Synergy Unleashed - Creating an integrated electric vehicle charging service for drivers' seamless customer experience

Project Objectives

This project aims to improve the EV charging experience in the Netherlands due to the growing European EV market and rising BEV driver expectations. Despite standardization efforts, fragmented charging services developed in siloed business lead to user inconvenience. It is imperative to identify the reasons behind drivers' less-than-ideal customer experiences and address them to support the transition to electric cars. Thus, this study represents a collaboration between VanBerlo, TU Delft, and KAIST to address the initial question:

"What are the primary challenges and limitations experienced by Dutch BEV drivers that impede a seamless customer experience when using public charging infrastructure?"

Research Questions and Methods

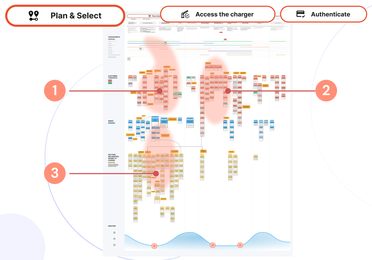
To address this, a literature review is first conducted. Two research gaps arise. First, empirical research concerning the entire user charging journey and service integration is lacking. Additionally, more influential factors should be identified while predicting user preference of charging decision. To bridge the gaps, **semi-structured interviews** is carried out to examine the journey from charging intent to completion and explore factors influencing driver decisions. **User pain points are clustered into a journey map**, revealing three main challenges hindering the seamless charging experience.

RQ 1. *"How can the BEV charging experience be optimized to provide seamlessness by considering a holistic view of the user journey, in terms of selecting, navigating to, authenticating at, and using public charging infrastructure, to address the challenges posed by the complex and fragmented charging sector?"*

RQ 2. *"What influential factors should be considered while predicting user preference of charging decision?"*

Three Challenges Hindering a Seamless Charging Journey

To answer the first research question, user pain points are clustered into a customer journey map, revealing three main challenges hindering the seamless charging experience: **Fragmented Information, Unpredictable Charger Availability, and Insufficient Context Awareness.**



RQ. 1

01 Fragmented Information
Users are required to cross-reference and overlay information to find a charging station that matches all their needs.

02 Unpredictable charger availability
Users need to guess charger availability and calculating the likelihood of accessing a functional charger with limited station information.

03 Insufficient context awareness
Users need to consider and process all the influential factors of their driving context to find a compatible, feasible, and hopefully workable charger manually.

Influential Factors in Charging Decision-Making: Four Key Categories

The Table in the right provides a clear distinction between the influential factors previously identified in the literature and the newly discovered factors in this research (highlighted in purple). Additionally, fundamental factors are documented at the bottom of the table. The details within each category are as follows:

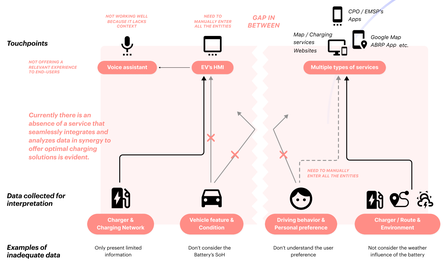
RQ. 2

THE CONCEPT

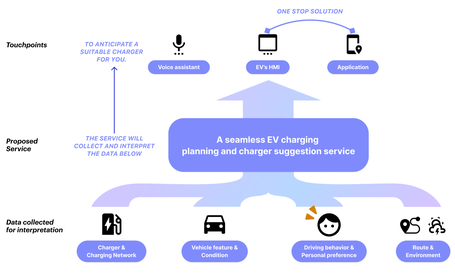
A Context-Aware Service Model Streamlining the Planning Phase of an EV Charging Journey

"How might we design an effortless planning phase that adapts to user needs and contextual factors, ensuring a seamless public charging experience for BEV drivers."

The Service Gap

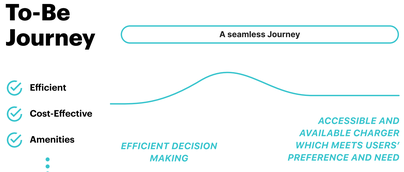


This Project Proposes



As-Is Journey

To-Be Journey



The Service & Design Guidelines

The Service

Follow the
Design Guidelines

Be aware of
Driver, Vehicle, and Environment Context

To present the
optimized and user-centric charging options.

Design Guidelines' Overview

Seamless & Integrated

1. One-stop solution
Offer a unified platform that enables users to seamlessly plan and complete their entire journey. This platform should establish a smooth connection between the vehicle and charger, manage authentication processes, and provide real-time charging status updates.

2. Seamless Platform Transition
Eliminate the need for users to manually cross-reference information between different platforms. Ensure effortless data exchange between portable devices and in-car Human-Machine Interface (HMI) to create a cohesive and uninterrupted user experience during platform transitions.

