Charging at the workplace: boosting acceptance for electric mobility on the go? Empirical evidence from a pre-post-design study in Germany

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Abstract

Studies indicate that the availability of sufficient charging infrastructure plays a crucial role in the acceptance of electric mobility. The lack of charging stations and concerns about limited range are perceived as barriers to purchase and use electric vehicles, particularly for non-users. Charging at the workplace appears promising for addressing these challenges. Specifically, it can contribute to a higher perceived compatibility for individuals (e.g. for those without home charging options), potentially increasing interest in electric vehicles. Additionally, the increased visibility and accessibility of charging stations could contribute to overall acceptance. Hence, we investigated if (recently installed) charging stations at the workplace can influence attitudes and behaviours related to electric mobility.

Between 2019 and 2022, new charging stations were installed in four German cities, in close proximity to research institutes. Before (N = 1183) and after the installation (N = 522) of the charging stations, employees of the research institutes participated in an acceptance study. About 270 individuals participated in both online surveys. The statistical analyses reveal that the installation of charging stations makes the purchase of an electric vehicle more appealing to employees. The new charging stations appear to be a significant factor associated with an increased perception of compatibility of using an electric vehicle with people's everyday life. In addition, we find that general attitudes toward electric mobility became more polarized. Overall, the study suggests that establishing charging stations within organizational settings can be a driver for the transition to electric mobility. However, we discuss additional factors that impact attitudes toward electric mobility – especially for individuals that are particularly sceptical – such as hands-on experiences with the technology, concurrent societal discourses and relevant policies.

Introduction

The transport sector accounts for about one-quarter of all greenhouse gas (GHG) emissions in the EU. Decarbonisation of the transport sector is of great importance for mitigating climate change. Electric vehicles (EVs) including battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs) count as part of the efficiency sustainability approach to downsize emissions in the transport sector (Märtz et al., 2021). The current state of electric mobility signifies a shift toward sustainable transport, with EVs playing a crucial role. Worldwide, policy measures are being promoted to boost their adoption (Rietmann & Lieven, 2019). The increasing global embrace of EVs reflects a collective effort to reduce carbon emissions and address climate change alike. The successful integration of EVs into mainstream transportation hinges heavily on the development of a robust and convenient charging infrastructure (Pamidimukkala et al., 2024). The availability and accessibility of charging stations seems to present pivotal factors influencing the broad acceptance and adoption of EVs. Investments from governments, industries, and communities in expanding charging networks play a crucial role in normalizing EV use and ensuring the success of electric mobility (Falchetta & Noussan, 2021). The interplay between EVs and charging infrastructure

is a critical factor shaping the future of sustainable transportation. This study emphasizes the importance of understanding charging behaviour, essential for policy development and corporate mobility management. Specifically, the study focuses on the role of workplace charging stations in influencing people's intentions to adopt EVs. Our main research questions are the following: Do charging stations at the workplace impact employees' attitude toward and adoption intention of EVs? What role do social norms, need compatibility and the perception of barriers play? Does charging at the workplace impact all people equally or only specific subgroups?

Literature review

CHARGING INFRASTRUCTURE AND ELECTRIC VEHICLE ADOPTION

The widespread adoption of EVs faces various barriers that contribute to the challenges of transitioning to a more sustainable transportation system. Based on a current review, these barriers can be categorized in four types, namely contextual, situational, demographic, and psychological (Pamidimukkala et al., 2024). Contextual factors include charging infrastructure or policy incentives whereas situational factors include economic aspects (e.g. purchase costs, limited driving range) as well as environmental barriers (e.g. pollution from battery production). However, besides given demographic factors such as age and education, psychological factors such as the lack of knowledge or practical experience may interfere or even overrule situational and contextual factors. The lack of charging stations counts as the most cited barrier to EV adoption which interacts with the psychological phenomena of range anxiety (Kumar & Alok, 2020; Pamidimukkala et al., 2024). It is described as the fear of not reaching one's transport destination with the (remaining) battery power (Neubauer & Wood, 2014; Pevec et al., 2020). To counter range anxiety and situational barriers such as limited driving range and longer charging time (which both interfere with range anxiety), a charging network that fits to the people's mobility needs and daily habits is important (Preuß et al., 2022). Concerns about the limited driving range and/or longer charging times contribute to range anxiety, dissuading potential users from embracing EVs. This is especially the case during longer journeys which is majorly a question for leisure activities but potentially also when arriving at the workplace on time during rush hours or also when doing business trips. Hence, the scarcity of charging stations is a significant impediment, creating obstacles for (potential) EV users who rely on convenient and accessible charging infrastructure. These challenges are particularly pronounced among non-users, who may view EVs as less practical due to these barriers (Hardman et al., 2018; Patt et al., 2019). According to a recent study by White et al. (2022), the density of public charging stations for EVs is correlated with a higher adoption intention. The study investigates three potential mechanisms through which increased charging station density could influence EV adoption intent: reducing range anxiety, decreasing perceived mobility restriction, and fostering more positive subjective norms in favour of EVs. Their results suggest that perceived subjective norms supporting EVs explain a significant portion of the association between charging station density and adoption intention. Range anxiety plays a smaller and less consistent role as a mechanism, while perceived mobility restriction has no direct or indirect effect on EV adoption intention. In essence, there is no indication that the intention to adopt EVs is influenced by expectations that EVs cannot meet mobility needs. The findings underscore the importance of social norms for translating investments in charging infrastructure into increased EV adoption. Hence, addressing the concerns related to charging infrastructure is crucial for mitigating these barriers and fostering a more positive attitude toward electric mobility, encouraging broader acceptance and adoption of EVs among both current and prospective users.

