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In-Car Interface Design to Support Electric Taxi Drivers' Charging Decisions

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Abstract

As battery electric vehicles (BEVs) become increasingly used, electric taxi (e-taxi) drivers face challenges with frequent fast charging during work shifts. This paper explores how in-car interfaces can support efficient charging. Through user-centered research, including interviews, surveys, prototyping, and evaluations, eight design recommendations were developed to improve clarity, reduce cognitive load, and provide contextual guidance with fast charging.

CCS Concepts

• **Human-centered computing → Human computer interaction (HCI)**.

Keywords

electric vehicle, infotainment system, electric taxi, electric battery

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1 Overview

Battery charging remains a central challenge in the adoption of electric taxis (e-taxi), primarily due to their limited range. This leads to frequent charging needs and extended charging durations [3]. Various solutions, such as proactive partial charging [2] and optimal charging station placement [1], focus on systemic improvements rather than in-car infotainment support. This study investigates how infotainment systems can better support e-taxi drivers in planning and managing charging, addressing the research question: *What design improvements and recommendations can enhance drivers' understanding of the e-taxi charging process?*

2 Method and Findings

We adopted an iterative prototyping process, which started with an exploration phase, in which we conducted a pre-study, followed by interviews with 18 e-taxi drivers, interviews with 2 technical experts, and a survey with 54 battery electric vehicle (BEV) drivers ("BEV" refers to fully electric vehicles that rely solely on battery power). The data was analyzed through thematic analysis, affinity mapping, and descriptive statistical analysis. The findings revealed that e-taxi drivers face uncertainty and inefficiencies during charging due to a lack of clear, real-time information, with key pain points including unpredictable charging speeds, unclear preconditioning status (i.e., preparing the battery to an optimal temperature for efficient charging), and limited system feedback, impacting both workflow and user confidence. The collected data was used to build personas, user journey maps, and user requirements. Thereafter, we conducted three iterative prototyping rounds of infotainment concepts, evaluated through usability testing and focus groups involving both e-taxi and private BEV drivers. In total, there were 25 participants (9 female, 16 male), aged 25–63, including engineers, e-taxi drivers, and interaction design students with varied BEV experience and fast charging habits. Interaction design students were included not only as emerging UX practitioners, but also because their BEV experience allowed them to contribute both end-user and design perspectives. The final concepts included visualizing the charging curve while charging (see Figure 1), presenting information on the vehicle's charging capacity before and during charging, and allowing manual preconditioning. Although the final solution is designed to be compatible with any car model, this study uses the Volvo EX30's center stack display (CSD), along with its associated design guidelines and components, as a reference example to visualize the final concept.

Through a thematic analysis of the data collected, eight design recommendations emerged. **R1:** Provide transparent, contextual messaging to explain charging behavior; this clarifies variations in charging performance, aiding user understanding and trust. **R2:** Frame charging as a dynamic process; this helps users interpret

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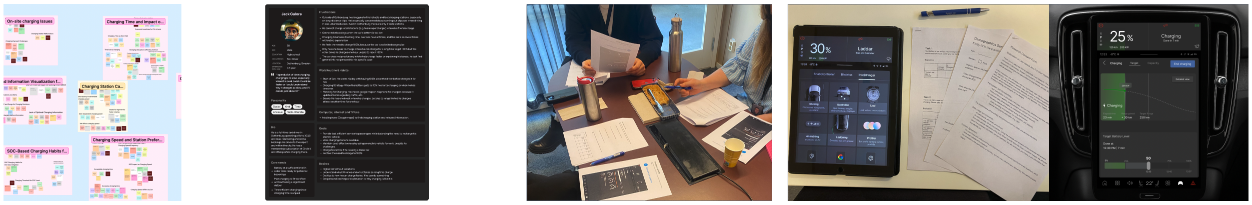

Affinity map **Persona** **Focus Group** **Usability Test** **Final Prototype**

Figure 1: Design stages of in-car charging visualizations

variations as normal results of SOC, temperature, and station conditions. **R3:** Prioritize key charging metrics; this reduces cognitive load with simplified, structured data presentation. **R4:** Give clear feedback on user actions; this reinforces learning and supports informed experimentation. **R5:** Use standardized icons and metrics; this reduces ambiguity, frustration, and improves consistency across systems. **R6:** Include historic, real-time, and forecasted data; this provides temporal context to help users understand charging trends. **R7:** Allow flexible data access; this supports different user needs and contexts through toggles or layered data views. **R8:** The interface should provide flexibility and information access; this allows users to tailor the interface to their needs by toggling between basic and detailed information.

Future work: The primary limitation of the study is that the majority of participants were male and from one city. Future work should evaluate the design in real-world scenarios with more diverse driver groups and explore its relevance for private BEV drivers across different regions and contexts.

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