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Building and utilizing funded charging infrastructure in Germany: Reasons and motivations

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Summary

Charging infrastructure for BEV is built all over Germany. However, it is indisputable that to comply with climate protection goals, more charging infrastructure is needed still. This paper focuses on the reasons why interviewees from different institutions decided to build charging infrastructure. By applying Self-Determination Theory (SDT), these decisions are contextualized in the larger frame of institutions [6, 7]. It is found that most reasons for building charging infrastructure can be categorized as controlled motivation. This paper is part of German funding program LINOx BW and its accompanying corporate research program.

Keywords: BEV (battery electric vehicle), charging, infrastructure, communication, user behaviour

1 Introduction

This abstract is part of a German corporate research and funding program called LINOx BW (itself part of Sofortprogramm "Saubere Luft 2017-2020"), funded by German Federal Ministry for Economic Affairs and Climate Action, BMWK. The funding program aims to assist different institutions (among them municipalities, companies, and homeowners' associations) by subsidizing their efforts to build charging infrastructure in private and semi-public spaces. By April 2022, 178 recipients from 23 different cities in Baden-Württemberg have been granted funding to build over 2.358 charging points [1].

The corporate research part of the project concerns itself with the effects of building charging infrastructure for battery electric vehicles on local emissions of nitrogen oxides. To make an assessment on the reduction in local emissions of nitrogen oxides, a triangular approach is used. It consists of quantitative data collection directly from charging infrastructure in a minority of cases, standardized surveys in two waves (at the beginning and the end of the project) which is mandatory for all funding recipients as well as qualitative expert interviews. These interviews are conducted with a selected number of participants who receive funding for their respective institution. Once it has been decided that an applicant will receive funding for their project, it is then categorized into one of six use cases, namely residential quarter, semi-public space, parking lots and park & ride, private on-site parking, nursing services, tourism or pedelecs. An overview of preliminary results within LINOX BW and

the use cases of parking lots and park & ride as well as private on-site parking was published in 2022 [10], a paper on the impact of charging infrastructure on local emissions of nitrogen oxides is forthcoming [11].

2 Research design and methodology

While there is research on what motivates commercial fleet managers to campaign for the adoption of BEV (Globisch, Dütschke and Wietschel,[8]) and on reasons for purchasing fleet vehicles in general and BEV in particular (Sugihara and Hardman, [6]), both utilizing SDT, there is a lack of research concerning motivation to build charging infrastructure. Therefore, the focus of this paper is to investigate reasons for building charging infrastructure in different kinds of institutions. Data collection is done by conducting qualitative expert interviews [2], evaluation takes place by applying qualitative content analysis [3,4].

2.1 Theoretical approach

Similar to Sugihara and Hardman [6], who researched purchasing decisions in California fleets, Self-Determination Theory (SDT) is utilized for its "ability to describe the motivations of the individual within the context of the larger organization" ([6]: 2) and to try and understand how future funding efforts could help facilitate the building of charging infrastructure. SDT as described by Gagné and Deci [7] is a theory of work motivation and differentiates between motivation and amotivation. Motivation is characterized by intentionality, amotivation is characterized by a lack thereof. Gagné and Deci further distinguish between autonomous motivation and controlled motivation, with autonomous motivation being characterized by a greater degree of internalization. They define internalization as

„[…] people taking in values, attitudes, or regulatory structures, such that the external regulation of a behavior is transformed into an internal regulation and thus no longer requires the presence of an external contingency […]. However, although most theories of internalization view it as a dichotomy—that is, a regulation either is external to the person or has been internalized—SDT posits a controlled-to-autonomous continuum to describe the degree to which an external regulation has been internalized. The more fully it has been internalized, the more autonomous will be the subsequent, extrinsically motivated behavior. According to SDT, internalization is an overarching term that refers to three different processes: introjection, identification, and integration." (Gagné and Deci [7]: 334).

