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”Need Tweets”: New Insights about Customer Needs from Micro Blog Data in the Field of E-mobility

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Abstract: In order to design new services in e-mobility, the knowledge of customer needs is crucial. In this paper, we compare the results from a literature review about customer needs with the results from harvesting a modern data source: micro blog data.

Keywords: Customer Needs, E-Mobility, Literature Review, Micro Blog Data, Twitter

1 Introduction

The correct identification of customer needs is one of the main challenges for service providers [AP02]. As part of research, it plays an important role in different areas, namely *Needs Elicitation* [HD03], *Customer Requirement Analysis* [BL95], *Service Engineering* [BS06] and *Service Design Thinking* [St11]. While there is a large amount of publications on customer needs in time-tested domains, e.g. tourism [AH98] or software (engineering) [RJ00], the field of electric mobility (e-mobility[3]) is a rather new, emerging phenomenon which is still under development with high dynamics [BPS10]. As stated in [Kl14, St15], there is a lack of e-mobility services to accelerate the successful implementation and adoption of the new technology. In order to support the development of such services, it is important to identify customer needs in the field of e-mobility to translate them into new or improved services at a later point.

In the work at hand we aim at identifying customer needs in the field of e-mobility by leveraging a modern data source: micro blog data (e.g. Twitter). Recent studies show that people using social media tend to talk about technology-related topics [MLF15]. Therefore, we assume that a certain share of (potential) e-mobility customers have an affinity for social media which implies that they share their opinions and needs in social media networks. These statements enable us to identify new customer needs. Although this data is not representative, it allows to regard first-hand postings of (potential) customers, who expressed a need in an emotional situation like dissatisfaction or joy. This is an advantage compared to data from traditional surveys, where non-response bias is a major challenge [Gr06].

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[3] In order to allow for a uniform comprehension, we define *e-mobility* as a ”highly connective industry which focuses on serving mobility needs under the aspect of sustainability with a vehicle using a portable energy source and an electric drive that can vary in the degree of electrification.”([Sc15, p.9]).

The contribution of this work is twofold. First, it gives an overview about the current state of research of customer needs in the field of e-mobility. We propose a clustering pattern to structure the needs in four major need categories. Second, we use relevant micro blog data in the field of e-mobility in the German-speaking area, expressed over a time span of six months in 2015. These data provide us deep insights about customer needs on the subject of e-mobility. We compare the expressed customer needs with the current state of research and discuss differences.

2 Prerequisites

Before we are able to focus on the methodology, the study and the results, we have to outline the term *customer need* and relate to the used dataset as a prerequisite in order to lay a foundation for the remaining work.

Customer Needs Traditionally, the term *customer need* originates from the discipline of Marketing. Kotler and Armstrong suggest to split the term into three different categories: *need*, *want* and *demand* [KA01]. *Needs* cover—amongst others—the basic human requirements in life like security or food. Every need is necessary for a decent existence of a human being. A *want* is the form a need takes. It is shaped by culture and personality. In case a want is backed by the power to buy something, the want is called *demand*. When we regard our domain of e-mobility, we could imagine a human being who has the need of mobility. The need can take the form of an electric vehicle (EV), so someone wants an EV and demands (exemplary) a Tesla Model S. *Needs*, *wants* and *demands* can be translated into every other requirement. A *need* can be translated into a *demand* similar to the translation of a *want* into a *need*. Additionally, Harding et al. outline that a customer need can also be expressed as a *requirement* of a product or service [Ha01]. *Requirements* are often expressed by humans when a service or a product lacks on a certain attribute. Referring to our previous example, the person can express that he[4] *requires* an EV with more airbags. In case there is an EV with more airbags than currently on the market, this person would buy that car. Therefore, the person has the *requirement* for an airbag, but his *requirement* is actually referred to the *need* of safety. *Requirements* can also be translated into *needs*, *wants* and *demands*—and since the terms can be easily translated, humans express their requirements in every of the four categories. Referring to our aim to quantify customer needs, there is no necessity to differentiate between the different characterizations. For simplicity, we use the terms *needs* or *customer needs* as thesauri for all four mentioned types *need*, *want* and *demand* as well as *requirement*.

Micro Blog Dataset The retrieval of our relevant micro blog data set is not part of this work and is only explained briefly. A more detailed description can be found in Kuehl et al. 2016, which illustrates an approach to automatically detect micro blog instances containing customer needs [KSS16]. As stated before, the domain for our dataset is e-mobility.

[4] To ensure a steady reading flow in this work, we use only one gender. Based on the outcome of a coin-flip, we use male pronouns (he, his, him) when necessary. This always includes the female gender as well.

In addition to the domain, we also define a geographical area as well as the language. The first is important because we need a comparable area in the field of legislation, design of economy and living standard of the population to be not biased towards one specific group of people in the area. The second is important because different languages tend to have different semantic structures which would distort our analysis. With our decision to use only German tweets, we cover both of these additional conditions: German is only spoken in Germany, Austria and in parts of Switzerland which have comparable socio-economic preconditions.

