Adoption of Sustainable Technologies: A concept of Smart Vehicles

Masterarbeit

zur Erlangung des akademischen Grades „Master of Science (M. Sc.)" im
Studiengang Wirtschaftswissenschaft der Wirtschaftswissenschaftlichen Fakultät der
Leibniz Universität Hannover.

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Hannover, den 29.09.2020*

*(Abgabedatum)

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1 Introduction and Motivation

Regarding fossil fuel scarcity (Lopes et al. 2010, p. 168), increasing environmental uncertainties and recent scandals regarding CO_2 emissions (Grée et al. 2020, p. 1) it is very likely that electric vehicles will gain more and more importance in the automotive as well as the power industry. A KPMG report (EQ International, 2017) mentioned that electric vehicles will make up between 11-15% of new vehicle sales in the EU und China by 2025. Furthermore, several Original Equipment Manufacturers (OEM) like Volkswagen and Volvo already stated that they will introduce new electric vehicle varieties within the next years.

Since most residentially used vehicles are parked for approximately 15 hours per day right by the house (Cvetkovic et al. 2009, p. 2675), green energy production and saving can be started right at people's residences. Especially equipped with the vehicle-to-grid technology and its possible connection to a smart home, an electric vehicle can smartly save energy. Therefore, an electric vehicle equipped with vehicle-to-grid technology and connected to a smart home is considered a smart vehicle in this paper. Still, due to range anxiety and relatively high adoption costs, the diffusion of electric vehicles and therefore of smart vehicles is relatively low (Adepetu and Keshav, 2017, pp. 353-354).

In order to promote smart vehicles all over the world, it is important to assess the factors that are salient for the intention to adopt. As of the latest report from the United Nations (UNEP, 2019), emissions need to be reduced in order to limit global warming to beneath 2°C by 2030. Especially fossil CO_2 dominates the total greenhouse gas emissions. Analyzing individual`s intention to adopt emission-free vehicles or other emission-free appliances might help policy makers to adjust special policies that encourage individuals to adopt green technologies. Furthermore, possible impacts of cultural differences between countries need to be assessed and interpreted in order to have more meaningful and worldwide results. This might give insights to culturally inherited factors that have an impact on individuals' general adoption behavior and might show patterns. Accordingly, this study focuses on answering the following two research questions:

What are the salient factors that affect the intention to adopt smart vehicles?

and

Do cultural differences moderate the relationship between salient factors and the intention to adopt?

The structure of this paper is organized as follows. At first, the second chapter provides general information about smart vehicles in general and the technology behind it. Further on, the applied research model, the so-called STARS research model is introduced and explained. Referring to a research suggestion from Wunderlich et al. (2019), while answering the two research questions the applicability of the STARS research model on other energy efficient innovations is examined. Further on, the six cultural dimensions by Hofstede et al. (2010) will be presented. Overall, insights on current literature as well as future trends are listed within these chapters. In the third chapter, hypotheses are developed and their underlying conceptual models are presented. Chapter four deals with the overall research methodology and the collection of data. Chapter five summarizes the results of the quantitative cross-cultural analysis. The outcoming results are then discussed in chapter six and possible implications are named. The next chapter reviews the study and its implications critically and formulates further research opportunities. Finally, the research is summarized and findings are highlighted in the last chapter.

2 Theoretical Background

The theoretical background provides an important overview on the researched technologies as well as theories and models used for the conducted survey. It is divided in three parts: smart vehicles, STARS research model and the cultural dimensions by Hofstede et al. (2010). The first and the last part both include a literature review for further research.