Individual travel patterns and vehicle driving ranges primarily impact EV owners' charging needs. Past studies have identified four main locations at which charging usually occurs: overnight charging at or near home, at workplaces, at publicly accessible locations like those near grocery stores, shopping malls, and in parking lots; and on travel corridors where drivers stop between their trip origin and destination points (Hardman et al., 2018). In particular, they outline that workplace charging (i) plays an important role for purchasing EVs as well as (ii) represents the second important place of charging for current EV users after charging at home. This aligns with the findings from Germany indicating that the majority of EVs are primarily charged at home, with 61 % of charging processes taking place at residences, with 15 % occur at workplaces and 25 % at public charging points (Preuß et al., 2024). Early adopters of EVs, typically middle-aged men with high incomes, living in suburban or rural settings, are more likely to own homes and have home-charging capabilities (Pamidimukkala et al., 2024; Plötz et al., 2014). These characteristics may also apply partly to car users in general but they have specifically been found for early adopters of EVs. However, as EV adoption expands to more diverse population groups, including those without home ownership, the significance of public and semi-public charging – which workplace charging would count as – is expected to grow.

WORKPLACE CHARGING

Workplace charging addresses significant contextual barriers to the adoption of EVs (Pamidimukkala et al., 2024) and may also enhance the perceived compatibility of EVs with individuals' everyday lives (Preuß et al., 2022). For those without home charging options, having charging stations at the workplace provides a convenient solution, making EVs more appealing for potential buyers and users (Hardman et al., 2018). According to surveys, EV users are most likely to plug-in their vehicles when they arrive at work in the morning and when they return at home in the evening (Axsen et al., 2011; Schäuble et al., 2017). Furthermore, distance of commuting is decisive for a mixed usage of charging stations (Lee et al., 2020) which however interacts with the maximum driving range of the car. The increased availability of charging infrastructure at the workplace may not only decrease concerns about limited range but may also contribute to the overall visibility and accessibility of charging stations, and thus, may boost social norms and overall acceptance – just as public charging infrastructure does (White et al., 2022). Based on these insights, we argue that workplace charging enhances the use of EVs by making their use more tangible and practical for employees and by fostering a favourable environment for the acceptance and adoption of EVs. Furthermore,

workplace charging potentially contributes to normalizing EVs within organizational settings by increasing general awareness and inducing a social norm shift (Haustein et al., 2021). When employees witness and experience the convenience of charging their EV at work, it can positively impact their perceptions and attitudes toward electric mobility in general and may offer "a safety net" for current EV users and in particular for people in multi-unit dwellings without reliable access to charging stations (Chakraborty et al., 2019, p. 2). Hence, workplace charging may contribute further to a more widespread acceptance of EVs, potentially acting as a catalyst for the broader transition to sustainable transportation.

THE ROLE OF COMPATIBILITY, WORKING TIME, AND GENDER

One approach to understand the adoption of EVs is Rogers' (2003) Diffusion of Innovations-theory (DoI). The most commonly examined variables of the DoI are the five perceived attributes of an innovation. These are (i) relative advantage, (ii) compatibility, (iii) complexity, (iv) trialability, and (v) observability. Rogers (2003) stated that the perceived compatibility of an innovation is most likely related to the adoption of the innovation. Compatibility is defined as the degree to which an innovation is perceived as consistent with personal values, past experiences, and needs of potential adopters. In short, compatibility presents a construct that represents the degree to which an innovation meets the needs, values and lifestyles of the respective adopter. For instance, an EV would be bought or used if it fits the person's needs regarding mobility, their values such as pro-environmental beliefs and/or their lifestyle and habits regarding commuting to work by car. In line with Rogers' (2003) assumption, recent research on the adoption of low-emission transport options showed that compatibility is commonly the strongest predictor of the outlined DoI variables (Burghard & Scherrer, 2022; Preuß et al., 2022). Studies in Germany focusing on early adopters identified perceived compatibility with personal needs as the primary factor influencing the willingness to purchase an EV (Peters & Dütschke, 2014). This relationship between compatibility and adoption intention is further supported by research on sharing services. Perceived compatibility with daily life significantly predicted attitudes toward car sharing, both with conventional cars and EVs (Burghard & Dütschke, 2019). Hence, we assume that compatibility plays a major role also for explaining the use of charging stations at the workplace and may potentially influence the adoption of EVs.