As a source for micro blog instances we use Twitter since it is the most popular micro blogging service provider [De16]. We conduct the retrieval of relevant micro blog data by using the Twitter Streaming API. We collect every instance (tweet) which contains at least one word of a predefined keyword list. The list is reasoned on the opinion of professionals and popular EVs in Germany. It consists of eight German[5] and five English[6] generic terms which are supplemented by ten EVs vehicles [7]. From March 3^{rd} to August 25^{th} 2015, tweets were collected. To cover the time before March 3^{rd}, IBM Insights for Twitter was used to retrieve older instances. 645,226 instances were acquired in total. The database consists of 86.3% instance from the six month period and only the remainder is from the time before these six months.

Based on the language information of Twitter, all non German instances are sorted out which reduces our dataset to 39,739 instances. Thereafter, *Descriptive Coding* reveals that there is only one conspicuous correlation: Tweets containing an URL also contain a need with the probability of only 3.64%. Since the remaining dataset comprises 91.5% instances with URLs, one achieves a great reduction and coincidently loosing a significantly low share of relevant needs. After removing duplications in the dataset which result either in the multiple collection with the tools or the collection of re-tweets, the dataset has the amount of 2,396 possibly relevant instances. The last step is the labeling of all remaining tweets on whether or not they contain a customer need, which is done in a lab session by at least three participants per tweet. Finally, we end up with 332 remaining instances containing needs, which were only identified as such if at least 2 out of 3 labelers agreed on the tweet containing a need. This resembles the dataset of the work at hand, called ”need tweets” or ”instances”. An exemplary tweet is shown in figure 1.

Fig. 1: Exemplary ”Need tweet” in the field of e-mobility

[5] e-tankstelle, eauto, elektroauto, elektrofahrzeug, elektromobilitaet, elektromobilität, ladesaeule, ladesäule
[6] ecar, electric mobility, EV vehicle, e-mobility, emobility
[7] bmw i3, egolf, eup, fortwo electric drive, miev, nissan leaf, opel ampera, peugeot ion, renault zoe, tesla model s

3 Methodology and Study

To identify customer needs in recent research, we have to conduct a literature review. We select relevant publications about needs in the field of e-mobility, determine their identified customer needs and cluster them in a bottom-up approach to summarize major need categories (3.1). In a second step, we assign every micro blog instance to one or more major need categories and use this allocation as a basis to analyze our given dataset by splitting the major categories into smaller clusters for a more detailed analysis (3.2). The comparison of the identified needs in the literature and the allocation of our dataset represents the third step of our results (4).

3.1 Identification and Clustering of Customer Needs from Literature

The identification of customer needs in recent research starts with the selection of relevant publications. There is no systematized approach in current need research which depicts every aspect of customer needs in every possible field of interest. Therefore, we limit our focus only on our domain of interest, e-mobility, to depict the current state of need research in this field. Our main database for the literature is *Google Scholar*. We use the application *Paperfinder* to search, filter and download literature [Sc15]. According to the principles of Randolph, we start with a keyword search based on the generic words ”e-mobility” and ”need” [Ra09]. The relevance of the found literature is assessed mainly by its content but we also evaluate the number of citations and the authors. Afterwards, we repeat this step with ”electric mobility” and its German translation (”Elektromobilität”). The next step is to use the keywords and titles of the found literature as the basis for a new keyword search. Additionally, the bibliographies in the identified literature are also a source for the detection of relevant publications. We continue to send search requests with the keywords and parts of the title of the already found literature until we reach saturation, which means that we only receive already identified literature.

Moreover, we discuss our found literature with experts in the field of e-mobility. They help us to enrich our list of literature with publications which we did not find e.g. because the publication is in progress and does not appear in online databases. In total we determine a number of 38 papers, field studies and computer simulations. We look at each publication separately and roughly ascertain their identified needs. Afterwards, we exclude five publications from the time period 1981-2000 because we consider these papers as too old to reflect current research. We also exclude 15 papers about EV adoption to be not affected by a specific research method. Since we roughly ascertained the identified needs in every publication, we ensure that the excluded papers do not contain any fundamentally different needs compared to the needs in the remaining literature. Finally, our set consists of 18 publications[8] from the period between 2010 and 2016, representing all kinds of studies, e.g. surveys, observations or computer simulations. The next step is to analyze the papers more precisely. We are especially interested in a clustering of needs by the researchers and which gradation of needs (e.g. needs, wants and demands) they use in their research.

