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Leveraging user preferences to develop profitable business models for electric vehicle charging

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Summary

To design profitable business models for electric vehicle (EV) charging it is necessary to understand user preferences. For this purpose, prior literature is analyzed to develop a conceptual framework linking a focal company's assets, the surrounding value network and user preferences. Then, survey insights from two EV charging projects (ultra-E, SLAM) are summarized to illustrate user preferences in this space. Based on this data, the framework is eventually visualized by applying it to four case studies from the EV charging market.

Keywords: electric vehicles, business model, charging, market development, user behaviour

1 Introduction

1.1 Motivation & prior research

Even after several measures have been implemented to harmonize the market for electric vehicle (EV) charging in Germany, e.g. the Verification Act (*Eichrecht*) and the Price Indication Ordinance (*Preisangaben-verordnung*), users still face an inhomogoneous landscape of charging tariffs and prices [1]. At the same time, providers of charging services struggle to establish profitable business models [2][3][4]. Several studies have addressed user preferences concerning the usage and pricing of charging services [5][6][7][8]. However, only a few studies connect these results to how the charging ecosystem for electric mobility shall be designed.

1.2 Objectives

The paper aims to outline the critical user preferences and decision criteria that are relevant for designing a profitable business model for electric vehicle charging. Building on these insights, the paper in hand will help companies to define their "play" in a network of interrelated actors.

This research pays special attention to the focal company's situation in a network of interrelated actors [9] and its user-oriented influencing factors on charging services' acceptance and attractivity. Based on the analysis of users' likings and the comparison with established sectors it is the goal to develop a conceptual framework that connects a company's assets, the value network it is embedded in, and user preferences. For this purpose, the paper builds upon an approach suggested by Rüger & Fischer. [10] In chapter 2, the state of the art is analyzed and, concurrently, a conceptual framework is developed. Chapter 3 then zooms in on user preferencens, one of the easily observable elements of the framework. In chapter 4, the framework is exemplarily applied to understand observable business model choices of four companies that are active in the EV charging market. Finally, the results are summarized and paths for further research are illustrated in chapter 5.

1.3 EV charging as one example for an emerging mobility ecosystem: Cooperation and interaction of actors for joint service provision

Value is not always created in a linear process by a single firm but often results from cooperation and interaction. Stabell & Fjeldstad identified three different value cofigurations: the value chain, the value shop, and the value network, the latter describing the value creation by a firm offering mediating technologies. The firm creates a network by linking other firms and/or customers thus enabling cooperation and interaction. According to Stabell & Fjeldstad, „examples of firms that rely on a mediating technology are telephone companies, retail banks, insurance companies, and postal services.“ [11]

The value creation in the case of electric vehicle charging is also based on cooperations and interactions between multiple actors. Figure 1 gives an overview of the actors and their cooperations in the electric vehicle charging process with its key roles electric mobility service provider (EMSP), charge point operator (CPO), location partner, and electric vehicle driver. Similar to Stabell & Fjelstads model of value networks there is a linkage of electric vehicle driver and CPO on a physical and a digital level. In the physical world, the location partner is connecting the electric vehicle driver to the CPO by building or permitting charging infrastructure on its premises. In the digital world, the EMSP is connecting EV drivers (through an app or an RFID-card) to the backend management system of the CPO, which allows to unlock the charging station and the payment of the charging session. Thus, in most cases, this "value network" involves several actors that bring different resources to the "joint value sphere" [11][12].

