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Smart Mobility in Smart Cities: Chances and Challenges of Autonomous Passenger Transport

Matthias Rose², Sven-Jonas Tautz³, Max Leyerer⁴ and Michael H. Breitner⁵



¹ Copies or PDF file are available on request: Institut für Wirtschaftsinformatik, Leibniz Universität Hannover, Königsworther Platz 1, 30167 Hannover (www.iwi.uni-hannover.de).

² Student of Economics and Management at Leibniz Universität Hannover

³ Student of Economics and Management at Leibniz Universität Hannover

⁴ External Ph.D. Candidate, Leibniz Universität Hannover, Information Systems Institute, Hanover, Germany (leyerer@iwi.uni-hannover.de)

⁵ Full Professor for Information Systems and Business Administration and Head of Information Systems Institute, Leibniz Universität Hannover, Hanover, Germany (breitner@iwi.uni-hannover.de)

1 Introduction

Nearly four billion people worldwide are currently living in cities and this number rises continuously and at high rates (cf. WHO, 2016). Cities are therefore a fundamental element of human coexistence. They represent the social and economic centers of society, in which countless individual activities and various forms of interaction are concentrated in limited spaces creating highly complex systems. However, such an enormous concentration of private and public functions necessarily requires an effective interplay of individual tasks to configure efficient processes and to avoid confusion. In this context, the concept of smart cities has become a focus topic of scientific literature as well as international politics over the past. The aspect of mobility in urban areas has developed into one of the most prominent and frequently discussed fields of smart city research (cf. Mirri et al., 2016).

One reason is that cities are not only social and economic agglomerations, but their ecological importance also extends far beyond their own geographical boundaries. Cities account for 60 - 80% of global energy consumption and consequently also for a large proportion of greenhouse gas emissions (cf. UN, 2008). However, it is precisely from this perspective that urbanization also represents a great opportunity, as the increased concentration reduces unnecessary long transport distances. CO₂ emissions per capita are therefore demonstrably decreasing as urban density increases (cf. Hammer et al., 2011). In this context, the research objective of the paper is to describe the chances and challenges of smart mobility and especially autonomous passenger transport in urban areas, focused on the situation in Germany. To reduce the complexity and scope of the topic to an appropriate level, the analysis is limited to private mobility. In the first step, we present scenarios that are emerging from the developments in mobility according to the current state of knowledge, which concrete characteristics these scenarios reveal, and which technological developments they are based on. Particular attention is paid on autonomous driving, which is explained and assessed in detail as this paper progresses. After designing a scenario that is derived from the most important current trends in mobility in the context of smart cities, opportunities and challenges of autonomous passenger transport are then examined using Germany as the field of application. Due to the breadth of the topic, a multidimensional approach is applied. In the course of a structured analysis, namely the PESTEL analysis, the topic is examined from a political, economic, socio-cultural, technological, ecological and legal perspective to investigate the opportunities and risks for various actors and to derive recommendations for required actions. The findings are discussed and integrated to generate comprehensive conclusions regarding the long-term development of personal mobility solutions in urban areas in Germany.

comprehensive research. In the case of a different development, findings from the analysis may have to be adjusted accordingly.

Besides the described limitations, there are several recommendations to be given based on the conducted analysis. In general, the German government has several opportunities to promote autonomous passenger transport and smart cities by setting a proper environment for companies and individuals. First, the physical infrastructure (traffic signs, signaling systems, etc.) must be modernized to enable Car2Infrastructure communication. Therefore, high investments in information and communication systems are necessary.

Regarding the sustainability of passenger transport, electromobility can be one crucial element of the transformation. Besides the financial incentive of 4,000 euros at the purchase of an electric vehicle, the government must still support the use of renewable energy sources at power generation in the future. Only a low emission factor enables a truly eco-friendly mobility.

Regarding the legal dimension of autonomous driving, a concrete basis must be created as quickly as possible so that the questions of liability and dilemma situations can be clarified before the introduction of autonomous vehicles. If relevant issues remain unanswered, it can hinder companies at the technological development.

Further, the social dimension of autonomous passenger transport must be considered. The government must prepare for the situation where traditional jobs are no longer required, e.g., taxi or bus drivers. On the passenger side, existing concerns about safety and reliability must be addressed at an early stage.

In general, the technological development of autonomous vehicles can be supported by providing appropriate subsidies and funding projects. To conclude, several dimensions must be considered by the government to promote a successful and a holistic shift towards an autonomous passenger transport in smart cities.

5 Conclusions

The opportunities and challenges in autonomous passenger transport are very diverse and therefore require investigation from a variety of perspectives. This in turn requires a suitable method to be able to capture the topic's multidimensionality. For this reason, the PESTEL analysis was used in this paper as a methodical tool to illuminate the mobility of the future from the six different dimensions. The scenario constructed in chapter two was used as the foundation on which the later analysis was based on, so that in this work a holistic and detailed picture of a possible, realistic future would emerge. This was subjected to a critical analysis with the aim of highlighting the opportunities and challenges of autonomous passenger transport in smart cities on a political, economic, socio-cultural, technological, ecological and legal level, so that an outlook on future urban mobility in Germany can be provided.

Regarding the integration of intelligent mobility concepts into political objectives and plans, Germany is proving to be a promoter of the future mobility turnaround in an international comparison, even though there is room for improvement. However, the basis for the actual successive implementation of the technological prerequisites for autonomous transport is already being created at the highest level. This is necessary, since the digital infrastructure in Germany shows clear deficits in comparison to other pioneers in this field, especially regarding network coverage. The demand for car-sharing services in Germany is also limited, which is due to the very low acceptance of innovative mobility concepts. It is therefore important to present proposals for solutions to reduce existing uncertainties and fears, so that these do not represent an obstacle to their dissemination in the long term. One problem in the possible implementation of these concepts may be the legal provisions. The legal situation in Germany has not yet been adapted to the introduction of autonomous means of passenger transport. Here, a consistent and timely rethinking is necessary, so that the implementation of the already existing technological advantages (predominantly in the automotive industry) is not slowed down by missing regulatory adjustments. In the event of a consistent and holistic change in mobility, an immense economic potential can be revealed. These range from a much cheaper and more comfortable journey through efficiency and productivity gains with the new mobility offers, to a far-reaching change in the value-added network of the automotive industry. However, such value creation potentials should be approached cautiously and strategically, so that possible risks are minimized. On the other hand, only a few risks on the ecological dimension seem to exist in the course of the mobility turnaround. Only electromobility, which seems to be environmentally friendly at first glance, brings a few downsides that mainly affect developing and emerging countries. Computer-controlled transport, on the other hand, offers enormous potential for reducing emissions and the amount of space used, especially in cities. Thus, Germany can also send a significant signal about climate change mitigation by striving for a change in mobility.

Overall, it can be said that Germany is on a good to very good path towards integrating innovative and intelligent mobility concepts. Especially the supremacy in the automotive industry can be a decisive factor for a timely and successful realization of autonomous passenger transport with all its facets. However, there are risks that implementation will be delayed due to a lack of regulations, lengthy legislative procedures, and insufficient social awareness. Therefore, these obstacles are challenges that need to be addressed as quickly as possible to fully exploit the potential of autonomous passenger transport revealed by the different dimensions.