[8] [Hi11, EL12, Fr12, CGK10, CFM10, ABH12, PJL11, Gl13, Pr13, Pl14, FA12, Gö11, De12, Du13, Wi13, PG13, Fr15, SJF16]

We find neither information about the gradation of needs nor a uniform clustering pattern to summarize them. Based on our research, none of the selected publications mind the different aspects of needs[9]. Due to our best knowledge, we know of no publication clustering needs in e-mobility. Since a more global clustering of needs is crucial to find a pattern of e-mobility needs in research, we have to develop a clustering. We start clustering with the condensation of different expressions for one and the same need. We explain how this condensation works, e.g. on the need *retail price*: Based on the literature, we learn that the initial price a user has to pay to buy an EV is very relevant for him. When we look at the needs which are described in literature, some state that the customers demand a lower sales tax (e.g. [CGK10]), some found a request of subsidies of the government (e.g. [Hi11]) or they ask for lower sales prices by the selling company (e.g. [CFM10]). Although the wording and the method to fulfill the need differs from publication to publication, the need remains the same. The customer asks for a lower retail price, independently if this lower retail price is the result of a subsidy, a lower sales price by the company or other measures. Therefore, we sum up every need in the literature under the name *retail price*—as long as it is related to the retail price in some way. We conduct this kind of condensation of differently expressed but semantically identical needs into one general need expression for every need in our literature. Afterwards, we create an overview which can be found as a concept matrix in table 1. Every need in this table is one of the general needs we received due to the described condensation of need expressions.

With the basis of table 1, the next step is to build major categories out of the identified needs. It is important that the emerging clusters of needs are disjoint but intrinsically similar. There will always be a trade-off between broadly defined clusters and the number of clusters—which can not be solved perfectly. Most importantly, the clustering must to be unambiguous and every need is represented in one category. Subsequently, we assign every need from the literature review to exactly one major category. In some cases needs do not fit in any of the categories, meaning the categorical system is not entire and has to be revised. A method to create a clustering pattern, to which every need can be assigned, is to start with the single needs and merge them continuously with the most similar needs or cluster of needs until only a low number of major need categories remain. We start with needs which have the closest distance to each other. In our case, the closest distance to each other are all needs which have to do with the engine of a car, like its sound (e.g. [Gö11]) or performance (e.g. [CFM10]. We merge them to an *engine* cluster. We search again for needs or clusters which have the closest distance to each other after the execution of the first step. In this second step, we merge almost every need excluding retail price and environment, because the distance to other clusters or need expressions is still too wide. Besides these two categories, retail price and environment, we find a category which covers every cost which is dependent on the driving usage of the car, a cluster with essentials of an EV like its engine and safety, a category which covers all extras a car can have like the size of the luggage space, a cluster with all needs referring charging and a cluster which covers all personal needs like the demand to drive a popular brand.

[9] We tried to ascertain the used aspects on our own but due to the fact that the gradations are not part of their research, our findings are very subjective. The letters in the up right corner of the cells in table 1 represent our assessment which graduation of need is used (N=Need, W=Want, D=Demand).

Tab. 1: Overview about the current state of research in the field of e-mobility. The publications are listed in the bibliography. (N=Need, W=Want, D=Demand)

Publication	Type of Study	Citations from 01-19-16	cost-related needs: single costs	cost-related needs: multiple costs	car-related needs: essentials: engine	car-related needs: extras	needs referring charging	individual and social needs: environmental	individual and social needs: personal
Hidrue et al. 2011 - Willingness to pay for electric vehicles and ...	stated preference survey	203	D retail price	D electricity price	D performance		D charging time; D driving range	D environment	
Egbue and Long 2012 - Barriers to widespread adoption of electirc vehicles	internet-based survey	162	D retail price	D electricity price; D overhead	N reliability; N safety	W comfort; W style	N/W charging stations availability; N/W driving range	W environment	N/W independence from petroleum
Franke et al. 2012 - Experience range in an electric vehicle	6-month field study	109					W battery; N driving Range		
Chandra et al. 2010 - Green drivers or free riders?	empirical study with about 38,000 obervations	98	D retail price						
Caulfield et al. 2010 - Examining individuals preferences for hybrid ...	questionnaire / stated preference experiments	66	D retail price	W/D electricity price; W/D overhead; W/D car tax	W performance	N reliability; N safety; W style; W vehicle size		N/W environment	W brand; W image
Achtnicht et al. 2012 - The impact of fuel availability on demand ...	computer-assisted personal interview with choice experiment	37	D retail price	D electricity price	D engine		W/D charging stations availability	W/D environment	
Pierre et al. 2011 - Driving an electric vehicle. A sociological	social sience study / interviews	34					N/W charging stations availability	N/W environment	
Glerum et al. 2013 - Forecasting the demand for electric vehicles	stated preferences survey	26	D retail price	D electricity price; D battery lease; D overhead; D financing					
Propfe et al. 2013 - Market penetration analysis of electric vehicles in ...	scenario-based computer simulation	22	D retail price	D electricity price			D driving range		
Plötz et al. 2014 - Who will buy electric vehicles? Identifying early adopters ...	Paper-and-pencil and online questionnaire	19	D retail price	D electricity price; D overhead		W comfort		N/W environment	W interest in new technologies
Flamm and Agrawal 2012 - Constraints to green vehicle ownership.	recorded focus group discussions / focus group study	11		electricity price				N/W environment	
Götz et al. 2011 - Attraktivität und Akzeptanz von Elektroautos	focus group study and conjoint-analysis	8	W/D retail price	D overhead	W/D engine; W sound	N/W safety; W comfort; W luggage space; W style; W variety of different cars	W charging stations availability; W/D charging time; W/D driving range		
Deffner et al. 2012 - Elektrofahrzeuge in betrieblichen ...	field test observation	5			N/W engine; N/W sound	W comfort	W charging time; W charging issues; W driving range	W environment	
Dudenhöffer 2013 - Why electric vehicles failed.	comprehensive test drives / experiment	2					W/D driving Range		D Experience with e-mobility
Windisch 2013 - The impact of policy measures on the demand ...	scenario-based constraints analysis	2	W retail price	W electricity price			W charging stations availability; W driving range		
Plötz and Gnann 2013 - Who should buy electric vehicles?	public driving survey	2	D retail price	D electricity price; D battery lease; D financing					
Frenzel et al. 2015 - Erstnutzer von Elektrofahrzeugen ...	online questionnaire	1	W electricity price; W overhead		N/W driving pleasure	N/W luggage space	W charging stations availability; W charging time; W temperature-sensitive battery; W driving range	environment	N/W interest in new technologies; N/W Experience with e-mobility; W image
Schäuble et al. 2016 - Cross-border Mobility for Electric Vehicles	cross-border field test observation	0	W retail price	W electricity price; W overhead	W acceleration; W engine size; W gearshift	W versatility; N safety; W luggage space; W design; W vehicle size	W charging time; W driving range	N/W environment	W brand