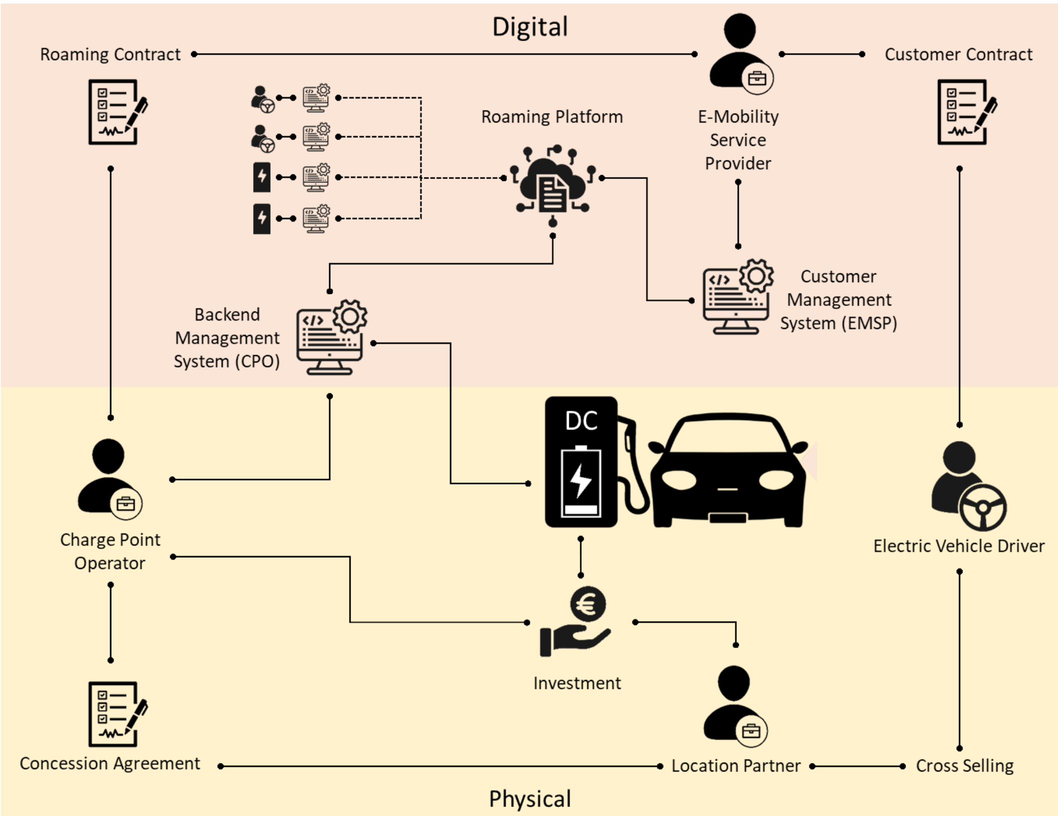

Figure 1: Actors involved in EV charging processes (own diagram based on [7])

2 State of the art used to develop a conceptual framework

2.1 Quality of service provision defined by digital and physical assets and brand power

Before assessing business models and their influencers it is helpful to classify the process of EV charging. Adopting Tukker's model of product-service systems [13] it becomes clear that EV charging covers the whole width from pure product to pure service. While the product-oriented and service-oriented systems apply to B2B activities, the use-oriented system applies to B2C use cases. Thus, EV charging can be seen as a system consisting of a physical product component in form of the charging station and a service component represented by different IT systems. The interaction of the components and the actors that are active in the value network defines the quality of service provision.

McNaughton, Osborne & Imrie developed a model that includes the relation between firm assets, competitive advantage and perceived customer value in service firms. Customer value can be created by gaining competitive advantages which in turn result from largely intangible market-based assets (e.g. knowledge about the market, relations, and their interaction) and other asset types. [14] Following the resource-based view (RBV), a company can gain a competitive advantage by having valuable, rare, imperfectly imitable and not substitutable resources and assets [15]. Even though the RBV implies a positive impact of resources with said characteristics on the firm's competitiveness this does not necessarily grant a superior performance. If advantages are only discrete, not fully exploited or a firm has many but misses a critical advantage a superior performance can fail to appear. [16] So it can be assumed that the right physical assets can have a positive impact on the competitiveness and hence on the service quality.

While the RBV could also be applied to the digital assets, the impact is in this case more sensitive to the actual use process. A synthesis by Soh & Markus focusses on how IT influences a firm's competitiveness and performance. It is stated that the IT assets gain their impact through usage. Appropriate use leads to positive impacts on competitiveness and performance [17]. Despite refering to internal IT assets these findings can also be transferred to more customer-oriented digital assets. Bharadawi et al. describe a value creation through digital assets as "multilayered where a company gives away certain products or services in one layer to capture value at a different layer" [18]. Furthermore, Keen & Williams identify the interface to customers, partners, and suppliers as a key role of digital businesses [19].