Derived from the existing literature on workplace charging and attitudes towards EVs, the amount of time that individuals spend working influences the perceived increase in need compatibility, potentially resulting from the installation of charging stations. The availability of workplace charging can significantly impact individuals' daily routines and the perceived convenience of incorporating EVs into their lives, with potential variations based on their employment status and the time commitments associated with different work arrangements. To the best of our knowledge, there is no particular research that deals with this question in detail, hence, we want to investigate potential interactions of EV work charging and adoption with employment situations in an exploratory way. Furthermore, we investigate gender effects that may interrelate with need compatibility as well. EVs are mainly a masculinized domain, with men more often owning a car, driving further distances and expressing higher interest in EVs overall (Sovacool et al., 2019). Hence, we investigate whether male and female individuals may benefit differently from the installation of charging stations at the workplace.

THE PRESENT RESEARCH

The present research aims to shed light on the role of charging stations at peoples' workplaces. Main interest of this research is 1) to explore if and how the installation of charging stations at peoples' workplaces changes peoples' attitudes and behavioural intentions towards electric mobility in general. 2) We were interested in important drivers of EV adoption, namely need compatibility, the role of social norms, the perception of further barriers and their relationship to acceptance of EVs. We seek to detect changes over time in the core variables social norms, trialability and need compatibility. 3) We want to explore if particular groups of people profit more than others from the installation of charging stations at the workplace, in particular, focusing on the current job situation (part-time vs. full-time job employment) and gender identity.

Methods

This section outlines the sample and the procedure of data collection, as well as the measures used to investigate the assumed associations between the variables of interest for the present research.

PARTICIPANTS

In wave 1, a total of 1,350 participants completed the online survey. However, after applying several exclusion criteria, the final sample size for analysis was 1,183. We excluded participants who (a) did not have a driver's licence (and, thus, were unlikely to adopt an EV in the near future, n = 33), (b) speeders (people whose duration time in the survey was shorter than 300 seconds, n = 96), and (c) participants who did not complete the relevant variables of the questionnaire (i.e. gender n = 37 and age n = 1).

In wave 2, we applied two attention check items and, in addition, (d) excluded participants that failed in answering both attention checks[1]. In wave 2, a total of 845 participants completed the online survey. We excluded participants (a) without a driver's licence (n = 13), (b) speeders (n = 32), (c) incomplete or inconsistent answers on central variables (gender n = 212; age n = 54, provided information on the frequency of use but stated in another question that they had never used the charging stations, n = 8), (d) failed attention checks (n = 4). After applying these exclusion criteria the final sample size was n = 522.

Participants that took part in both waves (i.e. completers) and could be used for pre-post-analyses were n = 277. Table 1[2] gives an overview of the samples and socio-demographics.

1. We checked for participants' attention by inserting two items into the questionnaire of wave 2. In these two items, we prompted respondents to select a particular answer option, namely to click the option 'I completely disagree' (first attention check item) and to click 'I completely agree' (second attention check item).

2. For further information on the project see www.lama.zone.

Table 1. Sample characteristics.

Sample characteristics	Wave 1 (T_1)	Wave 2 (T_2)	Completers (T_{1-2})	German population (2022)[3]
***N* (after data cleaning)**	1,183	522	277	84.4 Mio[a]
Women (%)	27.3	27.8	26.0	50.7[a]
Median age (Range)	36–40 (18–70)[1]	42 (20–83)	31–40 (18–80)	44.9[b]
University degree (%)	70.7	70.3	73.0	18.5[c]
Full time working (%)	68.1	73.8	75.8	70.0[d]
ICE usage (%)	71.7	76.3	85.6	78.0[e]
BEV ownership (%)[2]	3.8	13.3	13.7	3.0[f]

Note. [1] Age was measured in 11 categories with the lowest one ranging from 18–25 and the highest one ranging from 66–70 at T_1. ICE = Internal combustion engine. [2] Percentage displays the percentage of households that own at least one EV. [3] We choose 2022 for country-level data as study data assessment was completed in 2022. [a] Source: Destatis (2023a). [b] Source: Worldometer (2023). [c] Source: Destatis (2020). [d] Source: Destatis (2023b). [e] Source: Destatis (2023c). [f] Source: Destatis (2022).

PROCEDURE AND MEASURES

The study took place in four middle-sized cities of Germany. Places where the charging points were installed were all part of the project "LamA – charging at the workplace". Throughout the whole project, a total of 440 AC (up to 22 kW) and 40 DC (up to 150 kW) charging points were installed in four cities encompassing 18 research institutes (between 2019–2022).

Wave 1 (T_1) of data assessment was administered in summer 2019 (15 July–10 October). We planned the second wave (T_2) of data assessment six months later and after the installation of the charging stations at the respective institutes. However, due to Covid-19, time scheduling for the installation of the charging stations were heavily delayed. Depending on the installation of charging stations at the locations, invitations to participate in the second wave only started in May 2021 and ended in May 2022. The majority of people took part between January and May 2022. Overall, we invited 6,819 people at both time points of data assessment, resulting in an overall response rate of 20 % for wave 1 and 12 % for wave 2.

Participants were recruited via email. With the help of personalized links generated by our survey software tool (EFS Survey), we were able to combine datasets from wave 1 and 2 when participants took part in both waves. On the landing page of the online survey, participants were informed about the project, the target of the survey and asked to give their informed consent. They were informed in the introductory part that we would like to invite them to a second survey six months later.