overhead = (cost to run, operating costs, repair and maintenance, warranty) often used in TCO

charging stations availability = charging infrastructure financing = leasing price

Afterwards, we merge these categories again. The retail price is similar to the variable costs, so we decide to build a category for all *cost-related* needs. We also combine the essential and the extra car needs to one larger *car-related* needs cluster. The charging cluster is too distant to every other cluster, so it is not merged in this step. It remains a cluster which covers all the *charging-related* needs. However, we can unite the environment cluster and the personal cluster which covers all the *social and individual* needs. Now, we consider the merging as completed. Every further combination would lead to very heterogeneous clusters. Therefore, we define the following clusters as our four major need categories in the field of e-mobility; *Cost-related* needs, *car-related* needs, *charging-related* needs as well as *social and individual* needs.

3.2 Clustering of Customer Needs from Tweets

To compare the identified customer needs from our literature review with our dataset, we use the previously described categories. We start with the assignment of the *need tweets* to one or more major need category. Therefore, we look at every single instance and decide to which major category or categories it belongs. To determine its affiliation, we use the content of the instance, our interpretation what the author of the tweet meant and our definitions of the four major need categories from the literature review. It can occur that an instance is assigned to a major need category because the content refers to this category—although the need expression or the need itself was not part of the category creation process previously. We are also able to assign an instance to a fifth category named *other*, if it contains a need which is not covered by any of our major four need categories from the literature review. The allocation is depicted in figure 2.

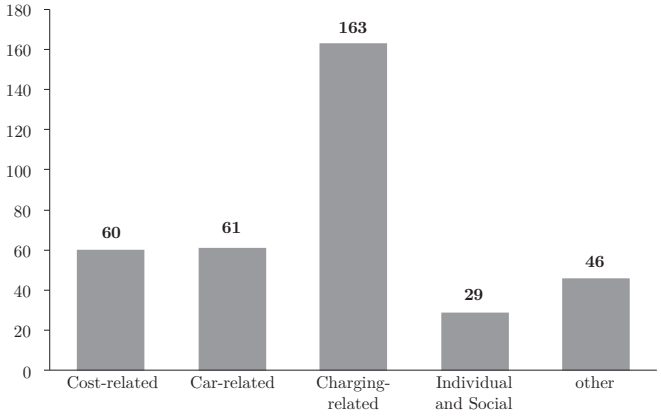

Fig. 2: Number of assigned *need tweets* to the different major need categories

During our assignment of instances to their need categories, we notice there are instances in which the concrete need is almost impossible to detect or it is hard to determine if the need fits in a major need category or is rather a need for the *other* category. Nevertheless, we consider our assignment as reasonable and scientifically reproducible as possible and it is checked by both researchers. Having assigned every instance to one or more of the

four major need categories (*cost-related*, *car-related*, *charging-related* and *social and individual* needs) and the *other* category, we proceed top-down when we use this allocation to build smaller clusters, derived from the major need categories. This allows an analysis in more detail and we can compare if we find the same sub-categories we discovered in our literature review.

We start with every instance which is assigned to the major need category *cost-related*. The instances of this category contain four tweets which refer to the electricity price, so we pool them together to a sub-category. All the other instances do not refer to a specific price because the people mix up retail prices and costs for a vehicle in general. Hence, we decide to group every instance, which does not contain an *electricity-price* need, to one large retail price and cost cluster. In the next step, we try to analyze our sub-categories in more detail to determine if there are smaller clusters we can build out of these instances. In this case a further reduction is not possible. Therefore, the set of *cost-related* instances is split and every instance is assigned to one of the two sub-categories. The number of how many instances are assigned to one sub-category stands for the quantity of this need in our whole dataset.