A study by Malik et al. found that brand image has a positive impact on customer satisfaction [20], which suggests to consider brand strength as a component of service provision. Davis states that through a strong brand higher margins and customer lifetime can be achieved. It attracts better employees and thus leads to better management, product and service quality [21]. Regarding the service sector, brand equity relies on the brand attitude as well as its image but with a larger impact of the attitude. The brand equity then has a positive influence on brand preference which finally leads to higher purchase intention. [22]

Thus, the overall performance of service provision is mainly determined by the resource configuration consisting of physical and digital assets as well as brand strength. As EV charging relies on cooperation and interaction of multiple actors [4], it is possible for a firm to only obtain some of the described assets and exploit other firms' assets which are accessible through the value network.

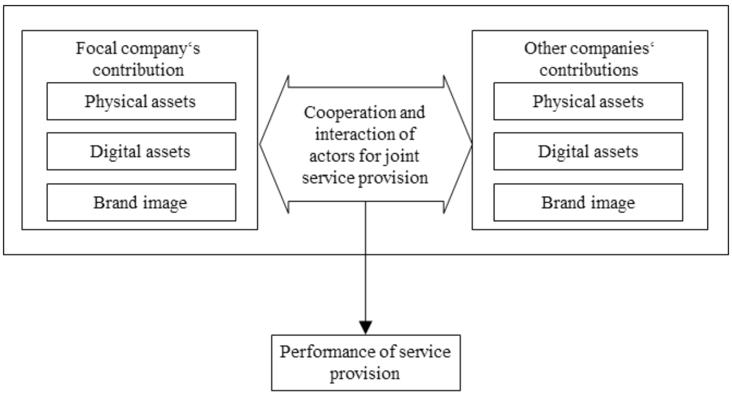

Figure 2: Presumed relationship between actors' cooperation & performance of service provision (own figure)

2.2 Power balance in the value network

As the value creation in the case of EV charging is carried out by a network, respectively through cooperation, the question arises how a focal company can gain a power position. Regarding horizontal cooperation, Bleeke & Ernst identified the initial strengths and weaknesses of the partners, as well as those over time and, additionally, the potential for competitive conflicts as main factors for relative bargaining power [23]. Gomes-Casseres presents two further approaches of how an advantage can be attained. The first is of gaining power over partners through the position in the network, which is also supported by Nohria & Garcia-Pont [24], Burt [25], and Lorenzoni & Baden-Fuller [26]. The second approach explains the possibility of extracting profit from partners by adding scarce resources to the network and is based on the works of Pfeffer & Salancik [27], Brandenberger & Nalebuff [28], and Ghemawat et al. [29]. As both approaches are important and often interdependent, Gomes-Casseres' synthesis elaborates factors that may lead to competitive advantages and increase a firm's claim on value, e.g. "the firm controls scarce, valued and well-protected assets". [30]

Even though there does not have to be a firm with a competitive advantage in a network, every network is in need of lead firms which are effectively communicating the business ideas' attractiveness and thereby attracting valuable partners [31][32]. In general, it can be assumed that larger firms have more power as they can benefit from a better bargaining position [33]. Thinking this in terms of networks it becomes clear that not the shere size of a firm but their contribution to the network defines the bargaining position and thus the power balance.

The general effect of market power on firms' profitability was examined by Mann. Based on the research of Bain, he assumed that the market power is determined by an industry's concentration ratio as well as its barriers to entry. Regarding 30 industries independent influences of concentration ratio and entry barriers on the average profit rate were determined. [34] Furthermore, Church and Ware explain the positive correlation between market power and profitability [35]. Therefore it can be assumed that a profitable business model is related to the power position of a firm.