After giving their informed consent, participants answered several items related to the content and aim of the whole project, i.e. on their mobility habits, means of available transport as well as attitudes towards EVs, knowledge, and the adoption intention of EVs. Moreover, the questionnaire contained instruments to assess additional variables that are not relevant for the scope of the present study (details on these measures can be obtained from the first author upon request). The questionnaire closed with several socio-demographic questions. The survey took about 10–15 minutes for each wave and participants did not receive any incentive for their participation.

In the following, we describe the measures that were used for the present analyses in more detail. If not stated otherwise, we computed mean scores across all items of each scale (for scale reliabilities see Table 2). Some concepts were measured differently between the separate waves due to changes of responsibilities within the project's team. Therefore, we display both versions of measurements for T_1 and T_2 while taking this restriction into account. For pre-post comparisons (T_{1-2}), we had to transform the scales to make them comparable which also resulted in further case-wise exclusions (i.e. exclusion of persons who selected the neutral answer option). Details on the transformation procedure will be explained below (for methodological discussions for a Likert-scale with odd or even answer options, see Wakita et al., 2012)

EV ownership, use of EVs, and intention to buy

Both at T_1 and T_2, we asked participants if they currently own an EV (T_1 & T_2: yes/no), if they have the opportunity to use an EV throughout their everyday life (T_1: 1 '(almost) never' to 4 '(almost) daily', T_2: 1 'never' to 5'(almost) daily') and if participants intent to buy an EV (in case of T_1 in course of the next three years: yes/no; for T_2, we asked on a 5-point Likert scale ranging from 1 'very unlikely' to 5 'very likely').

Attitudes towards EVs and charging stations at the workplace

General attitudes towards EVs were measured with one item, "In general, I consider electric cars to be a good thing." Participants at T_1 answered this question on a 6-point Likert scale ranging from 1 'completely disagree' to 6 'completely agree'. Participants in wave 2 answered on a 5-point Likert scale ranging from 1 'completely disagree' to 5 'completely agree'.

For (T_{1-2}) comparison, we transformed answers from both waves (T_1 and T_2) into a 4-point Likert scale, i.e. the people indicating either 2 'mostly disagree' or 3 'rather disagree' were collapsed into one category as well as participants indicating a 4 'rather agree' or 5 'mostly agree'. For T_2 answers, participants that indicated 3 'neither nor' were not analysed (pairwise exclusion). This resulted in a 4-point answer scale ranging from 1 'completely disagree' to 4 'completely agree'.

We also measured people's attitudes towards chargers (i.e. CP attitude) at the workplace by two items, namely "The (future) availability of charging infrastructure at my workplace a) … make me think about buying an electric car/plug-in hybrid" and b) "… makes electric cars more interesting to me." Participants at T_1 answered these questions on a 6-point Likert scales ranging from 1 'completely disagree' to 6 'completely agree'. Participants at T_2 answered on a 5-point Likert scale ranging from 1 'completely disagree' to 5 'completely agree'. Again, we transformed the scale for pre-post comparisons.

EV need and value compatibility

Participants answered three items measuring EV need compatibility with one item being reverse coded (e.g. "It is difficult to use an electric car in line with my plans"). Value compatibility was measured with two items (e.g. "An electric car fits well with my personality"). Participants at T_1 answered these questions on 6-point Likert scales ranging from 1 'completely disagree' to 6 'completely agree'. Participants at T_2 answered on 5-point Likert scales ranging from 1 'completely disagree' to 5 'completely agree'. Again, we transformed the answers for pre-post comparisons. Higher scores indicated higher need or value compatibility.

Trialability

Participants answered two items to measure trialability (e.g. "I have the opportunity to drive an electric car for testing purposes as long as I need to in order to form a judgement about it"). Participants at T_1 answered these questions on 6-point Likert scales ranging from 1 'completely disagree' to 6 'completely agree'. Participants at T_2 answered on 5-point Likert scales ranging from 1 'completely disagree' to 5 'completely agree'.

Easiness of use

Four items measured perceived easiness to use (e.g. "The way an e-car works is easy to understand"). Participants at T_1 answered these questions on 6-point Likert scales ranging from 1 'completely disagree' to 6 'completely agree'. Participants at T_2 answered on 5-point Likert scales ranging from 1 'completely disagree' to 5 'completely agree'.

Social norm influence

Four items measured social norm influence incorporating injunctive norms (e.g. "People that are important to me think EVs are good") and descriptive norms (e.g. "EV have a positive image in society"). Participants at T_1 answered these questions on 6-point Likert scales ranging from 1 'completely disagree' to 6 'completely agree'. Participants at T_2 answered on a 5-point Likert scale ranging from 1 'completely disagree' to 5 'completely agree'.

Perceived barriers for diffusion and future development of EVs

We measured perceived barriers for the diffusion of EVs at T_2 only. We asked, "Which overarching obstacles do you see for the implementation of electric cars" and seven different aspects should be evaluated by the participants such as "lack of charging infrastructure/lack of charging points" or "lack of network capacity". Participants answered on a 5-point Likert scale ranging from 1 'no barrier at all' to 5 'very large barrier'. Furthermore, we asked with one item if participants believe that driving EVs will be more ecological in the future on a 5-point Likert scale ranging from 1 'completely disagree' to 5 'completely agree'.

