A BEHAVIORAL APPROACH TO ENERGY-EFFICIENT DRIVING

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Introduction

The increase of energy efficiency and reduction of greenhouse gas emissions have become important targets of EU initiatives (European Commission 2014). Emissions from personal vehicles are a key cause of worldwide greenhouse gas emissions with 90% of personal transport emissions being caused by private vehicles (Barkenbus 2010). Energy efficient driving techniques, or eco-driving, can realize energy savings up to 20% (Stillwater et al. 2012). Combined with behavioral approaches, which are increasingly being used by governments (Cabinet Office 2012), these techniques represent a promising way to increase energy efficiency in the transport sector. Yet, practical solutions which are based on scientific findings are scarce. Since mobile apps are versatile in their functionality, characterized by a short time to market and low costs, they can represent a solution. The research question therefore is: How can a mobile application contribute to energy-efficient driving?

Theoretical Background

Eco-driving techniques include smooth acceleration and deceleration, maintaining steady speeds, coasting to a stop, driving in proper gear and keeping the vehicle in good maintenance (Neumann et al. 2014). Persuasive behavioral elements are user interface elements employed to influence behavior. Originating in game design, they are being applied in the real world as well. Mechanisms include scoring systems, badges, rankings (Blohm, Leimeister 2013) and goal-setting (Loock et al. 2013).

Research Method

To determine how an information system can be used effectively to increase energy efficiency in transportation, the design science research method was employed, backed by a literature review and market research. The key criterion of design research is that its technology output must be a useful artifact in the sense that it must be relevant to the practical problem it aims to solve and should contribute to theory (Hevner et al. 2004). This was ensured by an extensive literature and market research that resulted in literature grounded design criteria and is demonstrated by a proof-of-concept prototype.

Eco-driving Design Criteria

Based on the literature review in the fields of energy-efficient driving, behavioral mechanisms and persuasive technology, the criteria for the development of an eco-driving app were derived. The market research was conducted to build on existing solutions and to avoid reinventing existing approaches.

Criteria (software requirement)	Source	How it can be implemented
High context feedback	Tulusan et al. 2012	Provide immediate feedback to convey the connection between driving behavior and energy consumption impact.
Goal setting	Loock et al. 2013; Stillwater, Kurani 2012	Let the driver define their own consumption goals to increase energy savings.
Support electric vehicle use / fight range anxiety	Franke, Krems 2013	Increase awareness of eco-driving as a way to increase range and save energy, build range confidence using driving logs and simulations, create transparency about range requirements, recommend ideal electric vehicle models and suggest behavioral adaptations to make electric vehicle use feasible.
Social pressure/ normative feedback	Loock et al. 2013	Compare energy saving performance to other drivers and employ gamification elements.

Table 1: Design criteria for fostering energy-efficient driving (excerpt).

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The criteria identified for fostering energy efficiency using a mobile app are shown in Table 1 and include high context feedback, goal-setting, supporting electric vehicle use and applying social pressure to influence driver behavior. For electric vehicles driving efficiency is an enabler due to the limited energy supply available to the driver. In addition, eco-driving has a positive effect on the attractiveness of electric vehicles which suffer from lower range: Since energy-efficient driving increases the distance that can be driven electrically, it reduces required battery capacity and consequently vehicle purchasing costs. The market research revealed that there is a lack of applications promoting both energy efficient driving and the use of electric vehicles.

Discussion & Conclusion

Based on a thorough evaluation of literature and available technology on the market, a framework for a mobile application to support eco-driving was created which includes high context feedback, goal setting, electric vehicle use and social pressure. The proof-of-concept prototype serves to demonstrate and validate the design criteria. There are however limitations to the research conducted, including the lack of user experiments and determination of realizable energy economies. Yet, the findings represent a high value for science, as the systematic literature based assessment of design criteria can be the basis for further research on the relative impact of the criteria. The results possess a high value for practice as well, such as for vehicle manufacturers and utilities, since the research revealed that mobile solutions encompassing both aspects of energy efficiency and electric vehicle adoption are very promising, but have not yet been marketed.

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