2.1 Smart Vehicles

In this paper, smart vehicles are defined as vehicles that drive electrically and are equipped with a technology that allows electricity to flow in both directions - from grid to vehicle and from vehicle to grid (Brandt et al. 2013, p. 1668). Smart is hereby referring to the climate neutral usage of electricity – with low or zero emission (O´Connor and Jacobs, 2017, p. 1) as well as to its applicability to a smart home as a useful tool for energy storage (Mültin et al. 2012, pp. 1-3). The energy flow in both directions is known as Vehicle-to-Grid (V2G) technology. The V2G technology makes it possible for the vehicle to feed energy back into the electricity grid when the demand of the end-users are saturated and thus creates a bi-directional power flow (Brandt et al. 2013, p. 1669). Furthermore, it ensures the reliability of electrical power systems by supplying additional energy stored in one or more smart vehicles at peak hours which prevent building more power plants (Gurkaynak and Khaligh, 2009, p. 2086). The basic functioning of a smart vehicle is to charge when it is empty and to discharge and feed

a pandemic changes cultures or even the attitude of some individuals. For future research, it is therefore suggested to evaluate possible changes in the future regarding the effects of culture on people's behavior and examine if these cultural changes change the salient factors that influence the intention to adopt sustainable technologies and overall gain further insights. Furthermore, the existing literature on the moderating effect of culture either described suggestions about what possible outcomes can be achieved or measured only the moderating effect of some of the six cultural dimensions. In addition, due to its novelty, there are no other papers testing the STARS model at all or the effect of culture on it. This represents an indication for future research as well.

Finally, as already noted in chapter 6 (Discussion), the interaction between some of the cultural dimensions derived from Hofstede et al. (2010) demonstrate another limitation especially regarding the moderation conducted with only one cultural dimension as moderator at a time. In future research, the explained approach by Miles and Shevlin (2001, pp. 173-174) might indicate another research opportunity.

Another limitation might be the usage of the STARS model itself. Since the research model is based on interviews from German citizens, it might be the right fit for the German sample, but not for the sample from China or from the United States. This needs to be assessed by conducting other samples from different countries and compare them.

8 Conclusion

The aim of this paper was to identify factors that influence the intention to adopt smart vehicles across three countries – China, Germany and the United States. For that matter, the STARS research model introduced by Wunderlich et al. (2019) was used due to its focus on possible important factors for household adoption. Furthermore, it was analyzed if the cultural dimensions derived from Hofstede et al. (2010) moderate the relationship between the constructs of the STARS model and the intention to adopt, which was done by conducting a moderation. All findings are based on the data of a survey conducted in all three countries of interest and resulting in 436 participants. The results show that especially the motivational variables, namely attitude, internal PLOC and introjected PLOC affected the intention to adopt smart vehicles. The positive effect of introjected PLOC is surprising but in line with the findings of Wunderlich et al. (2019, p. 684). The moderation lead to few significant results with an overall low explanatory power.

To better justify the results, some limitations were named. Especially the composition of the survey needs to be assessed critically, since the samples consist of mostly

young, educated and female participants. The samples are therefore proposed to be used to compare the younger population in China, Germany and the United States with each other.

Since the STARS model has proven its applicability to other energy efficient household applications, it is suggested for future research to use the model in order to consolidate the results found in this study. Moreover, due to insignificance of findings regarding the moderating effect of cultural dimensions on the salient factors, it is suggested to do further research with respect to other cultural approaches.

As mentioned in the introduction, the protection of the global climate is important. This study sought to research and interpret salient factors for smart vehicle adoption, in order to give policy implications. Furthermore, cultural differences were assessed to detect patterns in cultural adoption of sustainable technologies and to find out suitable policies for each country. The discovered results which point out the importance of especially intrinsic motivations on the intention to adopt cause the following policy implications. External PLOC, which corresponds to financial incentives might no longer be reasonable according to these findings. Intrinsic motivations might be achieved through education and knowledge especially about the climatic and individual benefits deriving from the use of smart vehicles. Still, some limitations regarding the sample exist and made a statement for the whole population of each country difficult the following approach is suggested. Future research needs to further evaluate factors that influence the intention to adopt sustainable technologies in order to make meaningful statements regarding policy interventions for the sake of protecting the environment for future generations.