Therefore, while intrinsic motivation is always autonomous, extrinsic motivation can be autonomous or controlled to varying degrees as can be seen in Fig. 1 which summarizes SDT according to Gagné and Deci.

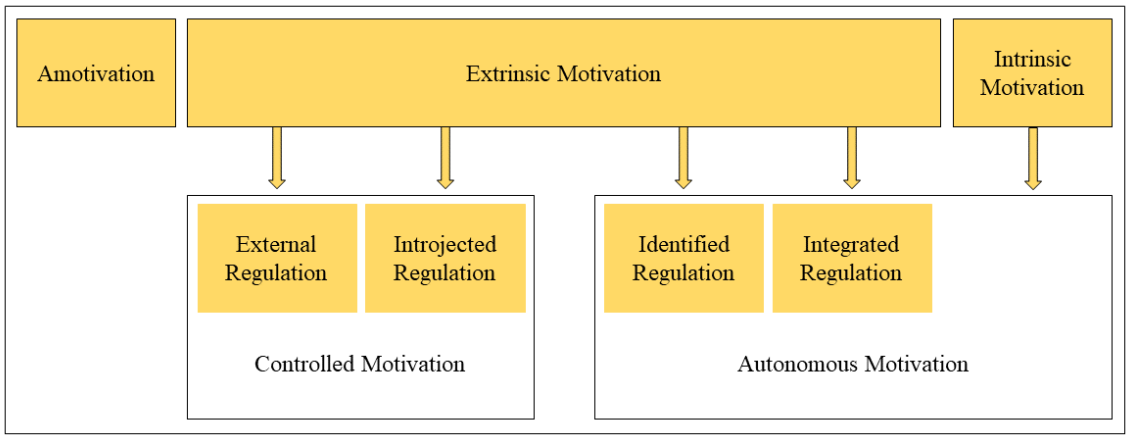

Figure 1: A visualization of Self-Determination Theory (adapted from Gagné and Deci [7] and Sugihara and Hardman [6])

2.2 Data collection

Data collection in LINOx BW is still ongoing due to a project extension request, which includes, if granted, further instances of qualitative expert interviews. So far, 21 interviews were conducted, with several more planned in the future. At the time of writing this paper, 20 interviews are included in data analysis. The interviews took place over a span of two years (March 2020 to April 2022). This long timespan comes to be due to the structure of the funding program, where new grant recipients can apply for funding continuously.

The interviews are carried out remotely (by telephone or online via VoIP) utilizing a semi-structured interview guideline. Modifications are only made to accommodate for special circumstances such as exceptional use cases (e.g., carsharing) and to ask follow-up questions. As suggested by Bogner [2], a relatively rigid questionnaire was utilized, which allows for a high level of comparability between interviews.

The interview guideline comprises of four main sections: decision-making and communication procedures; cost, revenue, and operator models; use intensity of charging infrastructure and use case specific aspects. These use case specific questions allow for accommodation of use cases like nursing services or tourism, which are very different from private on-site parking, the use case that is encountered the most inside the funding program. Since reasons for building charging infrastructure is not the only topic covered in the interviews, thematic saturation [9] could not be reached, with new reasons coming up almost every interview. This can partially be explained by the wide range of recipient type as can be seen in Table 1.

Table 1: Types of recipients, recipient number and interview length

Recipient number	Recipient type	Interview duration
01	Municipality	00:48:50
02	Tourist attraction	00:40:19
03	Nursing service	01:03:50
04	Nursing service	00:22:55
05	Homeowners' association	00:38:56
06	Electric carsharing	00:24:19
07	Car dealership	00:31:53
08	Electric carsharing	00:26:20
09	Municipality	00:53:34
10	Municipality	00:28:39
11	Homeowners' association	00:23:23
12	Nursing service	00:35:05
13	Nursing service	00:31:02

14	Utility company	00:48:52
15	Education provider	00:24:29
16	Car dealership	00:21:50
17	Hotel	00:21:17
18	Food retailer	00:42:09
19	Insurance provider	00:52:23
20	Car park operator	00:52:41

Respondents are chosen by the kind of project they are planning – if it is exceptionally large or interesting because of other factors, for example a company building charging points not only on-site but at their employees' homes as well, an interview-request is sent. Furthermore, the authors strive to distribute the interviews as evenly as possible across the aforementioned use cases.