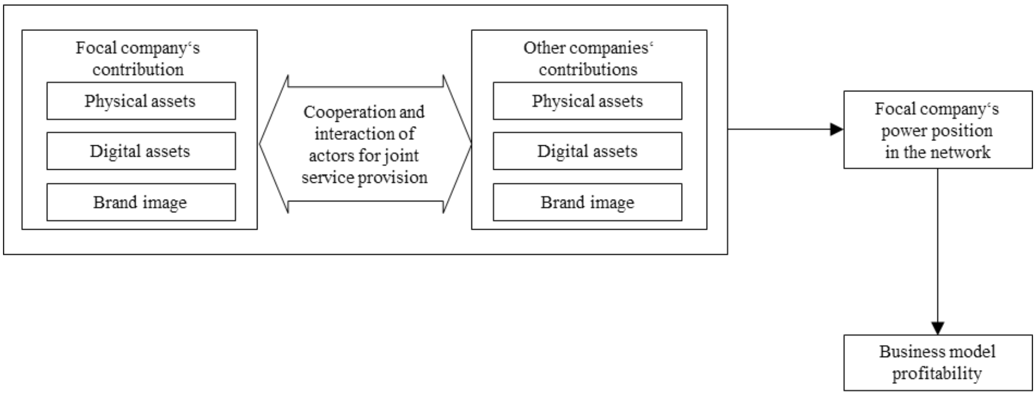

Figure 3: Presumed relationship between a company's power position & business model profitability (own figure)

2.3 Customer satisfaction: antecedents and its impact on business model profitability

In general, customer satisfaction has a large impact on a business' profitability [36][37] which is why it should be taken into account for the development of business models. As a totally satisfied customer contributes 2.6 times more to a company's revenues than a somewhat satisfied customer and 17 times more than a somewhat dissatisfied customer it becomes clear that profitable business models rely on satisfied customers [37].

While customer satisfaction can be highly affected by the characteristics of a company's employees [38] this is not directly applicable for EV charging as this does not necessarily require customer-employee-contact. Other models regard the value/price relationship of a product or the product quality as satisfaction dimensions [39]. Due to charging infrastructure's bilateral product-service composition, a comparison to telecommunications sector is possible. There, customer satisfaction is influenced by the service quality as well as by price and brand image. Service quality and price can be seen as parts of the performance of service provision with brand image as a mediating factor. [20] Similar to Tukker's use-oriented product-service systems where customers can rent a product [13], the process of EV charging can be considered as the "product sold" with its quality/performance determined by factors like location, charging speed, tariffs and payment methods.

One way of assessing user satisfaction is to compare customers' predicted and aquired value [40]. For business model development, instead of predicted value, the customer's desired value can be taken into consideration, which focusses on needs and desires [41] and can hence be described as preferences.

Therefore, user preferences are mediating the relationship between performance of service provision and customer satisfaction, meaning only if the performance of service provision matches the respective user's preferences, customer satisfaction and eventually, business model profitability, can be achieved.

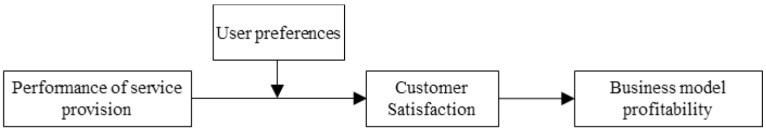

Figure 4: Presumed relationship between performance of service provision & business model profitability (own figure)

2.4 Overall hypothesis

Putting the three pieces described above together, an extensive set of presumed correlations emerges (cf. Figure 5). While the resource configuration as well as the corresponding contribution to the value network vary from firm to firm and cannot be easily observed, others can be assessed. User preferences, for instance, can be surveyed and are thus exemplarily presented in the following chapter.

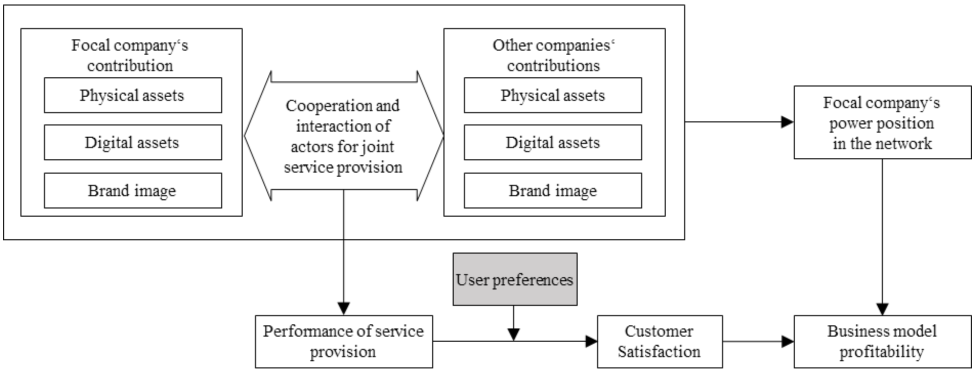

Figure 5: Conceptual framework (own figure)