We do the same proceeding with every instance which is assigned to the major need categories or to the *other* category. We try to find sub-categories in which we can subdivide our dataset. Sometimes, an instance can contain two needs of the same major need category. In this case we duplicate the instance and assign one instance to the one sub-need category and one to the other. Therefore, and because an instance can also be assigned to more than one major need category, we found 361 needs in 332 instances. Consequently, we receive a tree of major needs and sub-categories. This tree is depicted in figure 3. The numbers on the leaves represent the number of instances which are assigned to this sub-category and therefore contain this specific need. There are also some nodes which contain a number. In these cases, the instance contains a need which is expressed so widely that we are only able to say it refers to the node but do not recognize to which sub-category of this node.

4 Discussion

Since our dataset mainly covers the timespan from March 3^{rd} to August 25^{th} 2015 and we only have instances with content in German, we are also only able to give insights for this specific timespan and only for the German-speaking area. Events in the meantime like the reveal of the Volkswagen emissions scandal in September 2015 or the presentation of the Tesla Model 3 in March 2016 could have changed the current needs of people in the field of e-mobility—but is not reflected in our dataset. As mentioned before, the following statements do not claim to be representative but to deliver new insights and stimulus.

The dataset contains 60 *cost-related* needs, 61 *car-related* needs, 163 *charging-related* needs, 30 *social and individual* needs and 46 needs which are not represented by one of these categories. The *cost-related* needs can be split into needs which refer to the electricity price and in needs which refer to the retail price and the costs for an EV. In contrast to the needs from our literature review, the needs referring to the electricity price are underrepresented. The electricity price is a need in over half of the used literature whereas

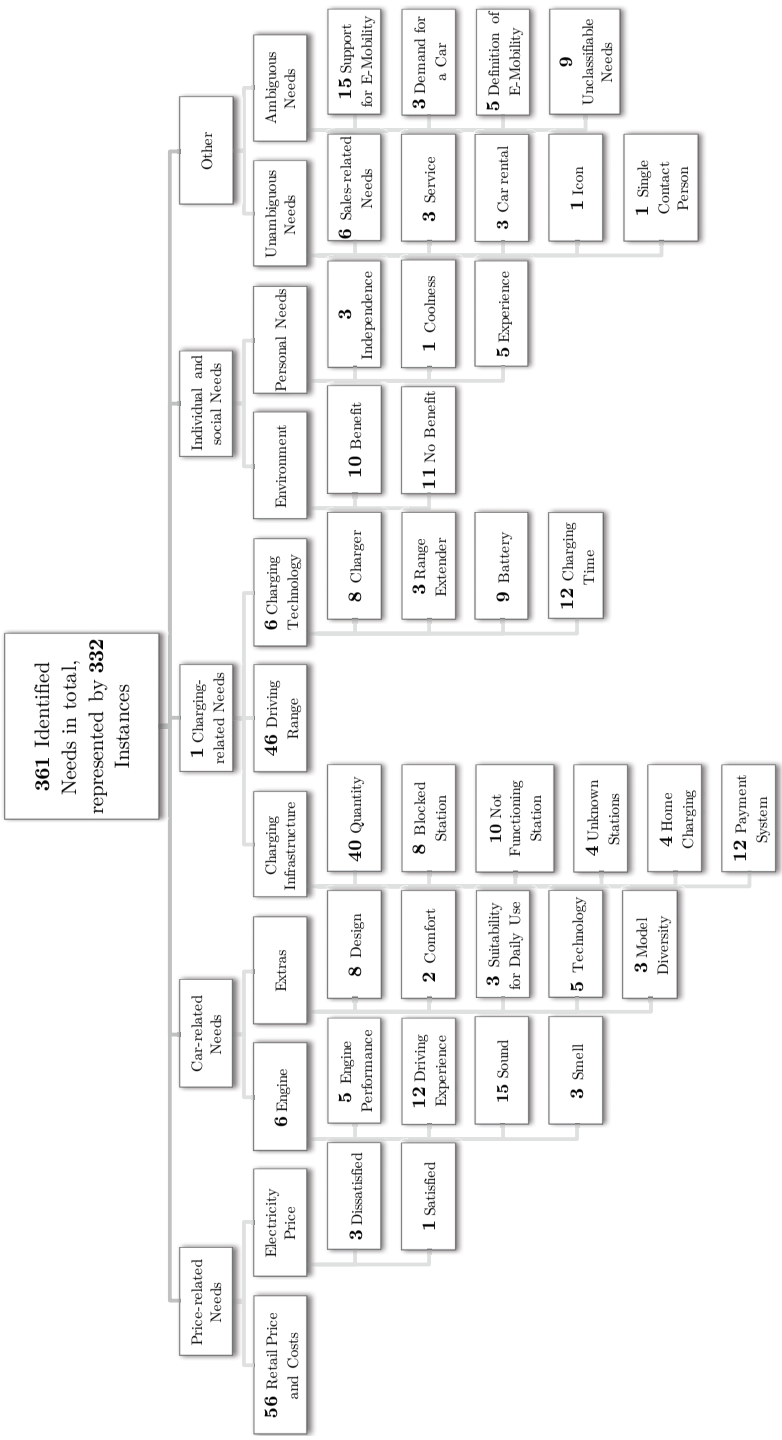

Fig. 3: Manual clustering tree of needs in the dataset

only 6.7% of the *cost-related* tweets contain a need in this domain. The remaining 93.3% instances contain needs which refer to the retail price in particular or to the costs of EVs in general. In many tweets, one is not able to say if the author of the tweet refers just to the retail price or to the total costs of the car, a distinction which is clearly made in the literature. Only two instance have positive sentiments towards the current costs whereas 54 request lower retail prices or costs.

