
Sustainable Measures of Micro-Mobility for Mobility Sector Changes

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Table of Contents

- List of Abbreviations.....I
- List of Figures.....II
- List of Tables..... III
- 1 Introduction.....1**
- 2 Classification and delimitation of micro mobility.....2**
 - 2.1 Urban mobility.....2
 - 2.2 Mobility-Sector-Change6
 - 2.3 Electromobility.....8
 - 2.4 Micro mobility.....11
- 3 Potential Micro mobility vehicles16**
 - 3.1 Bicycles and Pedelecs18
 - 3.2 Electric Scooters.....21
 - 3.3 Electric-Kick-Scooters.....23
- 4 Literature Review.....25**
 - 4.1 Search criteria and identifying of relevant literature.....25
 - 4.2 Development of current research fields.....27
 - 4.2.1 Business Model.....27
 - 4.2.2 Infrastructure.....33
 - 4.2.3 Sustainability.....37
 - 4.2.4 Acceptance.....38
 - 4.2.5 Safety38
 - 4.3 Concept matrix40
- 5 Methodical procedure of Expert Interviews43**
- 6 Result evaluation on the basis of the Literature Review and Expert Interviews.....45**
 - 6.1 Business Models.....46
 - 6.1.1 Sharing Economy47
 - 6.1.2 Private Ownership.....50
 - 6.1.3 Employee Mobility.....52
 - 6.1.4 Cooperation.....53
 - 6.2 Infrastructure.....55
 - 6.2.1 Charging Infrastructure.....56
 - 6.2.2 Traffic Infrastructure.....57
 - 6.2.3 Traffic Infrastructure Routes.....57
 - 6.2.4 Mobility Hubs.....58
 - 6.2.5 Digital Infrastructure.....60
 - 6.3 Sustainability.....61
 - 6.4 Acceptance.....63

6.5 Safety.....	65
7 Interim Conclusion.....	67
8 SWOT analysis including the PESTEL approach.....	69
8.1 Internal Analysis.....	70
8.2 External Analysis.....	73
9 Recommendations for German Automotive Manufactures.....	82
10 Limitations and Outlook.....	83
11 Conclusion.....	84
References.....	86
Appendix.....	103

1. Introduction

„If you care about climate change, you should care about micro mobility” is a quotation of Bruce (2019) which calls attention to the importance of reducing emissions and combating the climate change. The environmental pollution caused by CO₂ emissions intensifies the need for alternative driving engines and stimulates the partial shift to e-mobility. A complete replacement of conventional cars by e-mobility cars is not sufficient to solve all urban mobility problems. Urbanization and low capacity utilization of cars are accountable for traffic jams and the shortage of parking space (cf. Bauer et al, 2017). This powers the discussions about the usefulness of cars. The requirements for cities are getting stricter in connection with social change and digitalization. Especially the development of urban mobility is considered a difficult challenge in the future (cf. Mitteregger et al., 2020). A proved positive relationship between the mobility-sector-change and climate change indicates new mobility concepts as indispensable. Urban places offer a high potential of technologically innovative developments and are particularly suitable for mobility-sector-change realization (cf. VCÖ, 2019). More and more cities are aware of the importance of alternative mobility concepts and agree with the goal of empowering the local alternative mobility (cf. Agora Verkehrswende 2019).

Micro mobility is considered as a great mobility solution, due to the high climate-friendly potential. Especially urban places are suitable for micro mobility concepts, because of the high importance of the first and last mile (cf. Bauer et al., 2017). The adoption of the German “Elektrokleinstfahrzeuge-Verordnung “(eKFV) in 2019 enables the legal use of light electronic vehicles like the e-kick-scooter in road traffic and thus leads to a milestone of micro mobility and offers new opportunities in future (cf. Agora Verkehrswende 2019).

Nevertheless, micro mobility needs a holistic concept for the right implementation. The current distribution of different business models and different micro mobility vehicles causes complexity and lack of transparency for the contribution to the mobility-sector-changes (cf. McKenzie, 2020). This paper concentrates on sustainable measures of micro mobility for mobility sector changes in Germany, which results in the research question:

Which measures have to be observed for a sustainable integration of micro mobility in order to support the mobility-sector-change in the long term?

To answer this question, the paper is structured into different parts. The first part deals with the classification and delimitation of micro mobility. Theoretical principles like urban mobility, mobility-sector-changes and electromobility give the important background knowledge for the derivation of micro mobility. In accordance with the definition of micro mobility, the following point describes three different micro mobility vehicles. Pedelecs, e-scooters and e-kick-scooters (EKS) are frequently-used vehicles with electronic motors. All vehicles are described and analyzed according to their potential that is being rated on the basis of the Urban Mobility

Index. The succeeding literature review is based on the approach of Webster and Watson. It analyzes different literature to develop holistic micro mobility concepts. In this paragraph, the development of current research fields concentrates on categories of business models, infrastructure, sustainability, acceptance and safety. A subdivision of business models and infrastructure into more detailed parts detects connections and conflicts for the sustainable integration of micro mobility. The literature review identifies research gaps and gives a graphical illustration of explored literature in form of a concept matrix. In the following, insights of the literature review are supplemented by practical expert knowledge in form of interviews. When discussing the methodical procedure of the expert interviews, the framework for the selection and analysis of interview transcriptions is being described. A selection of three experts of different organizations enables additional practical knowledge in addition to the literature review. The next part combines the results of the literature review and expert interviews in a mutual evaluation. On the basis of both methods, the evaluation discusses different measures of all predetermined categories. In addition to that, a section with an interim conclusion gives a short summary of the evaluation before starting the SWOT analysis extended by means of the PESTEL approach. The main unit in the SWOT analysis is characterized by the Original Equipped Manufactures (OEMs) which are essential for the German economy. In order to answer the research question, it is necessary to examine the measures for German OEMs which are required to enable a successful and sustainable implementation of micro mobility concepts. After the internal and external analyses follows a recommendation for German OEMs to identify a strategy for the implementation of micro mobility. Hereafter, possible limitations will be discussed before ending with the conclusion in the last point.