The interviews are recorded with the interviewees' permission and undergo rigorous anonymization before any part of them is published. All respondents were informed about this before the start of the interview. To retain the highest possible degree of comparability between interviews, they were all conducted by the same interviewer except one, where an additional interviewer was present. All interviews were conducted in German.

2.3 Evaluation

Evaluation is performed utilizing qualitative content analysis [3]. All interviews are transcribed and then evaluated via MAXQDA, a computer software that allows for qualitative and mixed methods analysis [5]. Data analysis was conducted in German, the categories were translated when coding was finished. This approach was chosen to avoid the interviews and codes being in two different languages, which could have inhibited the process due to the necessity to code and translate at the same time.

To analyse the material, inductive coding is utilized, meaning that categories are established from the material as opposed to deductive coding, where pre-existing categories are applied [3]. Reasons for building charging infrastructure were given as a direct response to the question asked about it. Thus, the first coding step was to identify passages where reasons were given. These passages were then further differentiated into sub-categories, describing the kind of reason. These sub-categories were differentiated by the kind of motivation that drove them according to SDT when coding was finished.

3 Results

The categories formed inductively from the interview transcripts are introduced. The presented order of the categories was chosen to facilitate comparison between categories and does not represent the frequency of occurrence within the material. All direct quotes are translated from German by the authors.

3.1 External pressure to act

Many respondents voiced a sense of pressure from outside the institution to build charging infrastructure. Three main sub-categories could be identified: the feeling of having to innovate, the feeling of having no choice in the matter and direct requests from customers to build charging infrastructure. For example, one car dealership felt

the need to build charging infrastructure to remain up to date with technological advancements, another felt that it was necessary because an increasing number of people are driving BEV.

External pressure is also felt by other respondents, whose customers are demanding charging opportunities while utilizing their services. Others felt the need to build charging infrastructure now, before the already scarce capacity concerning electricians and hardware is depleted.

In terms of SDT, all of these reasons fall into the category of controlled motivation. As one of the respondents put it:

"We already had difficulties finding an electrician, so it went on for weeks. […] Who knows what the availability of electricians will be like later on, and at some point, the new cars will arrive. […] it's foreseeable that you'll only be able to get into the cities with electric vehicles." (Interviewee 11, Homeowners' association).

This quote can be attributed to external regulation, an action which is motivated by "contingencies of reward and punishment" ([7]: 336).

3.2 Charging as a service

Respondents often mentioned wanting to build charging infrastructure as a type of customer service, a service for their employees, a way to strengthen customer loyalty or even to provide a unique selling point for their services. There is an overlap between this category and the aforementioned one, external pressure to act. However, when compared to the types of motivation according to SDT, depending on the individual respondent, a broader spectrum of motivation is present. It ranges from moderately controlled motivation to moderately autonomous motivation:

"With the expansion, we are naturally also pursuing the goal of customer loyalty. We want to give customers the opportunity to charge while they shop with us." (Interviewee 18, Food retailer).

Here, the respondent shows a certain internalization of company goals in that they want to pursue customer loyalty.

3.3 Environmental reasons

Different kinds of environmental reasons were given by respondents. Some referred to sustainability goals required by their respective companies, one of the church institutions cited religious reasons related to nature ("preserving creation", Interviewee 13, Nursing service). Some respondents also cited the desire to utilize the electricity generated by their own PV systems:

"The moment we actually generate the electricity ourselves, it is probably much more efficient to drive e-vehicles than diesel or hydrogen or whatever. As long as we generate the electricity ourselves on the roof and then consume it ourselves, we assume that this is the best thing for the climate and the environment." (Interviewee 01, Municipality).

