Introduction

Christine Eisenmann, Dennis Seibert, and Christian Winkler

Abstract This opening chapter provides an initial overview of the various topics covered in the book, which explores CAD's implications, focusing on societal acceptance and technology diffusion. Key areas include the impact of existing mobility systems on CAD adoption, policy frameworks, ride-hailing market potential, and public perception in Germany and Japan. Through modeling and empirical studies, the research examines CAD's effects on transport systems, car ownership, and travel demand. This Japanese-German collaboration highlights CAD's importance for both countries, given their advanced automotive industries and demographic challenges, offering insights for future research and policy development.

Connected and Automated Driving (CAD) technologies are expected to increasingly penetrate road transport in the next decades. CAD consists of two aspects: the first—"connected"—means vehicles communicate with each other (Vehicle-to-Vehicle or V2V communication), or with infrastructure (Vehicle-to-infrastructure, or V2I communication), such as traffic lights [3]. The second aspect—"automated"—is related to driving systems which—depending on automation level (see below)—take over some or all driving tasks. Vehicle connectivity and vehicle automation can develop independently. However, the combination contributes to unfolding the potential of this new technology in terms of safety, efficiency and comfort [2]. The combination of the two terms, and consequently the two technologies, leads to the designation "connected and automated driving", or CAD, and implies utilizing the benefits of putting these technologies together. Figure 1 illustrates the SAE Levels of Driving Automation that we refer to in this book as the automation levels.

The expected benefits of CAD are increased safety, smoother traffic flow [1, 5], and reduced congestion, with the possibility for drivers to engage in other activities en route, and to maintain accessibility in regions with low demand for public transport services, or ensuring mobility for people with mobility constraints [4, 5]. CAD has the

C. Eisenmann (✉) · D. Seibert · C. Winkler
German Aerospace Center (DLR), Institute of Transport Research, Berlin, Germany

D. Seibert
e-mail: dennis.seibert@dlr.de

C. Eisenmann et al. (eds.), *Acceptance and Diffusion of Connected and Automated Driving in Japan and Germany*, https://doi.org/10.1007/978-3-031-59876-0_1

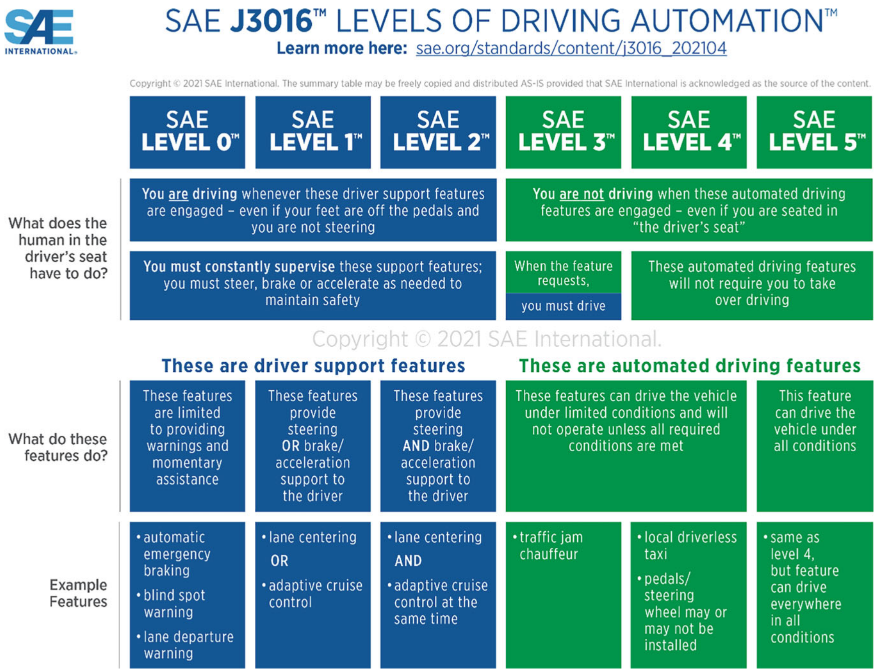

Fig. 1 SAE J3016 levels of driving automation. *Source* © SAE International from SAE J3016™ Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles (2021–04–30), https://saemobilus.sae.org/content/J3016_202104/

potential to change multiple dimensions of the transport system, ranging from altered patterns of car ownership, through the rise of new mobility services, to changes in traffic flow or even spatial structures. Far reaching socioeconomic impacts appear likely: Industrial production and value chains in the automotive and transport sectors may be affected substantially through the advent of CAD, not least because business models might change as new mobility services and players enter the scene.