Results

For analyses, we used the statistical package IBM SPSS version 25. The following section outlines the descriptive statistics as well as the inference statistical analyses.

DESCRIPTIVE STATISTICS

The descriptive statistics (means, standard deviations, minimum, maximum, and range), as well as intercorrelations of the main variables and the internal consistency of the scales (Cronbach's alpha) are presented in Table 2.

ATTITUDE, INTENTION TO BUY AND USAGE OF EVS

We graphically display results for general attitude, adoption intention and EV usage in everyday life at T_1 and T_2 in Figure 1. Regarding the attitude toward EVs, results reveal that a larger share of respondents in T_2 completely agrees that EVs are a good thing (compared to T_1). However, descriptively, there is also a slightly larger share of participants in wave 2 that completely disagree with this statement (compared to T_1) indicating a polarization of attitudes toward EVs. Regarding the intention to adoption an EV, the descriptive results demonstrate a strong increase of potential EV users in T_2 (> 20 %) compared to T_1 (< 10 %). It is worth to note that the questions differed slightly between the waves (asking for buying an EV in the next three years vs. as the next car). The answers regarding the actual use of EV are hardly comparable between T_1 and T_2 because the questions and answer options differ between the waves.

Gender effects at T_2

In order to determine gender-specific effects, we ran independent t-tests on intention to buy an EV, perceived barriers for future adoption, and future development of EVs. All three analyses revealed significant differences in means between female and male participants (see Table 3). Results indicate that women perceive more barriers for EV adoption than men, are less positive about the future development of EVs and have a significantly lower intention to buy an EV in the future (compared to men). However, the average intention of men and women on all three variables ranges around the scales midpoint (3 on a 6-point Likert scale).

ANALYSIS OF COMPLETERS: PRE-POST EFFECTS ($T_{1\text{-}2}$)

Need compatibility

To investigate the potential increase of need compatibility through the installation of charging stations at the workplace, we ran a paired-samples t-test. As result, need compatibility increased significantly over time in our subsample that took part in both waves *(*n=156; M_{T1}=3.01; SD_{T1}=0.60; M_{T2}=3.18; SD_{T2}=0.65); [$t(155)$ = -3.97, $p \leq .001$, n = 156].

Moderation effects of need compatibility working time and gender

To test the influence of charging station deployment in comparison of full-time versus part-time working by taking into account need compatibility, we compared if the changes in need compatibility for full-time versus part-time job employ-

Table 2. Descriptive statistics including internal consistency and intercorrelations between main variables.

Measures	Mean (*M*)[1]		Standard deviation (*SD*)[1]		*Min, Max*		Cronbach's alpha[2]		Intercorrelation
	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2	T_1-T_2
EV use	3.57	2.76	.67	1.77	1, 4	1, 5	–	–	.53*
Intention to buy an EV	–	2.96	–	1.46	–	1, 5	–	–	–
EV attitude	4.53	3.87	1.24	1.11	1, 6	1, 5	–	–	.62**
Charging point attitude	3.64	2.96	1.60	1.31	1, 6	1, 5	.89	88	.54**
Value compatibility	3.80	3.26	1.40	1.15	1, 6	1, 5	.80	.87	.69**
Need compatibility	4.12	3.68	1.29	1.00	1, 6	1, 5	.79	.74	.59**
Trialability	2.36	2.44	1.46	1.30	1, 6	1, 5	.68	.63	.43**
Easiness of use	5.32	4.48	.77	.65	1, 6	1, 5	.78	.75	.46**
Social norm	4.13	3.27	.91	.74	1, 6	1, 5	.87	.78	.50**
Perceived barriers EVs	–	3.71	–	.70	–	1.25, 5	––	.70	–
Future development EVs[3]	–	3.14	–	1.20	–	1, 5	–	–	–

*Note. Min = minimum, Max = maximum, [1] The displayed means and standard deviations are not normalized for comparison (cf. Min and Max), they present the values on the different Likert-scales for the two waves, hence, these values are not comparable between wave 1 and 2.[2] For scales with two items only, we report correlations of both items instead of Cronbach's alpha. [3] The concept was measured with one single item. * p < .05 ** p < .01, *** p < .001.*