3 Examining one observable element of the framework: user preferences

As described above, to develop a profitable business model, it is important to have a clear picture of what users of EV charging infrastructure really want, need, or expect.

Compared to fueling an ICEV, the market for EV charging exhibits much heterogeneity: Users can charge their car at different locations, e.g. at home or at a variety of public charge points, and at different power levels, e.g. slow charging at 3.7kW or fast charging at 100kW. EV charging is not as homogenous of a service as fueling an ICE vehicle. Instead, it consists of many different use cases. Prior studies on the topic have taken this into account. In the ultra-E survey, participants had to choose one out of three charging options. On the one hand, they had to cover their primary charging need, assuming they could not charge their car neither at home nor at work, and on the other hand they should choose one option for recharging during a long distance trip. Figure 6 displays preferences to cover primary charging needs while choices for range increase are shown in Figure 7. Clearly, the relatively slow 50kW charging is less attractive on long-distance trips (54% vs. 43%) than for primary charging needs. [6]

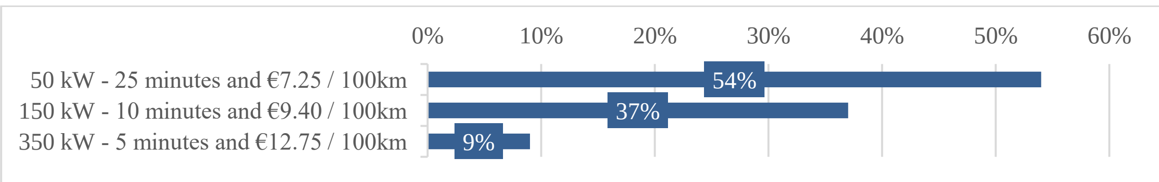

Figure 6: Preferences for primary charging (n=2977; own diagram based on [6])

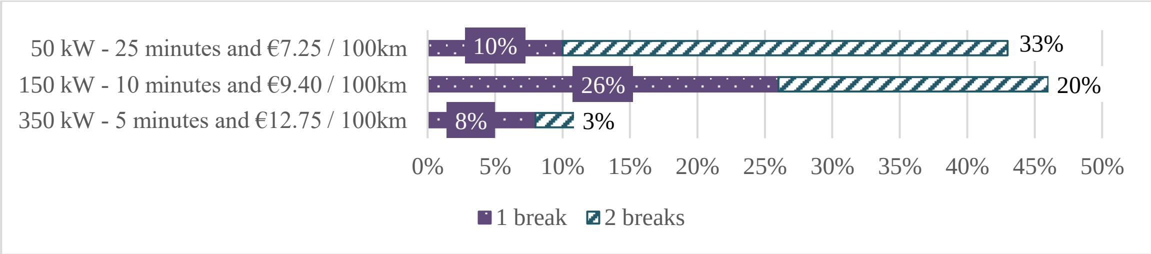

Figure 7: Preferences for range increase (n=2977; own diagram based on [6])