This quote can be attributed to autonomous motivation which is the most internalized form of extrinsic motivation. It seems that the respondent experiences "coherence among goals, values and regulations" ([7]: 336).

3.4 Access to funding

Access to funding seems to be a contributing factor to building charging infrastructure, but it was never the only reason given. Most of the time, the idea to build charging infrastructure was already there when respondents started looking for funding. One exception is recipient 12: the institution was contacted with the opportunity to apply for funding and thus decided to build charging infrastructure.

Access to funding is relatively easy to categorize as the two most controlled forms of motivation in SDT, external regulation and introjected regulation.

3.5 Interest in technology

Only two respondents mentioned that they were interested in technology related to BEV and charging infrastructure. Even in these two cases, interest in technology was mentioned in conjunction with other reasons – in case of respondent 06 the opinion that the chosen location is suitable to build charging infrastructure, in case of respondent 04 that the interest pertains to all kinds of technology to promote environmental protection, including PV systems. Therefore, even though an interest in technology and thus wanting to build charging infrastructure could be categorized as intrinsic motivation, it doesn't seem to be the deciding factor in the conducted interviews.

3.6 Top-down – decision wasn't made by the interviewee

This category was utilized when respondents didn't make the decision to build charging infrastructure themselves. Since it was important for the LINOx BW project in general to interview the person that was responsible for the operational part of the building of charging infrastructure, it was not always the same person that made the decision to build it in the first place.

3.7 Reasons specific to the kind of institution

This category was introduced to collect reasons very specific to the kind of institution that couldn't be generalised. For example, respondents cited problems with ICV, the desire to build charging infrastructure because BEV were already in their fleets and needed to be charged, the desire to gain experience with charging infrastructure to utilize this knowledge for training purposes or even safety concerns.

"With the expansion of the BEV, we realised that it doesn't work like that anymore. We actually had something like a cable fire at the socket twice. Then I said, it doesn't work like that, we can't run it like that. It was more of a provisional arrangement at the beginning, we definitely have to change something." (Interviewee 03, Nursing service).

4 Discussion and limitations

This paper is looking into reasons for building charging infrastructure in different organizational structures. There are some limitations pertaining to these results. Reasons for not building charging infrastructure could not be given since only grant recipients who have already built or were in the process of building charging infrastructure were interviewed. Furthermore, it is presumably not possible to continue interviewing new grant recipients until no new information is gathered due to financial and time constraints, even if the project extension request is granted. Therefore, it cannot be assumed that the list of reasons is complete just yet since data collection is still ongoing and reasons might change overtime as societal acceptance of EVs and the availability of public funding is shifting.

It proved difficult to characterize certain reasons according to SDT since the same reasons can sometimes range in their degree of internalization within groups of respondents. However, it seems that there is a tendency towards controlled motivation when it comes to building charging infrastructure. Intrinsic motivation was only found in the category of interest in technology, but other, less internalized reasons were present as well.

Further research could investigate how reasons change over time and how wide-spread different reasons are utilizing quantitative methods. The results could inform further funding efforts, especially when reasons for deciding not to build charging infrastructure are considered as well. Collection of quantitative survey data within LINOx BW is still ongoing and a mixed methods approach will be possible as soon as data collection is completed.

The interview data allows for a tremendous amount of analysis which could not be covered in this paper. Further research could investigate expanding the interviewees to those who had the intention to apply for funding but decided not to or those who had no intention to apply. This way, a more rounded picture of motivators and barriers for building charging infrastructure and thus adopting electric mobility could be derived. Furthermore, it could be analysed how different use cases of charging infrastructure (for example nursing services or homeowners' associations) influence the reasons for wanting to build it. A comparative analysis of use cases could highlight similarities and differences between and within use cases.

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