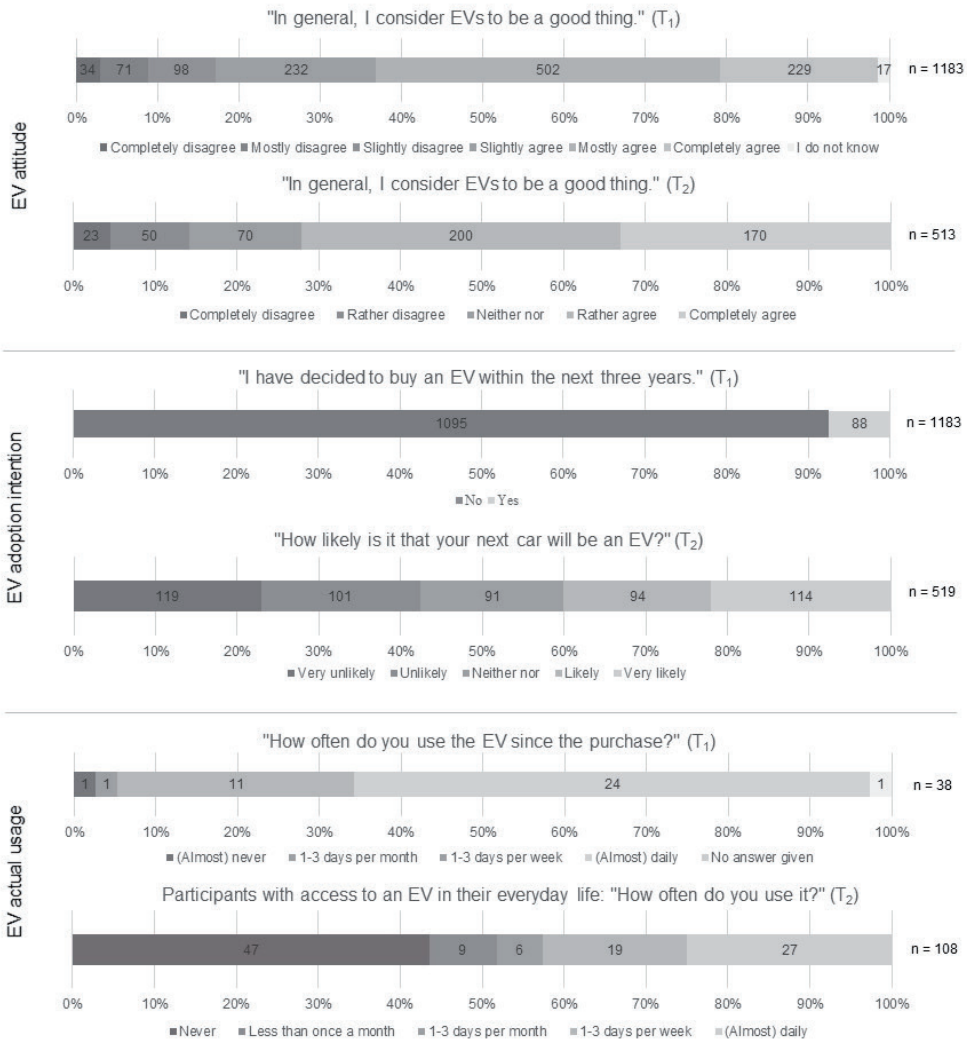

Figure 1. Graphical overview on the answers of focal variables from T_1 and T_2.

Table 3. Results for gender effects at T_2.

	Descriptive statistics for women		Descriptive statistics for men		t-value (degrees of freedom)	p-value
Perceived barriers for adoption	*M* = 4.03	*SD* = 0.63	*M* = 3.54	*SD* = 0.66	*t*(210) = 4.67	$p \leq .001$
Future development of EVs	*M* = 3.68	*SD* = 1.10	*M* = 4.24	*SD* = 0.78	*t*(251) = -4.33	$p \leq .001$
Intention to buy an EV	*M* = 2.46	*SD* = 1.47	*M* = 3.16	*SD* = 1.50	*t*(267) = -3.36	$p \leq .001$

ees increased by using a paired-samples t-test. As result, we find an higher change score of need compatibility for part-time job employees than for full-time job employees ($M_{T2\text{-}T1(Full)}$ =0.17; $SD_{T2\text{-}T1(Full)}$=0.53; $M_{T2\text{-}T1(Part)}$=0.24; $SD_{T2\text{-}T1(Part)}$=0.57); [$t(153)$ = -19.321, $p \leq .001$]. To assess the impact of charging station installations on perceived need compatibility while considering the factors of time and employment status, a repeated-measures analysis of variance (ANOVA) was conducted. The dependent variable was the participants' ratings of need compatibility, measured at two time points. The independent variable of interest was employment status, categorized into two levels (full-time vs. part-time). The repeated-measures ANOVA revealed a significant main effect of time on perceived need compatibility ($F(1, 257) = 31.32$, $p < 0.001$, $\eta^2 = 0.109$), again indicating an overall change in participants' ratings across survey waves. Against our assumption, there was no significant interaction effect between time points of measurement and employment status ($F(1, 275) = 1.59$, $p = 0.209$, $\eta^2 = 0.006$), indicating that the change in perceived need compatibility over time did not significantly differ between full-time and part-time employees (see Figure 2). Descriptively in Figure 2, there is a tendency that the need compatibility of full-time and part-time employees becomes more similar over time.

In a similar procedure, we tested the influence of charging station installation between men and women, taking into account the perceived need compatibility. In a first step, we compared the change scores in need compatibility between women and men at both time points with a paired-samples t-test. As result, men seems to have a higher perceived increase of need compatibility through the installation of charging stations at work in contrast to women, $M_{T2\text{-}T1(women)}$ =0.14; $SD_{T2\text{-}T1(women)}$=0.64; $M_{T2\text{-}T1(men)}$=0.19; $SD_{T2\text{-}T1(men)}$=0.53); [$t(155)$ = -29.11, $p \leq .001$].