The SLAM survey addresses the reasons for choosing or not choosing various types of charging infrastructure. It appears that, if users are aware what charging speed they can expect from a certain type of charging infrastructure, the charging speed is not much of a reason for not choosing a charging option. As shown in Figure 8, less than 15 % of the people who rarely use a charging option have stated the slow charging speed as a cause. This also pertains for charging at home, charging at work and streetside charging, which are usually considered relatively slow charging options. However, for 87 % respectively 79 % of the frequent users of charging stations at on- and nearby-highway service stations, the high charging speed is decisive. Thus, fast charging could be considered a main decision driver in favor of a charging option, while a slow charging speed not necessarily has a negative impact. In contrast, the price seems to influence the attractiveness of a charging option in both ways: “Charging is more expensive than elsewhere” is a reason for rare use, “Charging is cheaper than elsewhere” a reason for frequent use. [7] A look on the mobile communications, domestic power supply and petrol services sector shows a clear dominance of the price as main decision driver [42][43][44], which is attributable to the low differentiation of respective products. And even if there are heterogenous products like green electricity in the domestic power supply market, its influence on users’ preferences is insignificant. Indeed, the willingness to pay is even lower for green power than for the normal electricity mix [45]. However, despite the price’s dominance, other factors still play a role, for instance brand awareness (see above). Given equal tariffs and a selection of domestic power suppliers as well as big brands (from other markets) more than a fourth of respondents could imagine to switch to a big brand that is currently not active in the energy market [46].

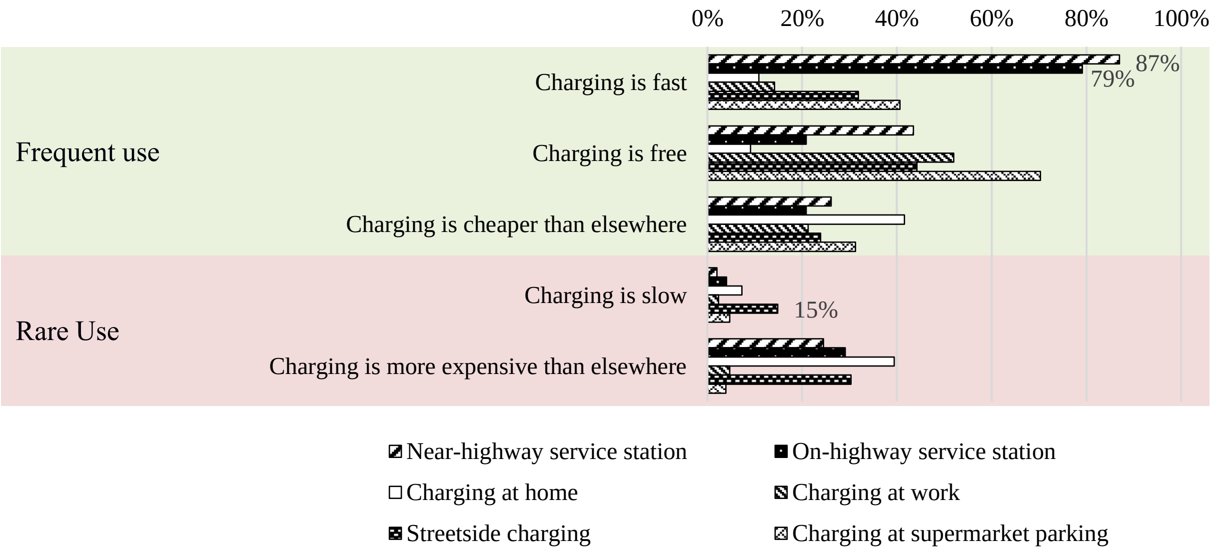

Figure 8: Reasons for frequent and rare use of charging infrastructure (n=403; own diagram based on [7])

Regarding different billing options for EV charging the SLAM survey queried the attractivity of five billing options using a five point likert scale. The results, divided into drivers of battery electric vehicles and non-drivers, are displayed in Figure 9. Billing via EC/credit card is the most attractive option. The other mostly known billing option, a digital payment service provider such as “PayPal”, is overall still attractive but not as much as EC and credit card. The results of a survey measuring the attractivity of paying via smartphone in 2016 shows similar levels of attractivity [47] with a slight shift towards positive appraisal. This and the development of the actual usage of smartphones or tablets as payment medium (12 % in 2016 [48] vs. 25 % in 2019 [49]) belay a change in user preferences and suggest further increase of digital payment attractivity. These findings also apply to the billing via a (new kind of) third-party provider (=EMSP) as they offer digital payment but also include RFID cards. This option was given a mediocre evaluation but with a more detailed view distinct differences between BEV users and non-users can be spotted. While non-users tend to see billing via third-party providers as a rather unattractive payment method, BEV users have a much better picture. A possible reason for this differentiation could be that BEV users are generally more open minded towards new innovations.