2. Classification and delimitation of micro mobility

Micro mobility is spreading especially in large cities. It is important to understand and classify the recent topic of mobility to comprehend the following paper. Regarding the research issue, there are some theoretical principles to put micro mobility into the right context.

Areas like urban mobility, sustainable mobility, electromobility and Mobility-Sector-Changes sound very similar to micro mobility but they are not equal. Moreover, all theoretical points are related to micro mobility. The next part shows the right delimitation and the complementary aspects of these principles. For the derivation of micro mobility, it is necessary to understand the topics urban mobility and electromobility.

2.1 Urban mobility:

In order to understand urban mobility, the definitions and connection of both words “urbanity” and “mobility” are needed.

easier to interpret statements and include the interview environment in the evaluation. All answers of the interviewees are subjective and can deliver a primarily positive or negative context. Especially the professional proximity of the interviewees to micro mobility can be very convincing and the negative sides can easily be neglected.

The third method of the SWOT analysis with the PESTEL approach deals with internal and external factors from the perspective of German OEMs. The SWOT analysis carried out in this paper offers much information with potential for the introduction of micro mobility, that could be used as a starting point. Nevertheless, the results are limited by the missing prioritization of the outcomes (cf. Helms et al., 2011). For a more precise recommendation, a more detailed analysis for every individual German OEM should be developed.

11 Conclusion

Today's rapidly increasing digitalization and urbanization is unstoppable. Together with social changes and the importance of climate change, a mobility sector change is indispensable. Micro mobility offers a potential solution as an alternative mobility concept. This leads to the research question, which measures have to be observed for a sustainable integration of micro mobility in order to support the mobility-sector-change in the long term, will be answered in the following.

The evaluation of three different research methods delivers measures of different categories for a long-term integration of micro mobility. Dependent upon the business model, there are different measures that result from the type of vehicle and their scope of action. The selection of the micro mobility vehicle and characteristics of a public or private mobility provider affect the acceptance by the society. Furthermore, micro mobility needs a high offer of different business models and vehicles to satisfy all mobility needs and support the multimodal mobility. Most business models only compete with each other when double structures with the same concept and vehicles are created in one place. Otherwise, many partial solutions support the holistic micro mobility integration.

An expansion of business models to employee mobility and other cooperations beside sharing systems and private sales increase the attention and potential customers. To improve the micro mobility for many target groups, a classification of each vehicle group is of high importance. A classification by different characteristics leads to more transparency and comparability. In combination with various distribution channels and the professional advice of experts, it is possible to create a better communication on safety behavior.

The transformation of controversial sharing systems into a hybrid system consisting of stations and free-floating parking solutions offers high potential for a better image of the city. Installed technical components like GPS and Geofencing can increase the safety for users and other road users in the future. Public providers, resulting from political goals on sustainability, have a great

cooperation with the political leaders of the city. In addition to that, every city should have the opportunity to decide between *Sondernutzung* und *Gemeingebrauch* for the implementation of micro mobility in dependence upon the image of the city.

A permanent renewal process of the infrastructure facilities support the introduction of micro mobility. Especially bicycle fast lanes and special lanes parallel to main roads with a micro mobility priority enable a safe handling of micro mobility vehicles. The dependence upon digitalization measures is a real chance for micro mobility. Mobile applications and the expansion of 5G simplify the access to micro mobility. Independent mobile applications have to combine the entire local multimodal mobility offer with other cultural offers by one registration and transformation process. Political financial support measures increase the chances for a micro mobility boom.

The biggest requirement micro mobility vehicles have is to avoid to be a substitute for a more environmentally friendly means of transport like walking. Cargo bikes and cargo systems provide a high future potential to be a real alternative for a combustion engine car.

German OEMs also contribute to a sustainable integration of micro mobility in combination with pushing the mobility-sector-change. A high market share in the car industry and the e-mobility development lead to advantages concerning the implementation of micro mobility. The use of strengths makes it possible to avoid market entry barriers. An important influencing factor is the sustainability of the whole product life cycle. It is important to use vehicles, which are much more sustainable than traditional cars. Investments of German OEMs and from the government in technological research and development are absolutely important in the future. In general, measures of the categories business model, infrastructure, acceptance, sustainability and safety are profoundly necessary for the integration of micro mobility. Yet, it is difficult to achieve measures without conflicts. An implementation of all measures requires time. The positive impact of the mobility-sector-change will be achieved if micro mobility is perceived as a whole alternative in comparison to traditional combustion vehicles. Micro mobility is still in its infancy in Germany. Increasing acceptance of the society and German OEMs leads to a faster integration. It is necessary to make an alternative vehicle out of an integrative vehicle when considering micro mobility. By each accomplished measure and sold vehicle the prospect of mobility-sector-change increases.