The wide deployment of CAD depends on various factors: most significant are the rate of adoption and the rate of diffusion of CAD vehicles and services, as well as changes in individual travel patterns and collective travel demand that result from the availability and use of CAD technologies. The Japanese-German research collaboration which has resulted in this book has therefore addressed two closely interrelated issues of impact assessment, in order to: (1) understand factors that contribute to the perception, adoption or rejection of CAD, phenomena which are usually framed as part of "societal acceptance" in public and political discourses, and (2) understand, describe and model the diffusion of CAD technology.

The book addresses a range of aspects along the two overarching themes of **societal acceptance** and **technology diffusion**:

- Today, **framework conditions for travel** shape our mobility and travel behavior. It is to be expected that the existing mobility systems are key as to how CAD will be adopted in different geographic, demographic, cultural and economic contexts. A comprehensive analysis of existing framework conditions of the prevailing mobility systems in Germany and Japan and their likely impact on the adoption of CAD is presented in **chapter** "Setting the Scene for Automated Mobility: A Comparative Introduction to the Mobility Systems in Germany and Japan".
- One specific framework condition that relates to the development and deployment of automated driving technologies and services in both Japan and Germany are policy processes. **Chapter** "Governance, Policy and Regulation in the Field of Automated Driving: A focus on Japan and Germany" investigates in particular how the governance style relates to **regulatory changes and resource allocation** in the development of new technologies and innovations in the two societies.
- The **ride-hailing market** is expected to grow significantly alongside the advancements in automated driving technology. However, profitability analyses are scarce, owing to insufficient data relating to underlying cost structures. A holistic business analysis and prognosis of the ride-hailing market is, therefore, highly beneficial in the current discussion and is presented for Germany in **chapter** "Business Analysis and Prognosis Regarding the Shared Autonomous Vehicle Market in Germany".
- Research and policy agree that **acceptance of CAD** is key to its diffusion. Therefore, defining social acceptance and elaborating the relationships between the subjects and objects of acceptance in the context of automated driving is crucial to understand the full scope of the concept. **Chapter** "Social Acceptance of CAD in Japan and Germany: Conceptual Issues and Empirical Insights" presents this work, enriched by empirical insights from original quantitative surveys performed within the research collaboration. Additionally, the chapter discusses changes in attitudes towards CAD and explores how automated vehicles are covered in newspapers.
- It is undisputed that the **diffusion of CAD** will have major impacts on the transport system. **Chapter** "Transportation Effects of Connected and Automated Driving in Germany" investigates the effects of CAD on various parameters of the **German transport system** by means of three consecutive transport models. Among these parameters are the development of car ownership, the diffusion of automated vehicles in the passenger car fleet, and multiple transport demand variables. Modeling insights suggest that CAD per se will not be accompanied by favorable outcomes for the transport system.
- Transportation effects of CAD depend on the framework conditions of the prevailing mobility systems. Moreover, the effects of CAD may differ when applying different modelling approaches. **Chapter** "Transportation Effects of CAD in Japan" addresses the effects of the **diffusion of CAD** on the **Japanese transport system** by means of a modeling approach that differs from that used in **chapter** "Transportation Effects of Connected and Automated Driving in Germany". Modeling insights partially point in a similar direction to the results from the German modeling, but the Japanese analysis shows that enhancement

of consumer expectations will be crucial for ensuring the spread of automated vehicles.

- **Chapter** "Overall Comparison between Germany and Japan in Relation to Social Impact of Connected and Automated Driving" concludes with a summary of the research undertaken in chapters "Setting the Scene for Automated Mobility: A Comparative Introduction to the Mobility Systems in Germany and Japan–Transportation Effects of CAD in Japan", and outlines implications for future research about CAD and its role in an efficient and sustainable mobility system.