The valuations for the two remaining billing options are varying as the payment via car manufacturers is rated rather unattractive and via house electricity tariff mostly attractive. Nevertheless, both options are more likely to be evaluated positively by BEV users than by non-users.

Are the following billing scenarios generally attractive or unattractive for you? Billing via…
With usual mobility behavior, electric vehicle with 400 km range and availability of every charging option.

	very unattractive BEV | No BEV	unattractive BEV | No BEV	neither nor BEV | No BEV	attractive BEV | No BEV	very attractive BEV | No BEV
House electricity tariff	5% 9%	8% 13%	16% 24%	36% 36%	34% 18%
Car manufacturer	24% 17%	18% 26%	29% 36%	18% 16%	12% 6%
Digital payment service provider	11% 5%	14% 7%	19% 22%	38% 45%	19% 21%
Third-party provider	8% 19%	16% 26%	32% 39%	34% 14%	10% 2%
EC/credit card	3% 4%	3% 5%	13% 19%	37% 51%	44% 22%

Figure 9: Attractivity of different billing models (n=1151; own diagram based on [7])

Besides the billing via the house electricity tariff the option of achieving lower prices by chosing a specific house electricity provider has been queried. Regarding public charging with a charging time of 30 minutes for 100 km, 30% would choose a specific house electricity provider while for fast charging with a charging time of 5 minutes per 100 km, 25% would do this for cheaper charging. [7]

4 Case studies exemplifying the framework

As already mentioned above, it is quite difficult to observe and objectively measure the brand strength as well as the quality and quantity of digitial and physical assets. The same applies for the power position of the focal company and business model profitability in each case. Therefore, publicly available information are used as an approximate value for determining these three factors that define the quality of service provision and, thereby, customer satisfaction. For instance, an existing customer base is assumed to reflect brand strength. Each case is summarized in tables 1-4 below (rating according to values shown in the right column).

Table 1: Analysis of EnBW [50][51][52][53][54][55][56]

Brand strength	++	5,5 million customers (electricity, gas, and water); 4.3/5 stars rating on check24 and customer loyalty rating of 80% on Verivox (online consumer portals)
Digital assets	+++	Charging app with ≥100.000 downloads and 4.7/5 stars rating; access to 47.000 charge points
Physical assets	+++	1000 fast charging locations (target for year end 2020)
Pricing (fast charging)	€€€	49 ct / kWh for general customers
	€€	39 ct / kWh for intensive users that pay a monthly fee of 5€
	€€	39 ct / kWh for customers that also have a house electricity contract

Table 2: Analysis of Deutsche Telekom [57][58][46][53][54]

Brand strength	+++	≥43 million customers (mobile, landline, and TV); 4/5 stars rating on check24 (online consumer portal); survey: 27% of survey sample (47% of people aged 18-27) could imagine to have Deutsche Telekom as their energy provider
Digital assets	++	Charging app with ≥10.000 downloads and 2/5 stars rating; access to 32.000 charge points (Telekom GetCharge)
Physical assets	+	≥100 fast charging stations (Telekom Comfort Charge)
Pricing (fast charging)	€€	39 ct / kWh at "privileged" charging stations (including own stations)
	€€€€	89 ct / kWh at "other" charging stations (including e.g. stations of EnBW)

Table 3: Analysis of Maingau [60][61][62][53][54][63]

Brand strength	++	300.000 customers (electricity and gas); 4.2/5 stars rating on check24 and customer loyalty rating of 88% on Verivox (online consumer portals)
Digital assets	+	Charging app with ≥10.000 downloads and 2.9/5 stars rating; access to 45.000 charge points
Physical assets		No own fast charging stations
Pricing (fast charging)	€€	35 ct / kWh for general customers
	€	25 ct / kWh for customers that also have a house electricity contract

Table 4: Analysis of Ionity [64][65][53][54][66][67][68]