Social norms

To investigate if there was an increase in social norm influence from T_1 to T_2, we ran a paired-samples t-test. Results revealed a significant difference between the two time points with a slightly higher mean value at T_2 (n = 182; M_{T1}=2.08; SD_{T1}=0.69; M_{T2}=2.22; SD_{T2}=0.78)[$t(188)$ = -2.279, p = .027]), indicating that social norms regarding EVs increased over time.

Trialability

To investigate if there was an increase in trialability from T_1 to T_2, we ran a paired-samples t-test. The test revealed a significant increase in the mean scores between the two time points (n = 155, M_{T1}=1.68; SD_{T1}=1.00; M_{T2}=2.08; SD_{T2}=1.18); [$t(237)$ = -5.392, $p \leq .001$]. Hence, the same pattern occurred for trialability as for social norms, i.e. as expected the results show an increase of trialability over time.

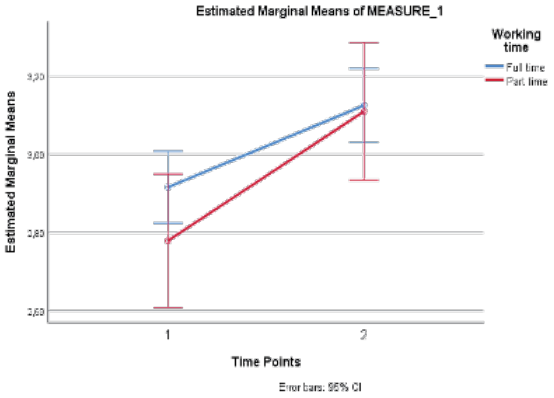

Figure 2. Results of the moderation analysis (working time x time points of measurement on need compatibility).

Easiness of use

We also compared the mean scores of easiness of EV use by running a paired-samples t-test. We found a significant but small increase from T_1 to T_2 in our sample (n = 187; M_{T1}=2.78; SD_{T1}=1.24; M_{T2}=3.00; SD_{T2}=1.39); [$t(215)$ = -2.505, $p \leq .01$]. This indicates that easiness of EV use also increased over time.

Discussion

The aim of our research was to investigate to what extent the installation of charging stations at peoples' workplaces can change the attitudes of employees at the locations regarding electric mobility. In doing so, we pursued the hypothesis that attitudes change positively and behavioural intentions increase over time. We also looked at need compatibility and perceived social norms and the extent to which this is positively influenced by the installation of charging stations at work, and whether other barriers can be reduced due to the implementation. We also investigated whether specific parts of our sample (full-time vs. part-time employees, men vs. women) benefit more or less from the installation of the charging stations at the workplace.

Our results show that need compatibility, social norm perceptions and trialability significantly increase over time. Although we cannot assume causality, we interpret these results as a positive side effect of the installed charging stations that may have contributed positively to the perception of electric mobility among employees, reflecting a promising trend in promoting sustainable transportation. However, it is important to note that the observed effects are relatively small, which can be attributed to the homogeneity of the sample.

Furthermore, we detected some relevant gender effects in our data analyses of T_2. Women perceive more barriers than

men when thinking about the future diffusion of EVs and also appear to be more skeptical regarding the future development of EVs, potentially becoming even more ecologically. This result is interesting in that some studies have found that women tend to hold stronger pro-environmental values, which to some extent contradicts our findings (Swim et al., 2020). However, we would argue that car mobility is also a predominantly male status behaviour. Nevertheless, women may potentially be more aware of the fact that EV usage contrasts active and sufficiency-oriented mobility which would include downsizing private car usage overall (Sandberg, 2021). However, and in line with former research, women in our study express a lower intention to buy an EV than men (Sovacool et al., 2019). Future research is needed to further disentangle these complex relationships of mobility preferences and patterns in regard to gender. In line with Sovacool et al. (2019), we argue that the examination of gender effects in electric mobility highlights an intriguing aspect – the potential "de-masculinisation" of electric mobility. This concept suggests a shift away from traditional gender associations with certain technologies, challenging stereotypical perceptions. Understanding and exploring these evolving gender dynamics in the context of electric mobility is an essential step towards fostering inclusivity and dismantling gender-related barriers. To further support and transform the mobility habits of diverse social groups, such as caregivers and breadwinners, additional infrastructures need consideration. Identifying specific infrastructural needs for different social groups can enhance the overall sustainability of transportation and specifically, the relevance of electric mobility. Tailored solutions may include childcare facilities, designated parking spaces, or flexible charging options to accommodate the unique requirements of various socio-demographics.

In Germany, the ongoing discourse on charging infrastructure is marked by controversy. While some stakeholders argue that expanding the number of charging stations is a crucial initial step to drive wider EV adoption, others express reservations about the systematic growth of public charging infrastructure to meet a predetermined target in Germany. They are concerned that these charging stations might be situated in locations that do not align with users' daily needs, potentially resulting in the creation of a vast but underutilized network. Our results are consistent with many findings that infrastructure is associated with higher acceptance of EVs. This can be supported by the finding that the seven EU countries leading in the amount of charging stations also show the highest EV shares (EAFO, 2021).