Compared to the previous category, the *car-related* needs show more diversity. The driving experience is lauded by every of the 12 instances whereas the opinion about the engine performance is balanced. Moreover, the sound of an EV is discussed very controversial: Four people like the silence of EVs but five people miss the sound of a fossil fuel engine during driving. Additionally, six people believe that the absence of a car sound is dangerous for traffic participants and pedestrians. The current design of EVs is mainly rejected and the comfort and suitability for daily use is disbelieved by 13 instances. Compared to the literature review, no tweet questions the reliability or safety of an EV. We assume the (potential) customers do not expect any differences in these topics between a fossil fuel vehicle and an EV.

Our dataset is dominated by various needs which refer to *charging*. 38 potential consumers and users of EVs fault the low quantity of charging stations and only two are satisfied with it. A great nuisance for current users is when they are not able to use existing charging infrastructure (see figure 1), a problem which can not be found in any of the used publications. Eight instances refer to blocked charging stations by non EVs or fully charged cars, ten users report not-functioning stations and four tweets describe situations where the user did not know of an existing charging station. Moreover, twelve people have problems with the different payment systems and often with the charging on a station of a provider, divergent from those they usually use.

The driving range of EVs, which is significantly lower to the range of fossil fuel vehicles, is an issue in 46 instances. There are two people which are satisfied with the current driving ranges, but the vast majority criticizes it. In addition, the charging technology is another topic of *charging-related* needs. The technology itself, the used charger and the battery are represented in 23 instances. The greatest single need in technology is the charging time with twelve mentions but in comparison to the other needs of the category *charging* it is only a minor need. This is also a difference to the findings of our literature review in which a fast charging time is a frequently mentioned need. Moreover, a fact that is represented by almost every instance is that the (potential) consumers are not willing to change their driving habits and demand the same comfort referring to the driving range like a fossil fuel vehicle has.

The *social and individual* needs are dominated by environmental needs. In contrast to the literature, a majority of people think that e-mobility is not a benefit for the environment. The most criticized issues are the origin of electricity, which is mainly produced by coal-fired power plants in Germany, and the emissions which are caused during the production. Other needs are the demand for test drives to get experience with EVs, to use e-mobility to be ”cool” or to become independent from oil companies. However, compared to our

dataset in total, the *social and individual* needs, especially the environment, only make up 8.3% of the total needs—and prove to be less frequent than current research assumes.

The last category *other* contains every need which is not covered by the major need categories and therefore also not represented in the current state of research. The instances are divided in needs which can be named and needs which are ambiguous and we do not have the ability to name the need unambiguously. The unambiguous needs refer to better sales and distribution by the companies, a better service and more EVs available to rent. There is also respectively one person who demands an icon for e-mobility and a single contact person for the topic e-mobility. Furthermore, the ambiguous needs include instances which contain the desire of a (better) support for e-mobility without specifying precisely how this support should look like, if it is financial support for the buyers, the companies, legislative changes or something totally different. These instances have in common that they are mainly addressed to the government or politicians. Additionally, other ambiguous needs are the criticism of the current definition of e-mobility by the public and the demand for a car without specifying why. We also find nine instances for which we are not able to determine the need.

When we look at the instances in general, we notice two issues which do not refer to a specific major needs category. Most instances are written by people who have no experience with EVs[10] and never did a test drive. They are the vast majority of people who criticize the costs as well as the driving range of cars. However, when we only look at the tweets of people who have experience with EVs, the sentiment towards e-mobility becomes much more positive e.g. every of the twelve opinions about the great driving experience is expressed by them. The other observation is that e-mobility is equaled with personal EVs. Other characteristics like new mobility concepts besides owning an own car are hardly ever represented in our dataset.

5 Conclusion and Outlook

We motivated the work at hand with the importance of the identification of customer needs, which can be of support in the design of market-driven services. By comparing needs in the field of e-mobility from literature with needs from micro blog posts, we get valuable insights about customer needs expressed in social media.

We gave an overview of current literature about customer needs in e-mobility. Afterwards, we analyzed the customer needs in the literature and assembled a representative set of 18 publications. Based on this set we learned that the detected needs can be pooled in four major categories (*cost-related* needs, *car-related* needs, *charging-related* needs and *social and individual* needs). We were able to assign every customer need in current research of e-mobility to exactly one category. To our knowledge there is no such pattern to cluster customer needs in the field of e-mobility research.