Brand strength	+++	Market share of about 55% of newly registered vehicles in Germany (as of 02/2020 – makes: Audi, BMW, Mercedes, Ford, Seat, Volkswagen)
Digital assets	+	Charging app with ≥10.000 downloads and 1.7/5 stars rating; access to 1.000 charge points
Physical assets	++	219 fast charging locations (as of 03/2020, target for year end 2020 is 400)
Pricing (fast charging)	€€€€	79 ct / kWh for general customers
	€	29 ct / kWh for customers of BMW, Daimler, Ford, Volkswagen

This simplified multiple case study provides the following insights:

1. **Companies that have a very strong position (+++) in one of the three resource classes that define quality of service provision ask a higher price for fast charging.** They do this even though a high price is one of the main drivers for not choosing a charging option. However, the main reason for (fast) charging at highway service stations (cf. blue and red bars in Figure 8) is "charging is fast", thus price is not a dealbreaker.
2. **Utility companies (EnBW, Maingau) leverage their existing customer base** (and indirectly their brand strength) and offer special rates for house electricity customers (10 ct cheaper per kWh). This step is well in line with user preferences. As shown in Figure 9, a majority of current and potential EV drivers considers this an attractive or very attractive option.

3. **New to the industry firms leverage their brand strength to enter the market.** Deutsche Telekom, originating from the telecommunications industry, has entered the market with an aggressive price policy in December 2018 [69]. This approach is easily comprehensible: The differentiation between EMSP apps is marginal and, more importantly, switching costs are extremely low (= downloading and setting up another app). In this case, consumers are generally open to trying new service providers – even if the tariffs are similar. Telekom's brand strength thus could explain the price difference to Maingau, another "discount EMSP" (29 ct vs. 25 ct).
4. **Selling below cost is not sustainable.** Both Deutsche Telekom and Maingau have (at least partially) raised their prices in the past year [70][71]. As both companies only have a limited network of fast charging stations or no fast charging stations at all (physical assets), their service provision heavily depends on (other) charge point operators. The price raise is an indicator that both "discount EMSP" have been selling below cost to gain market share.
5. **Sharp price distinctions reflect the power balance within the value network.** Both Ionity and Deutsche Telekom vary their pricing scheme depending on which other players are involved in the interaction. Ionity is asking a comparably high price, but offers special rates to drivers that use the EMSP service provided by the carmakers that jointly own Ionity (e.g. Audi e-tron Charging Service). [72] It seems that Ionity is using its bargaining power provided by brand strength and huge existing customer base to overcome the limited interest of users in billing models that involve the car manufacturer (cf. Figure 9). Deutsche Telekom, in turn, distinguishes the charging prices depending on the charging infrastructure that is being used. Fast charging stations by EnBW, for instance, are being classified as "other charging stations" and priced at 89 ct per kWh – more than twice the price that is asked for "preferred charging stations" (39 ct per kWh). [70] Most likely this is because EnBW, due to their own power position (resulting from physical assets: approaching 1000 fast charging locations), did not accept the prices that Deutsche Telekom asked for and/or because EnBW did not want to cannibalize their own EMSP service (offering fast charging at 39-49 ct per kWh).

5 Conclusion

This paper provides the theoretical background for understanding observed behavior of actors in the EV charging market. Key roles in this emerging mobility ecosystem are charge point operators (CPO), electric mobility service providers (EMSP) and location partners. These actors form a value network that is providing charging services to electric vehicle drivers. Each company involved in the network contributes different resources to the joint service provision: brand image, digital assets, physical assets. The cooperation and interaction of companies is presumed to affect both the quality of service provision and the power balance in the network. If service provision is matching the (target) users' preferences, it should positively affect customer satisfaction. The latter and the focal company's power position in the network are supposed to eventually impact business model profitability.

The theoretical framework and case studies presented above should only be considered a first step to a better understanding of market-driven business model design in emerging markets. Empirical research is needed to assess the actual relationship between resource configuration, user needs and business model profitability. This work can be used to define hypotheses for testing. Moreover, the user preferences outlined above are subject to change, especially when more mainstream customers (early adopters and early majority) switch to electric vehicles. Finally, for practitioners doing business in the EV charging space, the insights presented above can provide hints for business model development and/or adaption.

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