3. Automated Profile Syncing
Streamline the automatic synchronization of user preferences and profiles across various platforms, as detailed in the "User & Context Aware" Guideline.

User & Context-Aware

1. Ensure Charger Compatibility
Collect essential information such as the user's charging pass details and vehicle connector type to enable the system to efficiently present charger choices that are compatible with the user's setup.

2. Enhance Relevance of User Experience
Tailor comparative elements to align with the user's preferences, streamlining the decision-making process while preserving the user's autonomy. Recognizing that user perception and experience contribute to their expectations (Context-Aware Computing, n.d.), the system should store information from previous planning and charging sessions, calculate representative features (the influential factors), and compare them with the current context to actively provide relevant charger recommendations.

3. Account for External Influential Factors
Consider external variables such as weather conditions, route status, tariff rates, and other factors that can impact the state of charge (SoC) of vehicles and the user's preferences at the moment. Ensure that these elements are taken into account when making recommendations to the user.

Real-time & Adaptive

1. Real-time Information and Preparedness
Keep users informed about the outside world by providing continuous updates on available charging stations along their route. Maintain backup routes and charging locations in case of unexpected changes or station unavailability. Automatically suggest nearby charging options that align with user-defined criteria.

2. Personalized Alternative Solutions
Present tailored alternative routes and charging options based on the user's current driving behavior, in-car context (e.g., passengers), and other influencing factors (Ch. 3.4.3) at the moment. Still, it should empower users with the freedom and control to override historically recorded preferences when making decisions.

Insightful & Transparent

1. Offer Easily Understandable and Implementable Recommendations
Utilize real-time data derived from essential context, calculate relevant factors, and assist users in selecting the most suitable charging stations tailored to their specific circumstances. For example, the system can recommend the most time-efficient option by considering factors such as detour time, charging duration, and waiting time for the entire journey.

2. Offer Predictive Information
Predict the availability of charging stations upon arrival, taking into account factors such as the total number of available chargers, real-time traffic conditions, EV density in the region, and more.

3. Provide Clear and Comprehensive Instructions
Minimize unexpected surprises by offering transparent and detailed information about charging options, fees, regulations, and entrance procedures. This empowers users to make informed decisions and reduces concerns about additional costs.

Effortless & Intuitive

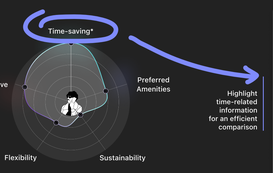
1. Effortless Charging Decision-Making
Employ proactive sensing and contextual analysis of the surroundings to predict and suggest appropriate chargers, reducing the need for manual settings and selections, particularly while driving.

2. Intuitive Interaction for Reducing Distraction
Implement a multi-modal interaction approach that provides both voice and visual assistance for navigation. Ensure that visual cues and other media elements remain non-distracting to enhance user safety and usability.

Understand Drivers' Preference of charging decisions

Dynamic preference of different trip

- *Basic : Available & Compatible Charger*
- *Waiting time & Detour time - Convenience of rerouting*
- *Cost - Charging and parking fee*
- *Preferred Amenities*
- *Flexibility - Alternative charger nearby, extra range upon arrival, accept a lower SoC in a familiar neighborhood.*
- *Sustainability - Battery health, Charging Network.*



Highlight time-related information for an efficient comparison

Only presented crucial data for drivers to understand the charging plan at a glance

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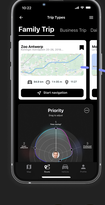
It should prioritize critical information based on the user's preferences for different attributes. Furthermore, it should be aware of the current driving context and external factors that may influence the recommendations.

For instance, consider the scenario where a driver called "Kevin" is driving with his family, including his two children. The system is aware that the kids have a preference for fast food, and Kevin values travel time as the top priority. Therefore, if Kevin requests a charging station along with a dining option, the system can suggest a nearby charger that involves minimal detour and waiting time, and also includes the kids' preferred fast-food restaurant."

Providing real-time updates on plan changes and offering corresponding alternative solutions. The generation of these alternatives should closely align with user preferences, ensuring the availability of information that can be quickly compared.

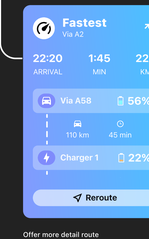


Facilitate a smooth trip planning across platforms

Adapt the information card context and information hierarchy based on human's preference.

Let's meet Sophia, another BEV drivers who cares sustainability the most.

Use the color platte to help users understand the estimated waiting time is increasing ro decreasing.



Offer more detail route overview to make each step transparent and clear.

Each route's information card prioritizes green energy consumption, keeping in mind users' time preferences. Supplementary details such as pricing are conveniently displayed on the map for swift reference.

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Design for Interaction I Master of Science
Industrial Design Engineering

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