The received (unrepresentative) Twitter dataset gave us useful insights in the field of e-mobility. *Charging-related* needs are the mostly expressed needs in our dataset. Besides

[10] As far as we can judge such statements.

the concerns about the quantity of charging stations and driving range, which can also be found in literature, we learned that a large set of instances refer to situations in which the infrastructure was available but could not used. For instance, the case that a charging station is blocked by another car is not covered by current research yet—but often occurred in our dataset. Additionally, the needs which refer to the costs of an electric vehicle are also frequently expressed. Their overwhelmingly share demand lower prices. When we look at the environmental benefit of e-mobility, the opinion is split because the origin of the used electricity is predominantly based on fossil energy sources. The analysis of customer needs, which do not fit in our major categories, reveals the need for better interaction of the selling company with the customer, when it comes to the sale of a electric vehicle or services which are offered by the company. Moreover, we learned that customer experience in the field of e-mobility leads to a better sentiment towards e-mobility—which is also a key finding of Dudenhöffer [Du13].

The work at hand has three major limitations. First, we used data which is collected by keywords. This could lead to the case that relevant instances are excluded from the dataset, because they did not match any of the keywords. The same could happen when we try to eliminate all non-relevant instances from the retrieved dataset. Second, subjective assessments can not be ruled out. Although we tried to work as impartial as possible, we can not guarantee that some decisions are influenced by personal circumstances as part of the clustering of needs to find our major need categories. In this case, we decided to merge clusters based on our opinion of homogeneity of the resulting cluster. Same applies for assignment of the micro blog posts to the categories; Some contain texts which allow interpretation about the underlying need or reply to an unknown tweet of another user which could lead to false interpretations. Third, the work only shows a static snap-shot of tweets in 2015 and does not consider dynamics of customer needs.

Nonetheless, the work at hand shows how valuable an in-depth analysis of first-hand customer expressions about a certain topic (in this case e-mobility) can be. We were able to detect new, previously unknown needs which were not named in the state of the art literature. This can be of help in the development of future, customer-centered e-mobility services. Future work will concentrate on ways to automate the described process of extracting needs from micro blog data within an automated tool [Ku16, KSS16]—an interesting field of work lies ahead.

References

[ABH12] Achtnicht, Martin; Bühler, Georg; Hermeling, Claudia: The impact of fuel availability on demand for alternative-fuel vehicles. Transportation Research Part D: Transport and Environment, 17(3):262–269, 2012.

[AH98] Augustyn, Marcjanna; Ho, Samuel K: Service quality and tourism. Journal of Travel Research, 37(1):71–75, 1998.

[AP02] Alam, Ian; Perry, Chad: A customer-oriented new service development process. Journal of Services Marketing, 16(6):515–534, 2002.

[BL95] Bailetti, Antonio J; Litva, Paul F: Integrating customer requirements into product designs. Journal of Product Innovation Management, 12(1):3–15, 1995.

[BPS10] Brown, Stephen; Pyke, David; Steenhof, Paul: Electric vehicles: The role and importance of standards in an emerging market. Energy Policy, 38(7):3797–3806, 2010.

[BS06] Bullinger, Hans-Jörg; Scheer, August-Wilhelm: Service engineering - Entwicklung und Gestaltung innovativer Dienstleistungen. Springer, 2006.

[CFM10] Caulfield, Brian; Farrell, Séona; McMahon, Brian: Examining individuals preferences for hybrid electric and alternatively fuelled vehicles. Transport Policy, 17(6):381–387, 2010.

[CGK10] Chandra, Ambarish; Gulati, Sumeet; Kandlikar, Milind: Green drivers or free riders? An analysis of tax rebates for hybrid vehicles. Journal of Environmental Economics and management, 60(2):78–93, 2010.

[De12] Deffner, Jutta; Birzle-Harder, Barbara; Hefter, Tomas; Götz, Konrad et al.: Elektrofahrzeuge in betrieblichen Fahrzeugflotten–Akzeptanz, Attraktivität und Nutzungsverhalten. Ergebnisbericht im Rahmen des Projekts Future Fleet. Frankfurt am Main. ISOE–Institut für sozial-ökologische Forschung, 2012.

[De16] Deutsch, Alison L.: , 4 Ways Sina Weibo and Twitter Compare, 2016.

[Du13] Dudenhöffer, Kathrin: Why electric vehicles failed. Journal of Management Control, 24(2):95–124, 2013.

[EL12] Egbue, Ona; Long, Suzanna: Barriers to widespread adoption of electric vehicles: An analysis of consumer attitudes and perceptions. Energy policy, 48:717–729, 2012.

[FA12] Flamm, Bradley J; Agrawal, Asha Weinstein: Constraints to green vehicle ownership: A focus group study. Transportation Research Part D: Transport and Environment, 17(2):108–115, 2012.

[Fr12] Franke, Thomas; Neumann, Isabel; Bühler, Franziska; Cocron, Peter; Krems, Josef F: Experiencing range in an electric vehicle: Understanding psychological barriers. Applied Psychology, 61(3):368–391, 2012.