The present book is a result of the Japanese-German Research Co-operation on Connected and Automated Driving. Research on CAD is of high relevance for both countries due to several reasons. Both countries are characterized of a crucial role of the automotive industry for past and future growth and employment. Moreover, they represent prototypes of mature mobility markets that many emerging economies are likely to follow in the next decades. Japan is characterized by a mix of high urban densities with low car use and mountainous areas with a small population with high car use while Germany features medium density, medium sized cities and average European car use. Demographic change is ubiquitous in both countries implying challenges for current and future mobility systems.

On the German side, research was conducted within the CADIA project (Connected and Automated Driving: Impact Assessment, 2019–22) funded by the Federal Ministry of Education and Research. The three-year project was led by the Institute of Transport Research at the German Aerospace Center (DLR). Project partners were the Institute for Technology Assessment and System Analysis (ITAS) at the Karlsruhe Institute of Technology (KIT), the Chair and Institute of Urban and Transport Planning at the RWTH Aachen University, and the Bayerische Motoren Werke AG (BMW).

On the Japanese side, two research groups were involved in the collaboration. A collaborative research group from the University of Tokyo and Doshisha University on '*Study of Socioeconomic Impacts of Automated Driving Including Traffic Accident Reduction*' (JPNP18012) was commissioned by the New Energy and Industrial Technology Development Organization (NEDO), under the National R&D Program *SIP-adus* (Automated Driving for Universal Services, Strategic Innovation Promotion program) led by Japanese Cabinet Office (CAO). The research group led by Prof. Ayako Taniguchi at the University of Tsukuba, conducting empirical studies on social acceptance of automated driving from various angles, was supported by the Japan Society for the Promotion of Science (JSPS) KAKENHI Grant Number 20K20491.

Researchers from both countries developed a deep understanding of the two transport systems and the potential impact of CAD on these systems. Through close contact by means of virtual and physical meetings, conferences, and workshops ideas, the approaches, and results of the research conducted were discussed transparently. Meetings in Berlin and Kyoto contributed significantly to a better understanding of the research, but also to cultural and personal exchanges. This book represents the result of close cooperation between Germany and Japan. It shall contribute to the further joint research activities in the spirit of the close partnership between the two countries.

References

1. Beiker, S. A. (2015). Einführungsszenarien für höhergradig automatisierte Straßenfahrzeuge. In M. Maurer, C. J. Gerdes, B. Lenz, & H. Winner (Eds.), *Autonomes Fahren: Technische, rechtliche und gesellschaftliche Aspekte* (197–217). Springer.
2. e-mobil BW GmbH-Landesagentur für Elektromobilität und Brennstoffzellentechnologie, Prognos AG, Fraunhofer-Institut für Verkehrs- und Infrastruktursysteme IVI, TÜV Rheinland Consulting GmbH, & Technische Universität Berlin. (2015). *Automatisiert. Vernetzt. Elektrisch.: Potenziale innovativer Mobilitätslösungen für Baden-Württemberg.*
3. Gerpott, T. J. (2021). Connected Car. In T. Kollmann (Ed.), *Handbuch Digitale Wirtschaft* (pp. 1071–1089). Springer Gabler.
4. Lenz, B., & Fraedrich, E. (2015). Neue Mobilitätskonzepte und autonomes Fahren: Potenziale der Veränderung. In M. Maurer, C. J. Gerdes, B. Lenz, & H. Winner (Eds.), *Autonomes Fahren: Technische, rechtliche und gesellschaftliche Aspekte* (pp. 175–195). Springer.
5. Schreurs, M. A., & Steuwer, S. D. (2015). Autonomous Driving - Political, Legal, Social, and Sustainability Dimensions. In M. Maurer, C. J. Gerdes, B. Lenz, & H. Winner (Eds.), *Autonomes Fahren: Technische, rechtliche und gesellschaftliche Aspekte* (pp. 151–173). Springer.