B. Ooi, The disruptive mobile wallet in the hospitality industry: an extended mobile technology acceptance model, Technol. Soc. 63 (2020) 101430, https://doi.org/10.1016/j.techsoc.2020.101430.
[91] VERBI Software, MAXQDA. Berlin, Germany: VERBI Software, 2020. Retrieved from, https://www.maxqda.com.