[Fr15] Frenzel, Ina; Jarass, Julia; Trommer, Stefan; Lenz, Barbara: Erstnutzer von Elektrofahrzeugen in Deutschland. Nutzerprofile, Anschaffung, Fahrzeugnutzung. Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Berlin, Germany, 2015.

[Gl13] Glerum, Aurélie; Stankovikj, Lidija; Thémans, Michaël; Bierlaire, Michel: Forecasting the demand for electric vehicles: accounting for attitudes and perceptions. Transportation Science, 48(4):483–499, 2013.

[Gö11] Götz, Konrad; Sunderer, Georg; Birzle-Harder, Barbara; Deffner, Jutta; Berlin, Büro: Attraktivität und Akzeptanz von Elektroautos. Institut für sozial-ökologische Forschung, S. 8, 2011.

[Gr06] Groves, Robert M: Nonresponse rates and nonresponse bias in household surveys. Public Opinion Quarterly, 70(5):646–675, 2006.

[Ha01] Harding, Jennifer A; Popplewell, K; Fung, Richard YK; Omar, Abdul R: An intelligent information framework relating customer requirements and product characteristics. Computers in Industry, 44(1):51–65, 2001.

[HD03] Hickey, Ann M; Davis, Alan M: Elicitation technique selection: how do experts do it? In: Requirements Engineering Conference, 2003. Proceedings. 11th IEEE International. IEEE, S. 169–178, 2003.

[Hi11] Hidrue, Michael K; Parsons, George R; Kempton, Willett; Gardner, Meryl P: Willingness to pay for electric vehicles and their attributes. Resource and Energy Economics, 33(3):686–705, 2011.

[KA01] Kotler, Philip; Armstrong, Gary: Principles of marketing. pearson education, 2001.

[Kl14] Klör, Benjamin; Bräuer, Sebastian; Beverungen, Daniel; Matzner, Martin: IT-basierte Dienstleistungen für die Elektromobilität-Konzeptioneller Rahmen und Literaturanalyse. 2014.

[KSS16] Kuehl, Niklas; Scheurenbrand, Jan; Satzger, Gerhard: Needmining: Identifying Micro Blog Data Containing Customer Needs. In: 24th European Conference of Information Systems. 2016.

[Ku16] Kuehl, Niklas: Needmining: Towards Analytical Support for Service Design. In: International Conference on Exploring Service Science. Jgg. 6. Springer, 2016.

[MLF15] Marshall, Tara C; Lefringhausen, Katharina; Ferenczi, Nelli: The Big Five, self-esteem, and narcissism as predictors of the topics people write about in Facebook status updates. Personality and Individual Differences, 85:35–40, 2015.

[PG13] Plötz, Patrick; Gnann, Till: Who should buy electric vehicles?–The potential early adopter from an economical perspective. Proceedings of the 2013 ECEEE summer study, Hyeres, France, 2013.

[PJL11] Pierre, Magali; Jemelin, Christophe; Louvet, Nicolas: Driving an electric vehicle. A sociological analysis on pioneer users. Energy Efficiency, 4(4):511–522, 2011.

[Pl14] Plötz, Patrick; Schneider, Uta; Globisch, Joachim; Dütschke, Elisabeth: Who will buy electric vehicles? Identifying early adopters in Germany. Transportation Research Part A: Policy and Practice, 67:96–109, 2014.

[Pr13] Propfe, Bernd; Kreyenberg, Danny; Wind, Joerg; Schmid, Stephan: Market penetration analysis of electric vehicles in the German passenger car market towards 2030. International Journal of Hydrogen Energy, 38(13):5201–5208, 2013.

[Ra09] Randolph, Justus J: A guide to writing the dissertation literature review. Practical Assessment, Research & Evaluation, 14(13):1–13, 2009.

[RJ00] Rising, Linda; Janoff, Norman S: The Scrum software development process for small teams. IEEE software, 17(4):26, 2000.

[Sc15] Scheurenbrand, Jan; Engel, Christian; Peters, Florin; Kuehl, Niklas: Holistically Defining E-Mobility: A Modern Approach to Systematic Literature Reviews. In: Proceedings of the First Karlsruhe Service Summit Workshop. Karlsruhe, Germany, S. 17–27, 2015.

[SJF16] Schäuble, Johannes; Jochem, Patrick; Fichtner, Wolf: Cross-border Mobility for Electric Vehicles - Selected results from one of the first cross-border field tests in Europe. KIT Scientific Publishing, 2016.

[St11] Stickdorn, Marc; Schneider, Jakob; Andrews, Kate; Lawrence, Adam: This is service design thinking: Basics, tools, cases. Wiley Hoboken, NJ, 2011.

[St15] Stryja, Carola; Fromm, Hansjörg; Ried, Sabrina; Jochem, Patrick; Fichtner, Wolf: On the Necessity and Nature of E-Mobility Services–Towards a Service Description Framework. In: Exploring services science, S. 109–122. Springer, 2015.

[Wi13] Windisch, Elisabeth: The impact of policy measures on the demand for privately-hold electric vehicles: a socio-economic analysis for France. In: 13th World Congress on Transportation Research, Rio de Janeiro, Brazil, July 15th-18th. 2013.