Considering charging stations at work appears important for the future. However, the charging situation at the workplaces should not be considered in isolation, as the charging behaviour of EV users is complex. Planning for charging infrastructure should therefore adopt a holistic perspective, intertwining charging events at home, at the workplace and in public spaces. The mixed use of the charging infrastructure by EV owners, particularly at different locations, emphasises the need for an integrated planning approach. At the moment, EV users residing in apartments heavily depend on charging facilities at the workplace and in public locations (Lee et al., 2020). This highlights the relevance of alternative charging options, especially as early and late majority adopters will increasingly seek such options.

The significance of workplace charging stations extends beyond individual convenience, contributing to the stability of the power grid. By using workplace charging stations, solar energy from distributed and utility-scale photovoltaic cells can be harnessed during the day, furthering the cause of sustainable energy. Pricing schemes that value workplace charging could create additional incentives (Chakraborty et al., 2019). In terms of policy measures, creating an attractive environment for EVs at the workplace requires a multifaceted approach. Fleet management strategies, workplace charging initiatives, and controlled charging protocols all play crucial roles. Policymakers should consider incentives, subsidies and regulatory frameworks that encourage the integration of EVs into corporate fleets. Additionally, implementing policies that promote controlled and sustainable charging practices at the workplace can enhance overall EV adoption. In conclusion, the discussion of the results emphasises the positive impact of the installed charging stations within the LamA project on the perception of electric mobility among employees. However, the nuances of small effects, gender dynamics, infrastructural considerations and policy measures underscore the complexity of promoting sustainable mobility at the workplace. Addressing these aspects collectively will contribute to a more comprehensive and inclusive transition towards electric mobility and sustainable transport overall.

LIMITATIONS AND FURTHER RESEARCH

The limitations of this study include several aspects that need to be considered. Firstly, the sample used for the research comprises individuals who are highly educated and well-informed, potentially introducing a bias that is not representative of the broader population. Additionally, the ecological context of the study could pose challenges in generalising the findings to different settings. A notable limitation involves the transformation of scales for pre-post comparisons which may influence the accuracy and reliability of the observed effects. In addition, the unforeseen effects of the Covid-19 pandemic and the resulting delays within the project have brought external factors into play over which we had no control but that may have influenced the results. Another critical limitation concerns the lack of a control group, which makes it difficult to prove causal effects. Without a control group, it becomes difficult to ascertain whether observed changes are indeed caused by the interventions implemented in the study (or not). The found changes remain very context-specific (for the lack of robust research in the field of EV uptake and ownership see Wicki et al., 2023). The potential influence of external factors such as media coverage or broader positive developments further complicates the isolation of causal relationships (Scherrer, 2023). However, panel study data from Germany points out that acceptance of EVs slightly declined over the past three years (Wolf et al., 2023) providing a small indication for the effect of the newly installed charging stations. In conclusion, while this study contributes valuable insights it is essential to acknowledge and address these limitations when interpreting the results. Future research endeavours may benefit from incorporating diverse samples, employing rigorous control measures and accounting for external influences to enhance the robustness and generalisability of findings.

Future research in the realm of workplace charging and the acceptance of EVs should explore several avenues to deepen our understanding and inform effective strategies. Firstly, in-

vestigating the long-term impacts of workplace charging on EV adoption is crucial. A longitudinal study tracking EV adoption behaviours over an extended period after the installation of workplace charging stations would provide insights into the sustainability and lasting effects of this infrastructure. Additionally, understanding the role of workplace charging in different organisational settings is essential. Research could explore how factors like company culture, size and industry influence the adoption patterns and perceptions of employees. Identifying organisational characteristics that enhance or impede the success of workplace charging initiatives can guide tailored interventions for diverse workplace environments. Moreover, exploring the interaction between workplace charging and other supporting measures appears vital. For instance, combining workplace charging with incentives, educational programs, or flexible work policies could create synergistic effects. Investigating the complementary nature of these strategies may provide a holistic understanding of how various elements can work together to promote EV adoption. Further research should delve into the impact of workplace charging on specific demographic groups, such as employees of varying ages, income levels or job roles. Understanding how workplace charging initiatives resonate differently among diverse populations can inform targeted interventions that address specific barriers or motivations unique to each group. Lastly, research should extend beyond quantitative analyses to include qualitative perspectives. In-depth interviews or focus group discussions with employees and organisational stakeholders can unveil nuanced insights into the experiential and social aspects of workplace charging. Qualitative research can capture the subjective meanings employees associate with workplace charging and shedding light on the underlying attitudes, perceptions, and social dynamics that shape acceptance.

Conclusion

In conclusion, the LamA project and the installation of charging stations at the workplace appear to be positively related to employees' perception of electric mobility and may represent progress in the area of sustainable transport. However, the observed pre-post effects are very small and causality cannot be clearly stated due to the design of the study. The ongoing German debate on charging infrastructure emphasises its link to higher EV acceptance, supported by several findings in the literature. Considering workplace charging holistically and intertwining home, work and public charging events is crucial for an integrated planning approach. Charging at the workplace not only contributes to grid stability, but also enables sustainable energy utilisation. Policymakers should therefore adopt a multifaceted approach, addressing small effects, gender dynamics, infrastructure, and policy measures collectively for a comprehensive mobility transition. Future research should examine long-term impacts, organisational influences, interactions with other interventions, demographic differences and qualitative perspectives to enable a nuanced understanding and effective strategies.

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